Comparative analysis of Zero-Tillage and Conventional Tillage practices in the Amahlathi Local Municipality of the Eastern Cape Province of South Africa

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Masters Degree in Agricultural Economics

Submitted to the Department of Agricultural Economics and Extension,

University of Fort Hare, Alice

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June 2017

DECLARATION

I hereby certify that this dissertation is my own original work and has not been previously submitted to any other university for the purpose of a degree. Where use has been made of the work of others, such work has been duly acknowledged in this text.

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DEDICATION

This dissertation is dedicated to my parents Mr Gizenga Gomo and Mrs Ntomboxolo Gomo, my brothers and sisters and the late Athenkosi Dana, who have been my pillar of strength and for being the reason I have been working hard throughout my life to achieve the best and to be the best I know I can be.

ACKNOWLEDGEMENTS

I wish to convey my heartfelt appreciation to the Almighty, for granting me the opportunity and strength to complete this study and I would like to express my gratitude to the people that contributed to the completion of this research work.

- To my supervisor Professor Ajuruchukwu Obi for constant support and valuable guidance.

- To the local extension officers, particularly Mr Nqokweni, without them I would not have been able to collect the massive data presented in this dissertation.

- To the farmers for their full participation and the kindness they have displayed during my data collection.

- To my colleagues Mdoda Lelethu, Christian Mzuyanda, Tafa Sanelise, Ngcobo Lindiwe, Kambanje Adinesh and Siseko Sixologu for their unconditional support and encouragement throughout the research work, I want to say to them, South Africa needs more people like them.

- My parents Mr Gizenga Gomo and Mrs Ntomboxolo Gomo, brothers Zukisa, Msimelelo, Sikelela, and Sisikelelwe Gomo, and to my sisters, Osulwe, Zimkita and Mihle Gomo and my daughter Nikitha Gomo for every role they played in helping me to get where I am today. God blessed me with such a wonderful and very supportive family.

ABSTRACT

The current interest in zero tillage/no-till technologies is a result of the need to reduce excessive land degradation in most crop producing areas as well as to enhance sustainable food production. Farmers are always looking for ways to increase yields and profits and zero-tillage may be a way to achieve this goal. However, a systematic comparative study of the performance of zero-tillage and conventional tillage within the former homeland areas of the Eastern Cape Province is lacking. The broad objective of the study is to comparatively analyze zero tillage and conventional tillage and to determine which practice is more beneficial for the land and farmers in the area. Specifically, the study investigated the relative performance of Zero-tillage and conventional–tillage in terms of quantity produced per farm and per hectare, factors influencing the adoption rate of zero tillage and conventional tillage and to determine the relative impact of zero-tillage and conventional tillage on household income.

The study was carried out in Amahlathi Local Municipality in the Eastern Cape Province and employed survey data obtained from 100 respondents using conventional tillage and zero tillage farmers growing spinach, cabbage, beetroot, maize, and potatoes. The study employed a cross-sectional research design. A multistage stratified sampling procedure was used in which the first stage involved selecting respondents from Amahlathi Local Municipally. This was followed by the selection of villages and then the respondents. This was done through stratification of smallholder farmers from the different Villages. This was followed by random sampling which was used to get the sample size for the study. Stata and SPSS were used to analyze the data. Descriptive statistics was used to examine current farming practices in the Eastern Cape Province while Propensity Score Matching was employed to estimate the factors that had an impact on zero tillage adoption as well as the relative impact of zero tillage and conventional tillage on household income. Gross margin analysis was used to estimate profitability of zero tillage and conventional.

The descriptive statistics employed included means, frequencies and percentages on the socio-economic characteristics of farmers in the study area. The results show that

female farmers are participating more in zero tillage with 63.8% while males are dominating the conventional tillage with 51.6%. These results show that females play a crucial role in decision making when it comes to agriculture and adoption of new agricultural technologies. The majority of the farmers involved in the study were young farmers with 58% from zero tillage and 42% practically involved in conventional tillage. Moreover, the study showed that 41% of the respondents practising ZT were married, and about 39% of the respondents practising conventional tillage were married. The marital status of the respondents suggested that zero-tillage farmers were relatively stable in their farming activities as compared to conventional tillage.

The results presented that 52.2% of the respondents who practised zero tillage were better educated than the 48.4% of the respondents practising conventional tillage. The respondents that were specialising in zero-tillage, about 41% relied on farming, 6% relied on salaried income and 54% relied on social grants. On the other hand, respondents that were specialising in conventional tillage about, 26% relied on farming, 16% relied on salaried income, while 58% relied on social grants. The respondents that were specialising in zero-tillage, about 28% used communal land, 1% used own land and 71% used family land. On the other hand, respondents that were specialising in conventional tillage about, 42% used communal land, 7% use own land and 52% used family land. The average household size for both groups of farmers is 5 people per household. Household income distribution for conventional tillage is giving the farmers an average of R3187.10 income while the zero tillage is giving them an income of R2305.80 on average. The study revealed that the landholdings for conventional tillage agriculture tend to be more (1.77 ha) compared to zero tillage (0.79 ha) agriculture.

The Propensity Score Matching results indicated that participation in smallholder zero tillage farming contributes to household income. This implies that participating in zero tillage farming can contribute to rural livelihoods, increased income and production yields. The study results showed that households chose different farming systems based on their knowledge, level of education and farming experiences.

The gross margin results show that conventional tillage farming households generated more income than zero tillage farming households. Farmers who were involved in conventional tillage farming were complaining that yields and income have decreased with time and they are continuing to decrease while farmers who carried out zero tillage farming indicated that their yields and income have improved considerably and continue to increase with time. Thus, support for adopting and implementing zero tillage practices can be an important factor for improving incomes for rural households.

Based on the findings highlighted above, the study recommends provision of farm inputs and continuation of government support with more emphasis on strengthening access to inputs and technical assistance. There is a need for support programmes that would help to motivate farmers for better performance. The programmes include infrastructure developments, research and extension activities.

Key words: Smallholder farmers, zero tillage, conventional tillage, gross margin, Propensity Score Matching.

LIST OF ABBREVATIONS AND ACRONYMS

CA	Conservation Agriculture
CT	Conventional Tillage
EC	Eastern Cape
FAO	Food and Agricultural Organization
IANR	Institution of Agriculture and Natural Resources
ILO	International Labour Organization
STAT SA	Statistics South Africa
UNEP	United Nations Environment Programmes
ZT/NT	Zero-Tillage/No-Tillage
PSM	Propensity Score Matching
GM	Gross margin

TABLE OF CONTENTS

LISTS OF TABLES

LISTS OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background

Over the years, many significant agricultural changes have occurred in order to supply enough food for the growing human population (Dube, 2012). The changes have mainly been associated with using conventional tillage as the main agricultural operation since its introduction in South Africa in the late 1950s (Rensburg, 2010). Conventional agriculture is normally based on soil tillage as the main operation and the most widely known tool for this operation is the plough, which has become a symbol of agriculture which results in the most disruptive form of soil tillage, “inversion tillage, where literally the soil is turned upside down, leaving no soil cover and destroying the soil structure and soil properties (FAO, 2008).

Soil tillage has in the past been associated with increased fertility, which originated from the mineralization of soil nutrients as a consequence of soil tillage. This process leads in the long term to a reduction of soil organic matter and soil erosion. Soil organic matter not only provides nutrients for the crops, but it is also, above all else, a crucial element for the stabilization of the soil structure (Dube, 2012). Therefore, most soils degrade under prolonged intensive conventional agriculture. This structural degradation of the soil results in the formation of crusts and soil compaction and leads in the end to soil erosion and poor soil fertility (Dube, 2012). The process is dramatic under tropical climatic situations but can be noticed all over the world.

Wherever conventional tillage has been practiced, it has led to soil degradation and erosion. Hence it is considered as the main cause of landscape degradation and soil. Although farmers experience the soil erosion problems every day, the dust bowls which were experienced in the 1930s in America raised more attention to all farmers around the world (Osman, 2010). For that reason, farmers and agricultural researchers have

been looking for alternative tillage practices which are going to be sustainable and productive. Among all agricultural sustainable tillage practices, zero tillage has been found worthy of every farmer's recommendation (Osman, 2010). Zero tillage is said to have a potential to mitigate challenges faced by smallholder farmers such as drought, low production, labour scarcity, etc. (Derpsch, 2005; Du Toit & Mashano, 2010). In the early 1980s, the late W. Behr was the first farmer in South Africa to conduct no-tillage trials on a commercial farmer's maize, wheat and dry bean fields in the Lichtenburg region in an effort to investigate the feasibility of such a system on the growing conditions in the North West province (Du Toit, 2007).

In 1999, no-tillage, which is also known as zero-tillage, was adopted on about 45 million ha worldwide (Derpsch, 2010), growing to 72 million ha in 2003 (Benites *et al*., 2003) and to 105 million ha in 2009 (Rensburg, 2010). The fastest adoption rate has been experienced in South America where some countries are using zero-tillage on about 70% of the total cultivated area (Osman, 2010). Zero-tillage describes a form of cropping which does not use mechanical tillage of the soil for crop establishment. Hence, soil tillage can no longer be considered to be compatible with sustainable agriculture or zero-tillage and therefore the possible solution to address the threat of unsustainability of the agricultural soil resource base would include the avoidance of extensive conventional tillage method (Friedrich *et al*., 2012).

However, there have been contrasting ideas over the adoption of these tillage systems. Some farmers believe that zero-tillage is the panacea for the predicament of soil degradation. At the same time, other farmers, especially those who are risk averse believe that zero-tillage is equated with an abusively high use of herbicides (FAO, 2006).

Therefore, to clarify these contrasting ideas over Zero-tillage and Conventional tillage, it is important to take a deeper look into zero-tillage and conventional tillage systems. This is to find out, whether zero-tillage or conventional tillage is really the problem, or whether there are other associated problems.

1.2 Problem Statement

Soil is a limited natural resource and an important growth medium in crop production. Soils in South Africa are very susceptible to degradation and this is exacerbated by mismanagement and ignorance. In South Africa, a staggering 300-400 million tons of top soil is lost annually (Du Toit, 2007). Soils in many areas of the Eastern Cape (EC) province of South Africa where smallholder farming is practiced are prone to erosion and rapid degradation due to high levels of conventional tillage (Mandiringana *et al*, 2005). A South African national state of the environment report (Dube, 2012) identified the EC province as having the second highest level of land degradation. Hence the Eastern Cape Province is characterized by poor soil fertility, land degradation and excessive soil erosion accompanied by the formation of large gullies (Fanadzo *et al*., 2010). Poor soil fertility is a major problem causing low crop production in many areas of South Africa, including the Eastern Cape Province. This is also exacerbated by several unsustainable land management practices which are reducing both the quantity of yield and the soil quality (FAO, 2008; Dube, 2012).

By 1990's, poor agricultural practices had contributed to the degradation of 562 million hectares, about 38% of the roughly 1.5 billion hectares in cropland worldwide (Osman, 2010). Since 1990, losses have continued to mount year by year, with an additional 5 to 6 million hectares lost to severe soil degradation annually (Osman, 2010). Apart from poor soil fertility, weeds are a major problem causing low crop yields in smallholder farmlands of the EC (FAO, 2008).

According to FAO (2008), the majority of crop production systems in the Eastern Cape are subjected to intense and frequent ploughing practices, referred to as conventional tillage. However, zero-tillage is an aspect of sustainable agriculture, whereby emphasis is placed on decreasing the amount of soil disturbance and managing crop residues to protect the soil surface, soil fertility and nutritional content of the soil. There is vast literature and progammes confirming the potential of zero-tillage in improving the soil properties, thus having the positive impact on yield.

Government has initiated a number of programmes to encourage the adoption of zero-tillage amongst smallholder and large-scale farmers through extension agents. Despite these programmes, small-scale farming still has not improved (institution of Agriculture and Natural Science, 2016). While Government is still committed to improving small-scale farming and supporting small-scale farmers to acquire the necessary skills to participate productively in the economic life of their communities, there is little information regarding the appropriate policies that can improve small-scale farming and rural livelihoods (KZN, 2008).

Researchers and policy makers debate about which land preparation practice is more suitable and argue that zero-tillage has the same and even more negative effects on the soil and environment than conventional tillage (FAO, 2008). Researches results exist that confirm that zero tillage is more suitable. To date, socioeconomic studies done by research institutions focus on large scale operations and based on aggregated data. For small remote communities, such information is not available and is needed especially for small resource poor farmers hence the present study.

1.3 Objectives

The main objective of this study is to comparatively analyse zero tillage and conventional tillage and to determine which practice is more beneficial for the land and farmers. More specifically, the study will:

- Describe the farming practices used in the Eastern Cape Province.
- Determine the relative performance of Zero-tillage and conventional –tillage in terms of quantity produced per farm and per hectare.
- Determine the factors influencing the adoption of zero tillage and conventional tillage.
- Describe the relative impact of zero-tillage and conventional tillage on household income

1.4 Research Questions

1. Which are the farming practices used in the Eastern Cape Province?
2. What is the relative performance of zero-tillage and conventional –tillage in terms of quantity produced per farm and per hectare?
3. What are the factors influencing the adoption of zero tillage and conventional tillage?
4. What is the relative impact of zero tillage and conventional tillage on household income?

1.5 Hypothesis

In order to achieve the general objective of the study, the following specific hypothesis was tested:

 Zero tillage farming is more profitable as compared to conventional tillage in terms of crop quantity produced per farm and per hectare.

1.6 Significance of the study

This study is based on the premise that agriculture constitutes one key element, within a broad spectrum of strategies that can be adopted to reduce land degradation practices, restore and improve soil fertility and contribute to local economic development. The study will contribute to an already rich body of knowledge on the subject, and provide key lessons to policy makers and practitioners engaged in agricultural development in communal settings. These include national, provincial, and local governments, as well as non-governmental organizations. More specifically, the study should do the following:

 highlight lessons, from both positive and negative experiences, that can be drawn from previous and current government interventions in agricultural development in communal areas.

 provide better insights into the possible contribution that agriculture could realistically make in reducing land degradation in the rural contexts and within communal settings.

 evaluate the role of government and its agencies in stimulating agricultural development in rural areas.

1.7 Delimitations and limitations of the study

A study of this nature has a number of potential limitations. This study will concentrate on the small scale farmers, emerging farmer and the people from the surrounding communities only. The study will not cover all the villages in Amahlathi Local municipality areas due to the limited time and money. The study will concentrate on crop farmers (vegetable). And will only focus on farmers using conventional tillage and zero tillage farming systems.

1.8 Organization of the study

This study will consist of five chapters, which all begin with the introduction and end with a chapter summary. Chapter one provides an outline of the introduction, problem statement, objectives, research questions, significance of the study and limitations of the study. Chapter two reviews both global and national literature on land preparation practices such as zero-tillage and conventional tillage which can help to reduce land degradation and labour, increase yields and maximize profit. Chapter three provides the methodology of the study (description of study area, research design, sampling frame and procedure, data collection and unit of analysis and data analysis). Chapter four covers the statistical analysis of the collected observations, result and discussion. Chapter five covers the discussion, conclusion and recommendations

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Over the years, many significant agricultural changes have occurred in order to supply enough food for the growing human population (Dube, 2012). The changes have mainly been associated with using conventional tillage as the main agricultural operation since its introduction in South Africa in the late 1950s (Rensburg, 2010). Soils in South Africa are very susceptible to degradation and are exacerbated by intensive conventional tillage, mismanagement and ignorance. Soils in many areas of the Eastern Cape (EC) province of South Africa where smallholder farming is practiced are prone to erosion and rapid degradation due to high levels of conventional tillage (Mandiringana *et al*, 2005). This chapter will give a brief background on farming practices that are used in the Eastern Cape Province, followed by the relative performance of Zero-tillage and conventional –tillage in terms of quantity produced per farm and per hectare. We will further explore the factors that influence the adoption rate of zero tillage and conventional tillage and lastly explore the impact of zero tillage and conventional tillage on crop yields.

2.2 The farming practices used in Eastern Cape Province of South Africa

The concept of zero tillage is not entirely new to smallholder systems of South Africa (Dube, 2012). In the 1970's researchers tried to promote minimal tillage as an entry point to zero tillage in various provinces to address increasing land degradation problems but with limited success (Murungu, 2010). Soils in many areas of the Eastern Cape (EC) province of South Africa where smallholder farming is practiced are prone to erosion and rapid degradation due to high levels of conventional tillage practices (Mandiringana *et al.,* 2005). Soil tillage systems are the sequences of all operations involved in producing crops. The aim of tillage is to prepare the soil environment

favorable to plant growth (Baradi, 2009). Soil tillage consists of all operations for seed sowing which improves soil, and environmental conditions for seed germination to crop growth (Baradi, 2009). Tillage is the traditional method to control weeds. Generally, there are two types of tillage systems i.e. conventional, and conservation tillage systems.

Conventional tillage practices refer to the use of a moldboard or animal drawn plough to incorporate residue into the soil by extensive tillage (Osman, 2010). Conventional type can be divided into two types i.e. Mechanized, and traditional systems. According to Petros (2010) mechanized conventional tillage is the ancient method of farming in which the soil is prepared for planting by completely inverting it with a moldboard plough. Subsequent working of the soil with other implements is usually performed to smoothen the soil surface and leaves the soil surface bare. Traditional tillage system is mainly practiced in rural areas, West Africa, and South America. It is carried out by manual labour using native tools such as hand tools and animal drawn plough. The cutlass and hoe are main tools used in the traditional tillage system, (Osman, 2010). In a mechanized tillage systems, mechanical soil manipulation of an entire field is done by ploughing through one or more harrowing (Reicosky & Hanson, 2007).

Conservation tillage is a term used to describe a number of farming practices that are utilized in agriculture to conserve water and soil (Dube, 2012). Emphasis is placed on decreasing the amount of soil disturbance and managing crop residues to protect the soil surface. Conservation tillage practices include, amongst others, strip tillage, cover cropping, contour farming, zero tillage or chemical tillage, mulch tillage, and reduced tillage, with the ultimate being low disturbance zero till or direct seeding (Petros, 2010). Zero tillage is any system or practice which aims to conserve soil and water by using surface cover (mulch) to minimise runoff and erosion and improve the conditions for plant establishment and growth (Rensburg, 2002). It involves planting crops and pastures directly into land which is protected by mulch using minimum or no-tillage techniques (Bollinher, 2006). According to Osman (2010), zero tillage is a practice used in agriculture to reduce the effects of tillage on soil degradation, poor soil quality, soil

organic matter and erosion. Zero Tillage is one of the ways of conservation tillage, zero tillage and minimum tillage practices are the most efficient conservation practices adopted for the purposes of soil and water conservation and for the protection of the environment (FAO, 2008).

2.3 A brief overview of agriculture globally

By 1990's, poor agricultural practices had contributed to the degradation of 562 million hectares, about 38% of the roughly 1.5 billion hectares in cropland worldwide. Since 1990, losses have continued to mount year by year, with an additional 5 to 6 million hectares lost to severe soil degradation annually. Globally, some 20% of land (450,000 km2) is salt-affected, with 2,500–5,000 km2 of lost production every year as a result of land degradation which is a result of conventional tillage (UNEP, 2008). In South Asia, the annual economic loss is estimated at US$600 million for nutrient loss by erosion, and US$1,200 million from soil fertility depletion (UNEP, 2008). Sub-Saharan Africa is particularly impacted by land degradation. In Kenya, over the period 1981–2003, despite improvements in woodland and grassland, productivity declined across 40% of cropland (Baker *et al*, 2007). In South Africa, production decreased overall and 29% of the country suffered land degradation, including 41% of all cropland (Baker *et al*, 2007) and about 17 million people, or 38% of the South African population, depend on these degrading areas (Baker *et al*, 2007). In Sub-Saharan Africa it is much larger; in some countries productivity has declined in over 40% of the cropland area in two decades while population has doubled. Africa is perhaps the continent most severely impacted by land degradation (Nkala *et al.,* 2011), with the global average being lower, possibly in the range of 1–8%. Hence today's agricultural practices are aiming to increase food production through conventional tillage practices, but they have negative effects like: (i) soil surface depletion, (ii) ground water pollution, (iii) increasing cost of production, and (iv) their detrimental effects on the environment. Therefore it is of great importance to shift to sustainable practices that could keep land degradation and soil erosion to the minimum as possible as well as meeting the needs of the present populations and still leaves opportunities for the coming generation, (Tola, 2002).

2.4 A brief overview of agriculture in rural areas

The agriculture production system in the rural communities is complex and has developed under the influence of the climate, labour, economics, traditional beliefs, and the communal land tenure system (FAO, 2007). Due to maize being the staple diet, the crop planted is mainly maize while other crops, such as pumpkin, spinach, potatoes, are intercropped or rotated (Kidson, 2014). The method of planting varies from farmer to farmer and after the soils are ploughed the soil is smoothened over by the use of a hand hoe, leaving the soil bare, exposed to direct sunlight, vulnerable to wind and water erosion, resulting to reduced soil fertility and soil degradation. If fertilizer is used, it is generally animal manure and it is spread in the furrows and covered with a thin layer of soil and the seed is drooped in the furrow and covered with soil (Kidson, 2014).

Therefore fertilization of the crops on the traditionally planted fields is mostly with 'kraal' manure or a mixture of 'kraal' manure and chemical fertilizer (Jezile 2004). The nutritional value of the manure varies greatly due to the quality of the grazing, the bedding, whether the liquid excrement has been retained and the amount of leaching that has taken place in the kraal (Kidson, 2014). According to Jezile (2004) in a study conducted in the Eastern Cape Province, the nutritional content of the kraal manure varied considerably as shown in the Table 2.1 below. From the Table below, the nitrogen content varied between 1,4kg to 9kg per ton of manure (Jezile, 2004).

Table: 2. 1 Nutrient composition of kraal manure

Manure type	**Total Nitrogen kg ton^{-1}**	**Phosphorus kg ton^{-1}**	**Potassium kg ton^{-1}**
Manure scraped from kraal	4,5	2,7	4,1
Range of nutrients	1,4, to 9	0,3 to 5,8	0,9 to 9

Source: Kidson, (2014)

For the rural farmers to supply the recommended 200kg of 2:3:2 (22), two ton of manure per hectare would need to be applied (Gugino *et al*, 2009). Hence on the traditional plots, the applied quantity of manure was far below the recommended amount.

2.5 The relative performance of Zero-tillage and conventional –tillage in terms of quantity produced per farm and per hectare.

2.5.1 Crop yields and net farm income

It is important to recognize the effect that zero tillage has on two of the main aims of crop production, the optimization of yields and net farm income. Drawn from experiences across the globe, the Food and Agriculture Organization (2007) has drafted a theoretical representation to illustrate how these variables are affected in the first few years after adopting ZT. In Figure 2.1, yield is shown to decrease temporarily during the first phase after adoption, gradually increasing in phases two and three and more or less stabilizing in the fourth phase.

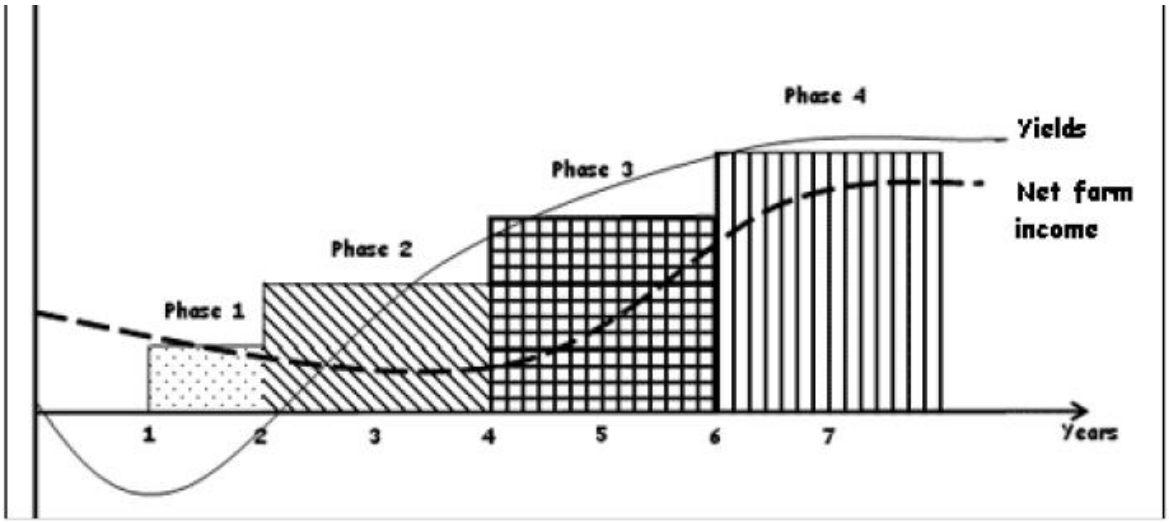

Figure: 2. 1 The transition phases of zero tillage adoption
Source: Adapted from Food and Agriculture Organization (2007)

Figure 2.1 illustrates the general trend in net farm income after ZT is adopted. In the first two phases, a marginal decrease in net farm income can be expected. Thereafter, an exponential increase in the third phase can be expected and a levelling off in the fourth

phase at a level higher than the initial starting point. According to Muscănescu, (2013) the initial decrease in yields and net farm income in the early stages of adoption can be largely attributed to two processes. The first process is that of familiarisation and adaptation on the farmer's part. Mistakes and inefficiencies occur inevitably in the early days, but, as time goes by, the farmer becomes more familiarised with the techniques, improves their practices and management, and learns from previous mistakes. Secondly zero-tillage restores the biophysical environment's natural balance (FAO, 2007). As the soil is not tilled as much anymore, several soil conditions (fertility, porosity and soil moisture content for example) are improved and this normally results in greater yields (Muscănescu, 2013). It must, however, be noted that Figure 2.1 only gives a general idea of what is normally expected to happen with regard to yields and net farm income and figure 2.2 below, it is expected to give us the following results:

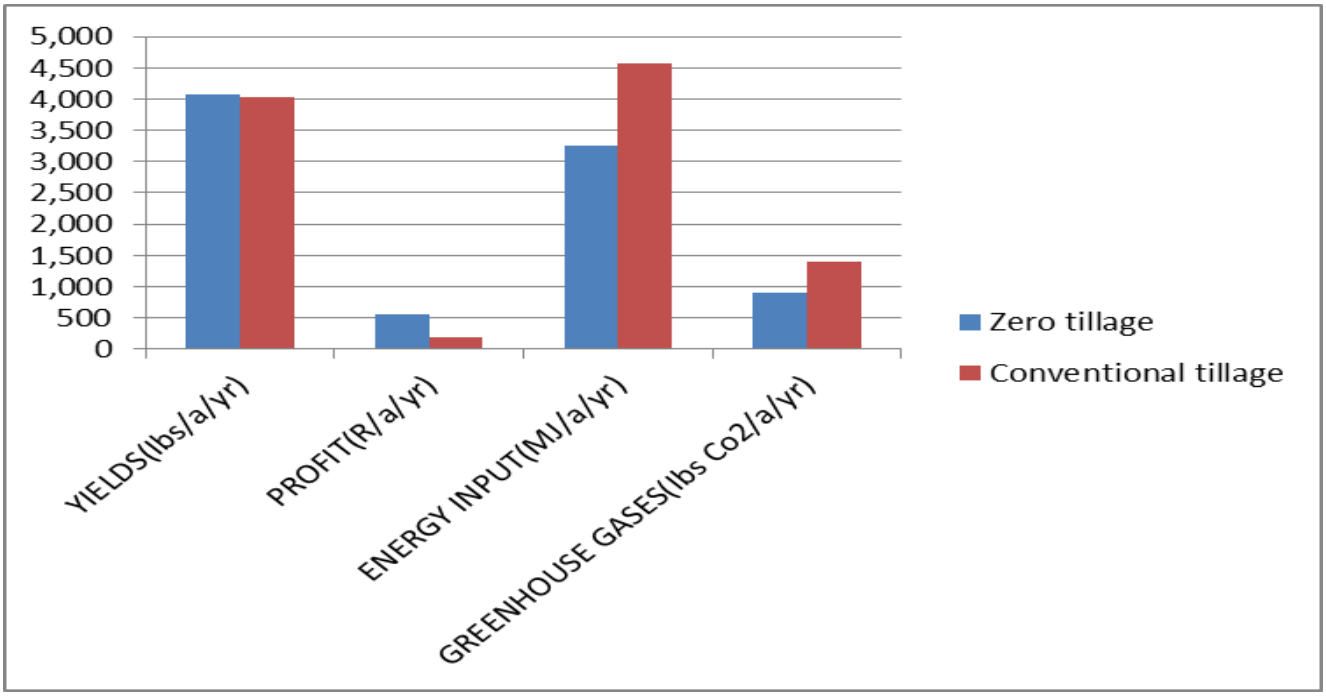

Figure: 2. 2 Zero tillage verses Conventional tillage
Source: Muscănescu, (2013)

The comparison in Figure 2.2 shows the following findings:

- There is a match between zero tillage and conventional tillage yields during the first two phases of zero tillage adoption

- The zero tillage system is a more sustainable system seeing as it builds, rather than depletes soil organic matter

- Zero tillage farming is more efficient due to the use of 45% less energy

- Conventional farming produces up to 40% more greenhouse gasses therefore they is a greater profitability in zero tillage farming then conventional tillage.

2.6. The adoption rate of zero and conventional tillage

2.6.1 Adoption decision process

There are an infinite number of factors, both internal and external to the farm, which affect a farmer's decision-making during the adoption of soil conservation technologies. The adoption of an innovation within a social system takes place through its adoption by individuals or groups. According to Petros, (2010) adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. Adoption, however, is not a permanent behavior.

Kidson, (2014) classified adoption as an individual (farm level) adoption and aggregate adoption. Adoption at the individual farmers' level is defined as the degree of use of new technology in long run equilibrium when the farmer has full information about the new technology and it's potential. In the context of aggregate adoption behavior, diffusion is defined as the spread of new technology within a region. This implies that aggregate adoption is measured by the aggregate level of specific new technology with a given geographical area or within the given population.

According to Rogers (2003) the innovation decision process is the process through which an individual or other decision making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to decision to adopt or reject, to

implementation of the decision, and to confirmation of this decision. This process consists of a series of actions and choices over time through which an individual or an organization evaluates a new idea and decides whether to incorporate the new idea in to ongoing practices. An individual's decision about innovation is not an instantaneous act, rather it is a process. Based on the innovation decision process conceptualization consists of five stages. Figure 2.3 presents the five stages in the decision innovation process.

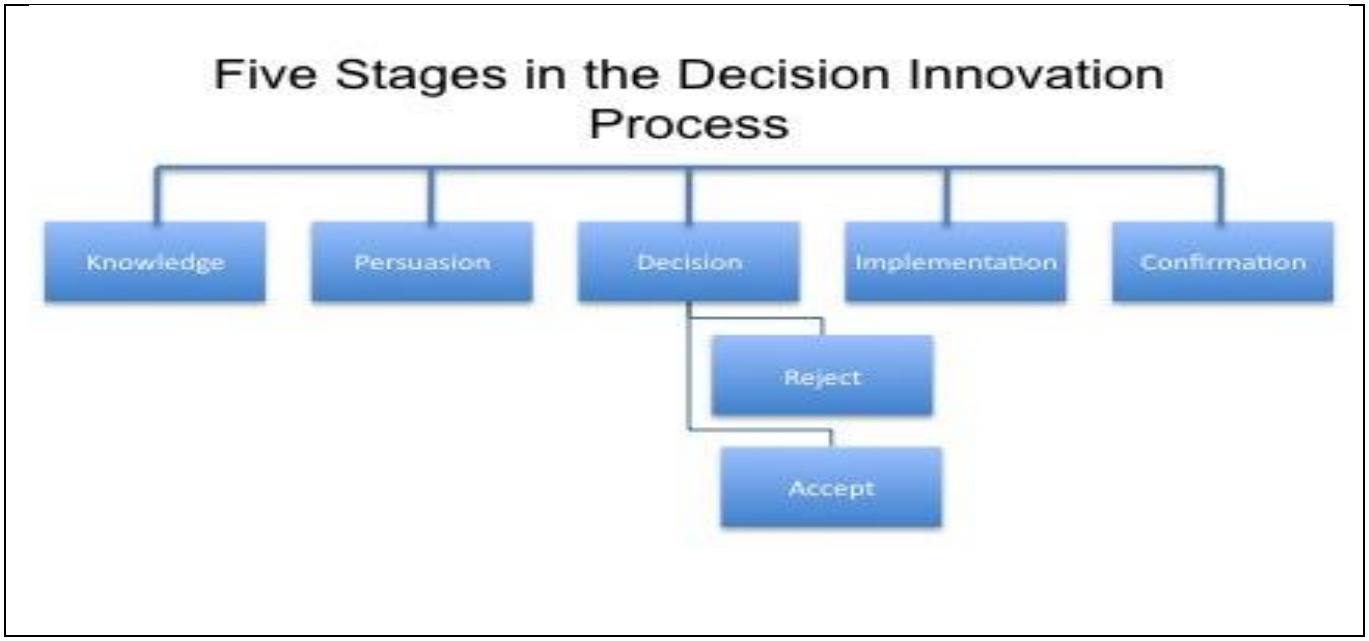

Figure: 2. 3 Stages of adoption decision process
Source: Rogers (2003)

Stage 1: The individual is first exposed to an innovation, but lacks information about the innovation. During this stage the individual has not yet been inspired to find out more information about the innovation.

Stage 2: The individual is interested in the innovation and actively seeks related information/details.

Stage 3: The individual takes the concept of the change and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or

reject the innovation. Due to the individualistic nature of this stage, Rogers notes that it is the most difficult stage on which to acquire empirical evidence.

Stage 4: The individual employs the innovation to a varying degree depending on the situation. During this stage the individual also determines the usefulness of the innovation and may search for further information about it.

Stage 5: Confirmation occurs when an individual (or other decision making unit) seeks reinforcement of an innovation decision already made, but he/she may reverse this previous decision if exposed to conflicting messages about the innovation. And there could also be modifications of the innovation to fit local circumstances.

2.6.2 The factors influence the adoption rate of Zero tillage farming system

Adoption of zero-tillage and conventional tillage can be influenced by a number of internal and external factors; Figure 2.4 below presents some of the factors:

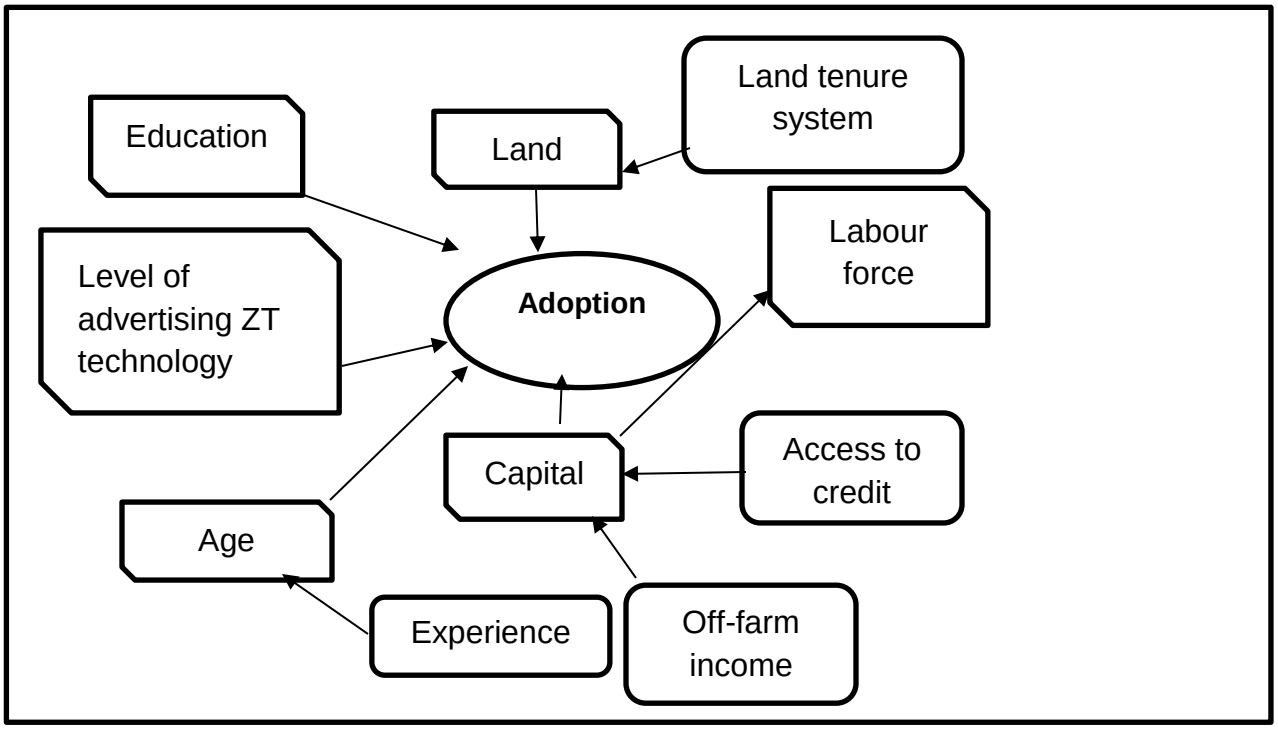

Figure: 2. 4 Factors affecting the adoption of zero tillage
Source: Researcher (2017)

As the age of the household head increases, the probability of using zero tillage is likely to decrease. Because, with age, a farmer can become more risk averse and then tend to be reluctant to new technologies. Therefore, it is hypothesized that age of household head are more likely to affect zero tillage farming negatively (Green, 2008). Education increases a farmers' capacity to create or innovate. Farmers having a good education level are more open to new technology. The study hypothesized that educational level would be positively related to technology adoption (Habtemariam, 2004). Farmers with higher experience appear to have often-full information and better knowledge and might be able to evaluate the advantage of the technology (Green, 2008). Hence, farming experience is hypothesized to affect adoption of ZT positively. Farmers who have access to credit may overcome their financial constraints and therefore be able to buy inputs. Farmers without cash and do not have access to credit may find it very difficult to attain and adopt new technologies (Mekonnen, 2007). Hence, access to credit is expected to increase the probability of adopting ZT technology. Contact with extension agent is hypothesized to increase farmers' likelihood of adopting the technology (Habtemariam, 2004). The higher number of contacts the farmer had with extension personnel the higher the exposure to ZT technology, and the more likely the adoption.

Training is one of the means by which farmers acquire new knowledge and skill (Green, 2008).Hence, participation in training is expected to positively influence farmers' adoption behavior. Participation in field days is expected to positively influence farmer's adoption level of the technology. A farmer who has access to all the three media (Radio, TV and print materials) and having time and ability to use receives a value of 3. It is expected that access to mass media to have positive association with the adoption (Baker *et al.*, 2007). It is hypothesized that the higher the perceived price of herbicide, the lower the likelihood of using zero tillage. Farm size is expected to motivate farmer's adoption of new technologies (Rensburg, 2002). A household with larger number of workers per hectare (unit) is more likely to be in a position to try and continue to use a potentially profitable innovation. In addition, it is expected to influence adoption positively (Kidane, 2001).

Income generated from selling off-farm produce, working as laborer in other farms, etc., at the study time. Off-farm income increases the probability of adoption of new technologies for additional income earned from off farm activities may augment the farmers' financial power, which in turn enable farmers to adopt new technologies by enhancing the household's access to inputs (Petros, 2010). Therefore, it expected that participation in off-farm activities are likely to positively influence adoption ZT technology. Perception about a technology directly influences adoption of a technology at HHs level. HHs has different perception on the same technology and this might affect adoption positively. The higher the number of social organizations the farmer is involved in, the higher the likelihood of adopting zero tillage technology. Information seeking behavior is assumed to have a positive relationship with the dependent variable. One of the important factors which hinder the adoption of innovative technologies is primarily, risks which are of two kinds: one is subjective risk (e.g. farmers believe yield is more uncertain with unfamiliar technology) and the other is objective risk (e.g. water variation, susceptibility to pests, and untimely availability of critical inputs, etc.). However, most of the empirical studies have rarely considered risks as they are difficult to measure.

2.7 The current status of zero tillage and conservation tillage in Eastern and Southern Africa

Worldwide, the adoption of conservation agriculture and zero tillage systems by smallholder farmers has lagged well behind the adoption on large, mechanized farms: only 0.3% of the area under no-till (NT) worldwide is on smallholder farms (Derpsch *et al*., 2010). It appears that well over 500,000 farmers in E&S Africa are currently using CA and ZT on at least part of their farm. The importance of this number is that the concepts of CA and ZT and have reached at least half a million minds, and there are likely more farmers in E&S Africa managing CA and ZT systems today than there are CA farmers in the USA, the country with the largest area of CA in the world.

Conservation tillage (CT) and No-Tillage (NT) is gaining more acceptance in South Africa. Table 2.2 shows figures from 2004 (the most recent update available). An

estimated 35% and 9% of total hectares in South Africa was under CT (mainly RT/MT) and ZT respectively in 2004. For CT the Free State led with 41% of the national total, followed by North-West (26%) and Mpumalanga (13%). For ZT the Free State led with 31% of the national total, followed by the Western Cape (22%) and Mpumalanga (20%). These figures are not recent and can only be used as a rough indication.

Table: 2. 2 Estimated ha under CT and NT practices-SA (2003/04)

	Total	Western Cape	Eastern Cape	Limpopo	Northern Cape	KwaZulu-Natal	Gauteng	Free State	Mpuma-lang	North West
Hectares	4,402,255	452,110	22,925	85,600	110,450	101,350	133,500	1,590,900	694,650	1,210,770
Conservation Tillage:										
Provincial Percentage		40.7%	19.3%	19.9%	19.6%	44.1%	24.6%	39.2%	29.1%	32.4%
Provincial Hectares	1,522,718	184,009	4,425	17,034	21,648	44,695	32,841	623,633	202,143	392,289
National Percentage	34.6%	12.1%	0.3%	1.1%	1.4%	2.9%	2.2%	41.0%	13.3%	25.8%
No-Tillage:										
Provincial Percentage		18.1	3.4	5	5.3	17.9	7.4	7.4	10.9	5.2
Provincial Hectares	377,169	81,832	779	4,280	5,854	18,142	9,879	117,727	75,717	62,960
National Percentage	8.6%	21.7%	0.2%	1.1%	1.6%	4.8%	2.6%	31.2%	20.1%	16.7%

Source: Fowler (2004)

Zero-tillage is gaining acceptance in many parts of the world as an alternative to conventional farming (Dumanski *et al*., 2006). It has been described as the most cost-effective, sustainable and rapidly expanding crop production system in the world today (Fowler 2006). In theory, ZT encourages a production system that is not only ecologically sustainable but also economically feasible and socially acceptable (Du Toit 2007; Dumanski *et al*., 2006). ZT is based on optimising yields and profits and not on maximising yields while exploiting the soil and agro-ecosystem resources (Dumanski *et al.,* 2006).

2.8 The impact of zero-tillage and conventional tillage on crop yields

2.8.1 The impact of zero-tillage on crop yields

According to FAO (2010) through zero-tillage an increased soil cover is facilitated which reduces the surface soil losses through wind and water erosion. Residue forms a mulch cover which reduces evaporation and creates a more stable temperature in the soil layer, increasing soil biodiversity. This is important for transformation of residue into chemicals available for plant uptake and for the moisture retention, resulting in long-term yield increase, decreased yields variations and reduction in toxic contamination of surface water and groundwater (Knowler *et al*, 2007). According to Sterve (2011), the lower soil disturbance of zero tillage reduces the oxidation process and increases thereby the soil organic matter and preserve aggregate formed by macro and micro organisms in the soil and this process is important for soil stability. Therefore the soil is more fertile since the content of earthworms is higher then that of conventional tillage (Sterve, 2011; Jezile, 2009) and also gives a better infiltration rate on heavy rains, since earthworms produce vertical connectivity between the different soil layers (FAO, 2010), and lower surface layers are less compacted with zero tillage then conventional tillage. Crop rotation of different crop such as (green pepper, onions, spinach, pumpkin) with maize or potatoes on a field in different cropping seasons helps to prevent crop pests and diseases by disturbing pest life cycles as part of integrated pest management (FAO, 2010; Petros, 2010). Hence crop rotation also improves nutrients cycling by use

of legumes in the rotation and optimizes water use through differences in rooting depths. Zero tillage also has the following known disadvantages, using herbicides instead of tilling the soil to control weed which is relatively expensive, and environmentally not accepted if not precisely applied and the crop residue left on the soil in zero-tillage systems makes planting more difficult. Zero-tillage poses many new management challenges for new zero-tillage farmers and the residue left on the field in zero-tillage may cause insect, disease, and weed problems if it is not properly applied and if it is too dense than in conventional tillage systems (Stubbs, 2004).

2.8.2 The impact of conventional tillage on crop yields

The aim of using conventional tillage is to prepare the soil environment favorable for plant growth (Baradi, 2009), from seed sowing which is believed to improves the soil fertility and environmental conditions for seed germination to crop growth (Baradi, 2009). Conventional tilling is also a way to destroy weeds and control pests (FAO, 2010). It is generally understood and well documented that conventional farming practice machinery is widely available and the techniques are well-known to farmers and that it increases porosity and loosen soil, allowing for good air exchange and root growth. Conventional tilling is also an effective way of incorporating manure, breaking up sod fields and the soils warm faster in the spring than those with less tillage. However, this approach also pulverizes the soil and destroys its physical structure with each ploughing, the top soil and soil organic matter are exposed to erosion by rain and wind (Husson, 2003), therefore the greater the level of tillage, the greater the loss of soil organic matter. Hence soil fertility declines and reduces the water-holding capacity of the soil, rendering it unproductive over time. Furthermore, it allows soil moisture to evaporate, making crops more vulnerable to moisture stress later in the season and reducing yields. For example: In a survey covering 31 magisterial districts of the EC where smallholder conventional farming is practiced, Mandiringana *et al.* (2005) found that most soils were low in soil organic matter (SOM) (<1%) and deficient in nitrogen (N), phosphorus (P) and zinc (Zn). Intensive soil tillage results in vast removal of

nutrients with practically nothing being returned to the soil in the form of manures or fertilizers (Dube, 2012).

2.9 Chapter Summary

No one tillage system is best for all farms because there is so much variability in soils, crops and climate conditions. The tillage system used to prepare a field for seeding is based on various factors including the approach's compatibility with the farm's soil type, soil moisture levels, slopes, drainage and climate. The effect on erosion control, timeliness weed control, insects, diseases and the profitability of the farm operation are also important considerations. The cost of fuel has increasingly become a principal factor in the selection of a tillage approach. Literature suggests that zero tillage aims on maintaining permanent soil cover, promoting healthy, living soil, promoting balanced application and precision placement of fertilizers, pesticides, and other crop inputs, promoting legume fallows, composting and organic soil amendments, and promoting agroforestry to enhance on farm biodiversity and alternate sources of income. And literature also states that soil degradation is mainly caused by intensive conventional soil tillage. Farmers choose conventional tillage, conservation tillage or no-till seeding practices, because each approach has advantages and disadvantages, but the best method depends on specific conditions such as climate conditions, soil type and soil properties. One advantage of conventional tillage is that the needed machinery is widely available and the techniques are well-known to farmers but for newer methods such as zero tillage, it may require the purchase of new equipment or attachments and often a learning effort on the part of the farmer. This results in decreased adoption rate for the zero tillage system because small scale farmers are reluctant to change.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the methodology of the study. The chapter begins by describing the study area. The research sites are rural areas of Amahlathi local municipality situated in the Amathole district in the Eastern Cape Province. The chapter then continues with the presentation of the methods employed for carrying out the study. The first section will reviews the research design, and then the model is described. Following that, the data and variables are described. The section on data collection methods will explain the nature of the data. Then the sampling techniques are described. This will be followed by a description of the tools that were employed for data collection and any special considerations related to the field work. The chapter then describes the analytical framework for the study.

3.2 Description of study area

The Amahlathi Local Municipality is situated in the Amathole District of the Eastern Cape province, South Africa, between 32° 21and 33° 07south and 26° 24 and 27° 13 east (Figure 3.1). It has a total land area of 3,725km2 and a population of 133,434 (STATS SA, 2003). The Municipality is characterized by high levels of unemployment, estimated at over 85%of the indigent population (Manyevere *et al*, 2014). Official figures revealed that the economy was able to create jobs for only 3.5% of the economically active population (STATS SA, 2003). For their livelihood, the population depended on public sector employment (which contributes to the bulk of income), government grants, agriculture and migratory labour (Hebinck & Van Averbeke, 2007). Small-scale agriculture is dominated by vegetable and livestock production in projects that are mainly funded by the Department of Agriculture. Other economic activities include tourism, forestry and sheep and wool production (Manyevere *et al*, 2014). For this study, we have selected the Amahlathi Local Municipality because, the small scale farmers in this municipality practices zero-tillage on a high level. We will select eleven

villages namely Burnhill, Donsta, Gwili, Lower Gxulu, Upper Gxulu, Lower Zingcuka, Sophumelelo, Madubela, Myeni, Ngxalawe, and Lower Rabula.Villages under the Amathole District Municipality as shown on the map.

Figure: 3. 1: Map of Amahlathi Local Municipality
Source: Google Maps

3.3 Research Design

Research design is a plan for assembling, organizing and integrating information (data) and it results in a specific end product (research findings). Cross sectional analysis: Where a survey will be done once to gather information from small scale farmers who participant in conventional tillage and zero tillage. A questionnaire is the instrument used for this survey.

The project was a case study dealing with current events, utilizing both quantitative and qualitative research methods such as direct observation systematic interviewing and

questionnaires. According to Institution of Agriculture and Natural Resource (2016) descriptive studies can involve a one-time interaction with groups of people (i.e., cross-sectional study). The primary reason why the study used this kind of research design was to seek to describe current status of identified variable

3.4 Sampling frame and procedure

Multi-stage sampling was done in which the first stage involves selecting respondents from Amahlathi Local Municipally. The selected households as the unit of the study was divided into two groups; the first group included rural households who are farming on half of a hectare and above using conventional tillage and the second group used zero-tillage. This was done through stratification by separating smallholder farmers from the different Villages. This was followed by random sampling which was used to get the sample size for the study (n=100). The unit of analysis in this study is the rural farmers (both small scale and emerging farmers).

3.5 Sampling method

For this research, the most suitable sampling procedure that was used was random sampling, which is a non-probability sampling method. From sampling frame, (n=100) respondents were randomly selected for direct questioning, using the “in-person interview” approach. A total of 100 questionnaires were administered to households in their local language to gather as much information for the study.

3.6 Data Collection

This study used a semi-structured questionnaire to collect the needed information and data was collected through field survey and farmer interviews. IsiXhosa and English are the languages employed when administering the questionnaires. The questionnaire was structured in such a way that the first part deals with the socio-economic variables such as:

1) Household general information aiming at identifying the household demographic characteristics, structure, gender distribution, occupations of household members etc.
2) Information on households' assets endowments, namely:

- Natural assets which include three important items: land, water and forest.
- Human assets which include education, knowledge and skills etc.
- Physical assets, which include public and private basic infrastructure (transportation including roads, secure shelter and buildings; water supply and sanitation,) as well as tools and technology (equipment for production, traditional technology).
- Financial assets, including all financial resources people use to achieve their livelihood objectives.
- Social assets, which refer to social relationships such as networks and connections.

3) Household strategies (activities) and motivations indicating the household's participation in agricultural and different activities non-agricultural activities.
4) Household income resources describing the main sources, and the distribution and share of household income sources into agricultural and non-agricultural categories.

The questionnaires were administered in person in order to eliminate the problem of misinterpretations or misunderstandings of words and questions and to avoid the problem of respondents omitting difficult questions. One of the best advantages of interviewer-administered questionnaires is that they can be administered to respondents who cannot read or write. The questionnaires comprised both closed and open-ended questions, so as to get as much information as possible from the respondents without taking too much of their time.

Data was collected according to the following steps:

1) Review of secondary sources
2) Direct observation through field visits
3) Interviews with farmers.

Primary data: was collected through administering a structured questionnaire. IsiXhosa and English were the languages employed when administering the questionnaires.
Secondary data: Journals, books, papers will be used for literature on Livestock production in South Africa as well as globally.

Table 3.1: below presents the dependent and independent variables.

Table: 3. 1 Description of estimated variables

Variable name	Variable description	Type of measurement	Expected sign
Dependent variable			
ZT	Zero tillage		
CT	Conventional tillage		
Independent variables			
GHH	Gender of household	Dummy	+/-
AHH	Age of household	Continuous	+/-
MSHH	Marital statues of household	Categorical	+/-
ES	Education statue	Categorical	+/-
OCC	Occupation of household	Continuous	+
HS	Household size	Continuous	+
LS	Land size	Continuous	+
HHSI	HH source of income	Categorical	+
INFR	Lack of infrastructure	Dummy	+
PIT	Participation CT/ZT technology	Dummy	+
AOI	Availability of inputs	Dummy	
COP	Cost of production	Continuous	+
HHFE	Farmer experience	Categorical	+
ESV	Extension Services visits	Categorical	+
AMM	Access to mass media	Categorical	+

Source: Author's own computation, 2017

3.1.1 Definition of variables and working hypothesis

Dependent variables

Adoption of conservation tillage is a dichotomous type represented by a value of 1 and practicing zero tillage or at least in one of his farms for the last 2 years and a value of 0 otherwise (practiced conventional tillage).

Independent Variables

Gender of household head: This variable measures the gender of the respondents either the respondent is male (0) or female (1). It is expressed as a dummy variable, depending on the nature of production, both male and female are likely to play different roles in agricultural practices. Gender differences is one of the factors influencing the amounts of yields obtained. The effect of this variable is not fixed or known in advance.

Age of the household head: This variable refers to the chronological age of household head at the time of the survey, measured in years. As the age of the household head increases, the probability of using ZT is likely to decrease. Because, with age, a farmer can become more risk averse and then tend to be reluctant to new technologies. Therefore, it is hypothesized that age of household head are more likely to affect zero-tillage technology negatively (Kidane, 2001).

Education: It measures formal education of household head in the family .It is a dummy variable, which takes a value 1 if the farm household is literate (can only read and write), and 0 illiterate. Education increases farmers' capacity to create or innovate. Farmers having a good education level are more open to new technology. The study hypothesized that educational level would be positively related to technology adoption (Habtemariam, 2004).

Marital status: This variable measures the likelihood of household head participating in farming in between single and married farmers. Henao & Baanante (1999) indicated

that marital status of household head is very significant in African societies as it determines stability of families. The belief is that married household heads tend to be more stable in farming activities than unmarried heads.

Occupation: This variable measures the type of job the respondent is doing. It assists in measuring the income earned in the household.

Household size: This variable explains the number of people in a household and is measured in actual years. The hypothesized sign is positive meaning that the more respondents in a household, the less labour costs as the household would sue family labour.

Land size: This is the area of the farm which is devoted to agricultural production and this variable is measured in hectares (ha). Access to and ownership of land is one of the most important resources. Therefore land size determines the people's ability to perform agricultural practices.

Availability of inputs: The issue of inputs (seeds and fertilizer) is also an important one as it improves soil fertility and the yield of production.
Cost of production: This variable will represent the household expenditure on inputs like, fertilizer, crop production, seeds, chemicals etc.

Farming experience: is to be measured in number of years of experience in farming. Farmers with higher experience appear to have often-full information and better knowledge and might be able to evaluate the advantage of the technology (Baker *et al*, 2007). Hence, farming experience is hypothesized to affect adoption of CT positively.

Contact with extension agents: This refers to the number of contacts per year for conservation tillage technology that the respondent made with extension agents and it is a continuous variable. Contact with extension agent is hypothesized to increase

farmers' likelihood of adopting the technology (Habtemariam, 2004). The higher number of contacts the farmer had with extension personnel the higher the exposure to CT technology, and the more likely the adoption.

3.7 Methods of Data Analysis

The collected survey data will be coded and analyzed using Statistical Package for Social Sciences (SPSS). This study employed descriptive statistics, gross marginal analysis and propensity score matching (PSM) models to analyse the collected survey data. For descriptive model, the main indicators that will be used for this study will be the frequency and the mean values for all the variables, because they are useful in analyzing household characteristics and the relationship between variables.

3.7.1 Descriptive research

Descriptive research is research in which a specific situation is studied either to see if gives rise to general theories, or to see if existing general theories are borne out of a specific situation. It is a method of research that simply looks with intense accuracy at the phenomena of the moment and then describes precisely what the researcher sees. In employing this method, the researcher does two things, first, the researcher observes with close scrutiny the population which is bounded by the research parameters, second, the researcher makes a careful record of what he/she observes so that when the aggregate record is made, the researcher can then return to the record to study the observations that have been "described" there.

3.7.2 Descriptive Analysis

Descriptive statistics will be computed to describe the major farm and household characteristics of smallholder farmers within the study area for the following major parameters: household characteristics (age, sex, education, land ownership etc.) and

broad farm running parameters (labor, technical skills, market accesses etc.) and cross tabulation will be done to test the relationship between those variables.

3.7.3 Propensity Score Matching Model

PSM is a semiparametric method that gives an average treatment effect on the treated (ATT), which is considered a better indicator of whether to continue promoting programs that target specific groups of interest like poor farmers than population-wide average treatment effects given by probit models (Nkala *et al,* 2011). CT/ZT is the treatment variable, while reported improvements in crop productivity, household income and soil fertility are the outcomes of interest and ZT farmers are the control group. PSM is based on the assumption that it is not possible for each farmer to be both in the CT as well as ZT farmers. This then necessitates the creation of a counterfactual of what can be observed by matching CT (treatment) and ZT (control) groups. PSM therefore matches CT to ZT farmers with similar values of X giving us the following equation to estimate:

$$ATT = E [yd=1 \mid d=1, p(X)] - E [yd=0 \mid d=0, p(X)]$$

For the analysis, the dependent variable will be Tillage (conventional tillage =1 or Zero tillage =0).

- ATT stands for the average treatment effect on the treated (CT and ZT farmers),
- yd=1|d = 1 is the reported changes in conventional tillage outcomes actually observed in the CT and ZT farmer subsample,
- While yd=0|d = 0 is the change observed in the zero-tillage farmers.
- p(X) is the propensity score, which is defined as conditional probability of being in the CT/ZT group conditional on X.

Matching on the propensity score avoids the challenge of matching on covariates, which poses a dimensionality problem particularly when matching on many covariates. The PSM is, thus, a two-stage process, first performing a probit or logit regression by

calculating the household's propensity to be in the CT group, that is, p(X) is calculated in this stage. The vector X contains a set of covariates deemed to influence the decision to adopt CT /ZT. The second stage uses propensity scores obtained in the first stage to match CT and ZT farmers. A number of matching methods can be used in this stage, each using a different function to conduct the matching although the result of each is an ATT value that indicates the impact of CT/ZT on the selected farmers' indicators. The propensity score (PSM) model relies on the conditional independence assumption that any correlation between unobserved factors and farmers decision to participate do not influence the investigated effects on productivity, household income and food security (Nkala *et al*, 2011).

3.3.2 Gross margin analysis

Gross margin analysis was the major tool, which was used in the analysis to compare the returns between zero tillage and conventional tillage and assess the benefits of zero tillage. The study looked at the agricultural performance of both zero tillage and conventional tillage farmers at Kieskammahoek. To determine any changes in the production or productivity levels and gross incomes, a comparative analysis of inter-farm was vital. Inter-farm comparative analysis compares the zero tillage and conventional tillage farmers who are located in the same geological area. The research study therefore used a gross margin analysis as an indication of level of performance, that is, how well farmers did on their land with the resources that were available to them. According to Nkala, (2011), gross margin analysis is useful for production cycles of less than a year as this enables costs and returns to be directly linked to enterprise. Gross margin is the difference between the total sales and the variable costs.

Gross Margin = Total Sales (Gross Income) - Variable Costs (2)

Where: Gross Income = Total Volume of Output (Q) x Price (P) (3)

and Variable Costs include the costs such as fertilizer, seed, crop chemicals, marketing costs, transport costs, machinery operational, labour costs, etc that would have been incurred in the production process until the produce has reached the market.

Table: 3.2 below presents the research objectives, research question and analytical tools which will be used to answer each research question and analysis the data.

Table: 3. 2 Analysis of objectives

Research objective	Research question	Analytical tool
Describe the farming practices used in the Keiskammahoek area.	Which are the farming practices used in the Keiskammahoek area?	Descriptive statistics
Determine the factors influencing the adoption of zero tillage and conventional tillage	What are the factors influencing the adoption of zero tillage and conventional tillage?	Propensity Score Matching Model - Analysis
Describe the relative yields of Zero-tillage and conventional –tillage in terms of quantity produced per hectare	What are the relative yields of zero-tillage and conventional –tillage in terms of quantity?	Gross Margin analysis
Determine the relative impact of zero tillage and conventional tillage on household income	What is the relative impact of zero tillage and conventional tillage on household income?	Propensity Score Matching Model - Analysis

Source: Researcher 2016

3.8 Reliability and validity

Reliability and validity are used in connection with measurement of data, and influence what is learned about phenomenon being studied and the meaningfulness of conclusions drawn from data collected (Leedy and Ormrod, 2005). Even though Sheppard (2004) suggested that reliability and validly were frequently related to quantitative research, however (Duffy, 1987) opposed that reliability is not a preserve of quantitative research alone and that both qualitative and quantitative researchers seek reliable and valid results but use different approaches. For Lewis and Ritchie (2003), the concept reliability meant sustainable while validity denoted well grounded. However, in the opinion of Sheppard (2004), a qualitative researcher focuses more on valid data that represent a true picture of what is being investigated, while the quantitative researcher focuses heavily on reliability. Leedy and Ormrod (2005) stated that there is no measure that has perfect validity and reliability. In support of this statement, Sheppard (2004) and other authors like Cohen, Sheppard (2004) explained that it was not possible for research to be 100% valid because of in-built standard error in quantitative research and bias from subjectivity, opinions and attitudes under qualitative research. Reliability and validity of data need to be maximized through the use of appropriate data collection techniques that yield information that is relevant to the research (Neuman, 2006).

3.8.1 Reliability

The goal of reliability in a study was to minimize errors and biases (Yin, 1989). According to Sheppard (2004), reliability has to do with how reliable the instruments are and the conditions under which the tool is used. Described differently, reliability has to do with stability, and assesses the results that would be yielded if a data collection tool was administered to the same individual on different occasions. Reliability ensures that the instruments gather measurements that are consistent.

Reliability in quantitative research differs from that in qualitative research (Cohen et al., 2007). On the one hand, reliability in quantitative research is considered replicability, consistency and dependability over time, instruments and respondents (groups). It is

also concerned with how precise and accurate the measurements are and ensure stability and consistency. On the other hand, reliability in qualitative research is considered debatable and while some authors have argued that qualitative research cannot be replicated or validated, others hold on that reliability can be addressed by striving for accuracy in data reporting.

In this study, reliability was improved by having clearly defined constructs, using precise levels of measurement and using multiple indicators. Data collection instruments (questionnaire and interviews) developed was pre-tested to ensure accuracy and consistency. Cohen et al., (2007) stated that reliability is a necessary precondition of validity and validity may be a sufficient but not a necessary condition for reliability.

3.8.2 Validity

Validity in relation to research is a judgment regarding the degree to which the components of the research reflect the theory, concept, or variable under study (Streiner and Norman, 1996). The validity of the instrument used and validity of the research design as whole are important criteria in evaluating the worth of the results of the results conducted. In addition, validity assesses the accuracy, correctness or precision of whether measures attained for an attribute are what are supposed to be measured (Leedy and Ormrod, 2005). Internal validity refers to the likelihood that experimental manipulation indeed was responsible for the differences observed. While the external validity refers to the extent to which the results of the study can be generalized to the larger population. Moreover, validity also entails demonstrating some correlations with other related variables (Sheppard, 2004).

However, Cooper and Schindler (2003) contended that it is challenging to satisfy the test of validity as often the researcher does not know the true differences without confirming knowledge. Specific threats to validity have thus been advanced to improve validity of data namely internal, external and construct validity, content validity, and criterion related validity and construct validity. The main threats to validity are discussed below.

3.8.2.1 Construct validity

Construct validity pertains to the accuracy of the instruments for data collection and how well the results measured fit the theories being tested (Gravetter and Forzano, 2009). The researcher made predictions based on existing theoretical background and linked them to relationships in similar conditions (Sheppard, 2004). Where the characteristics being measured were not being directly observed, they were inferred from the behaviours of farmers (Leedy and Ormrod, 2005), for example satisfaction with information services.

According to McBurney and White (2007), threats to construct validity are caused by the relationship to theories. Construct validity is difficult to achieve because there may be many theories accounting for a relationship. Two main areas that pose threats to construct validity include loose connection between theory and method and ambiguous effect of independent variables. The latter may occur where all the respondents do not understand the circumstances of the research in the same way, leading to ambiguity. The informants may also choose to act according to what they think the researcher wants instead of basing their actions on the purpose of the research. In this study, construct validity was addressed by presenting the operational definitions of both dependent and independent variable. Furthermore, data collection an instrument was also be pre-tested.

3.8.2.2 Criterion-related validity

Criterion-related validity measures the extent to which the results of an assessment instrument are related to another related standard that compares the measures to ensure that the construct is accurately represented (Leedy and Ormrod, 2005). There were two types of criterion-related validity, namely predictive and concurrent validity. Therefore this study addressed criterion-related validity through triangulation of data collection methods and instruments including a questionnaire, interviews and secondary data.

3.8.2.3 Internal validity

Internal validity looks at the research design and how well it eliminates bias (Beins *et al*., 2002). In addition, it assesses the degree to which the independent variables interfere with the dependent variable (Beins *et al*., 2004). Internal validity applies to qualitative and quantitative research and examines the manner in which data obtained explains a particular issue and how alternative plausible explanations are excluded. Threats to internal validity include history, maturation, testing, instrumentation, statistical regression, selection, mortality, interactions with selection, ambiguity about the direction of causal influence and imitation of treatments.

3.8.2.4 External validity

External validity seeks to define the domains to which the study was generalised beyond the context of the study (Lowe et al., 2002). External validity measures how well the findings are related to other situations. In this study, all the data was collected within the same period to avoid external validity.

3.8.2.5 Face validity

Sekaran (2003) considered face validity to be a basic and minor index of content validity. Face validity focuses on expert judgement of the extent to which the instrument measures key dimensions of what they theoretically represent (Sheppard et al., 2004). According to Neuman (2006), face validity is the most basic kind of validity and the easiest to achieve, as the indicator used is the judgement by the scientific community. Face validity in this study was addressed by having some structured interviews with a uniform format and sequence. The study improved face validity by pre-testing the data collection instruments to minimise bias and to ensure that the questions on the instruments measured the true value of the variable.

3.8.2.6 Content validity

Content validity measures the extent to which a data collection instrument reflects the content domain in appropriate proportions, ideas or areas in the conceptual domain (Leedy and Ormrod, 2005). The present study addressed content validity by using data collection instruments that were fairly detailed and comprehensive, and encompassing

the key areas covered in the research questions. Content validity was also addressed by providing definitions of key concepts and constructs that were studied (Neuman, 2006).

3.8 Ethical Clearance

Study researches are very concerned with ethical issues and this concern is perceived because of the common use of people in research studies. People are considered to have diverse cultures and research involves cultural, legal, economic, and political phenomena. The word “ethic” is from the Greek word “ethos” which means character. Therefore, there are important questions which need to be considered such as, what moral principles guide your research? How do ethical issues enter into your selection of research problems? How do ethical issues affect how you conduct your research (the design of your study, your sampling procedure, etc.)? What responsibility do you have towards your research subjects? For example, do you have their informed consent to participate in your project? What ethical issues might come into mind when deciding which research findings you may publish? Will your research directly benefit those who participated in the study?

The following basic ethical issues will be observed in this project:

- Informed consent
- Privacy
- Respect and Honesty

Informed consent

The respondents were firstly informed about the procedures and purpose of the survey before the people could participate in the study. In some case where language is a barrier to the farmers, questions were asked and explained in farmer’s native language. The researcher should keep in mind that most of the information that is required especially about the community activities and people is mostly gathered from the people or community members. People always have questions about the research work being done on their communities and feel the need to be informed; therefore informed consent

is a vital step for this research project. This is a process whereby participants who partake in a research project will be informed of the procedures, risks, and benefits of the study. This research project considers principles that lay the foundation of an informed consent such as allowing respondents to make their own decisions, competence, provision of adequate information and allowing the participants to change their decisions when they feel the need to.

The informed consent was obtained verbally and through written forms. This depended on the situation involved and the degree of potential risk participants. Most often our research projects create less risk, it will be free to be informal in this research and give an informed consent verbally. Two forms of informed consent shall be followed, i.e. direct and substitute. Direct consent will allow the researcher to get the agreement directly from the person to be involved in the study. Substitute consent were obtained when a person to be involved does not have the capacity to make the decision or else is dependent on others for his welfare such as peoples with emotional disabilities and people under the age of 18.

Privacy

Privacy is considered as a human right in some parts of the world. When conducting a research using people, the researcher allowed the respondents to have control over how long the interview take and when the person was available. Respondents will be asked verbally about the privacy before beginning interviewed. There are three important things which this researcher shall take note of when considering privacy, i.e. sensitivity of the data, setting in which the research is going to be conducted and how public the information will be? Some data may be viewed as sensitive under any circumstances while others may be less sensitive. In conducting a research, there are those settings that are nearly always considered private, such as a person's names, thoughts and homes. It was stated that the information obtained was not be published in newspapers; even if it might be published the people's identity will be hind so no one will be able to locate the people.

Respect and Honesty

In this research, respondents will be treated with autonomy and respect. The interviews will be a two way communication where by the people will also get to ask some questions. Respect for the farmers and community members will be of thorough mount importance in the study.

3.9 Chapter Summary

This study was carried out in Amahlathi local municipality. Eleven villages were purposively selected because they have farmers who applied both conventional tillage and zero-tillage. This study employed a cross-sectional research design. Data were collected at one point in time. Multi-stage sampling technique was employed to arrive at the sample size of the study. From sampling frame, 100 farmers/ households were randomly selected for direct questioning, using the “in-person interview” approach. The sampling frame consisted of households in rural areas. The research relied on both primary and secondary data. Sampling survey techniques were followed where enumerators were trained to administer questionnaires to the research subjects. The main objective of the study was to compare zero-tillage and conventional tillage. In order to know if the model is applicable to the study, three specific objectives were analysed using descriptive analysis, propensity score matching and marginal analysis. Descriptive statistics were used to describe the types of tillage systems which were used and to explain the possible reasons on why the farmers would choose the tillage system they are using The propensity score matching model was employed to analyze the factors influencing adoption of zero and conventional tillage and to determine the relative impact of zero and conventional tillage on household income, gross margin analysis was employed to analyse performance of zero and conventional tillage in terms of quantity produced.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results of the study. The main objective of the study was to undertake a comparative analysis of zero-tillage and conventional tillage practices in the rural areas of kieskammahoek in the Amahlathi local municipality. More specifically the research seeks to understand the farming practices used in Eastern Cape Province, the relative performance of zero-tillage and conventional tillage in terms of quantity produced per farm and per hectare, the factors influencing the adoption rate of zero tillage and conventional tillage and lastly the relative impacts of zero-tillage and conventional tillage on crop yields. To achieve the foregoing, the data were analyzed by means of descriptive and inferential statistics and econometric models, the results of which are presented in three separate sections. This chapter begins with the brief explanation of the demographic and socio-economic characteristics of the sampled households. It goes on to discuss descriptive statistics such as percentages, frequencies and inferential analysis such as propensity score matching, gross margin analysis.

4.2 Demographic and Socio-Economic Characteristics of Households

In this section, household heads' demographic information such as gender, age, marital status, household size, level of education, source of income, land tenure system, soil fertility status and farm size are discussed. Such information relating to the household head is important because the main household head activities are coordinated by the household head and the households decisions are most likely to be influenced by such demographic aspects. The demographic information is analysed using descriptive statistics measures. The results of the demographic and socio-economic characteristics of households are presented in Table 4.1 and the results are grouped according to the type of tillage system practiced (either zero-tillage or conventional tillage).

Table: 4. 1 Socio-Economic and Demographics Characteristics of Households

Variables	Conventional Tillage (n=)		Zero Tillage (n=)	
	Frequency	Percentage	**Frequency**	**Percentage**
Gender				
Female	15	48.4	44	63.8
Male	16	51.6	25	36.2
Total		**31**		69
Age				
20-50	17	54.8	40	58
50>	14	45.2	29	42.0
Marital status				
Married	12	38.7	41	59.4
Single	13	41.9	18	26.1
Widow	6	19.4	10	14.5
Highest educational level				
No formal education	1	3.2	2	2.9
Primary	10	32.3	23	33.3
Secondary	15	48.4	36	52.2
Tertiary	5	16.1	8	11.6
Source of income				
Farming	8	25.8	28	40.6
Salaried employment	5	16.1	4	5.8
Social grants	18	58.1	37	53.6
Land tenure system				
Communal	13	41.9	19	27.5
Own	2	6.5	1	1.4
Family	16	51.6	49	71
Soil fertility status				
Moderately fertile	9	29	22	31.9
Very fertile	22	71	42	60.9
Highly manured			5	7.2
Tillage system	31	31	69	69
	Conventional Tillage		**Zero Tillage**	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Household size	4.35	1.942	4.64	2.121
Household income	3187.10	2750.151	2305.80	1328.271
Farm size	1.774	2.1324	0.791	0.4025

Source: Based on SPSS data processing field data, 2017

4.2.1 Distribution of households by gender of household head

Gender division plays an important role in traditional agriculture because there are important gender based differences in the way men and women decide about crucial issues such as land size, inputs to use, which product to sell and when to market the products. Empirical evidence shows that women play a big role in decision making when it comes to agriculture and adoption of new agricultural technologies because men migrate to big cities in pursuit of jobs and women are left behind to look after their families and provide for them (Jat *et al*., 2014). Gender influences the choice of farming and the results are presented in Table 4.1.

The results in Table 4.1 showed that the data was collected from 100 respondents of which 59% were female and 41% were males. The results showed that more males (52%) practised conventional tillage than females (48%) and more females with (64%) practised zero tillage than males (36%). It was observed that women participated more in farming than the men. This can be due to the fact that more men migrate to the cities in pursuit of better jobs and the women are left be-hide to take care of their families and to provide for their families. In most cases women farmers were classified as household heads when they are single, divorced, widowed or husband has migrated.

4.2.2 Distribution of households by age of household head

Age in farming determines how experienced a farmer is and the older people tend to be more experienced then the young people. The results are presented in Table 4.1 above. The age groups of the respondents used were grouped as 20-50 years and above 50 years. The results showed that about 57% of the respondents practising ZT were between the age groups of 20-50 years, while 42% of the respondents were above 50 years and 1% of the respondents were below 20 years. On the other hand, about, 55%of the respondents practising CT were between 21-50 years of age, while 45% of the respondents were above 50 years of age.

Therefore more young people with 57% are involved in farming than old people with 43% and this is because, as the age of the household head increases, the willingness to use ZT is likely to decrease. Young farmers are more open to the adoption of new farming technologies or methods than older farmers. Kidane (2001) agrees that age may be a contributing factor influencing success in farming because younger farmers are more adaptable and willing than the old farmers which are risk averse

4.2.3 Distribution of households by marital status of household head

MUSCĂNESCU, (2013) indicated that marital status of household head is very significant in African societies as it determines stability of families. The marital status of the respondents was divided into four main groups married, single, widow and divorced. As shown in Table 4.1 many household heads were married.

The results showed that about 5% of the respondents which were practising ZT were married, while 26% of the respondents were single and 15% of the respondents were widows. On the other hand, about, 39%of the respondents practising CT were married, while 39% of the respondents were single while 19% of the respondents were widows and 3% of the respondents were divorced.

The belief is that married household heads tend to be more stable in farming activities than unmarried heads. Marriage plays an exclusively important role in agricultural production because, for many people who are married, agriculture is their life and source of family income. Marital status is also said to influence the stability of the farming business if both husband and wife are engaged in farming (Benites *et al*, 2003).

4.2.4 Distribution of households by educational level of household head

Education is one of the assets that is needed to enhance productivity in farming households as well as non-farming households. Education may enhance productivity directly and indirectly by improving soil management, enhancing farming skills, adjust to changes and adoption of new technologies and farming methods (Jat *et al*, 2014, 2010). The educational level of the respondents used was grouped as no formal education, primary education, secondary education and tertiary education.

The respondents that were practising zero-tillage, about 3% had no formal education, 33% had primary education, 52% had secondary education and 12% had tertiary education. On the other hand, respondents that were practising conventional tillage about, 3% had no formal education, 32% had primary education, 48% had secondary education and 16% had tertiary education. These results give an indication that zero tillage household heads were more educated as compared to conventional tillage households.

This indicates that household heads from both groups are able to make better farming decisions. Education may increase the chances of success in the farming business and the ability to understand and evaluate the information on new techniques and the processes of better farming. The perception is that, the level of education has a great influence on the development of farming households. Educated farmers tend to be more progressive than uneducated farmers (Bolliger, 2007).

4.2.5 Distribution of households by source of income household

From the study, occupation of respondents is important since income helps them to purchase some items for farming. Employment in off-farm and non-farm activities is important for diversification of sources of farm households' livelihoods (FAO, 2010). It enables households to modernize their production by giving them an opportunity to

apply proper inputs and reduce the risk of food shortage during periods of drought. The results are presented in the Table 4.1.

The household's source of income of the respondents was grouped as farming, salaried income and social grants. To the respondents that were practising zero-tillage, about 41% relied on farming, 6% relied on salaried income and 54% relied on social grants. On the other hand, respondents that were practising conventional tillage about, 26% relied on farming, 16% relied on salaried income, while 58% relied on social grants.

The overall source of income results shows that, the majority of farmers in the study area depend on the mentioned category for their main source of income such as 54% of the ZT respondents depend on social grants while 58% of CT respondents depended on social grants, 41% of ZT respondents depended on farming while 26% of CT depended on farming and 6% of ZT respondents depended on salaried income while 16% of CT respondents depended on salaried income. This shows that the majority of the study respondents were highly dependent on social grant. This could be the result of the high unemployment rate.

4.2.6 Distribution of household by land tenure system of household head

According to Ngqangweni and Delgado (2003), land that is available to smallholder farmers in South Africa is usually shared between residential and farming purposes. This situation leaves less arable land for farming purposes. The land tenure systems of the respondents used was grouped as Communal land, own land, and family land. The respondents that were practising zero-tillage, about 28% used communal land, 1% used own land and 71% used family land. On the other hand, respondents that were specialising in conventional tillage about, 42% used communal land, 7% use own land and 52% used family land. The results indicate that most of the smallholder farmers do not own the land they farm on, even though they have rights to use it.

4.2.7 Distribution of household by soil fertility status of household head

Soil fertility status is one of the main assets that are needed in order to produce good quality products which also help to enhance farming productivity. Soil fertility status help to enhance soil quality, soil structure and to increase yields. Table 4.1 shows that the soil fertility status of the areas in which both groups of respondents resided in are moderately fertile to very fertile.

The fertility status of the land which the respondents used was grouped as very fertile, moderately fertile, and highly manured. The respondents that were practising zero-tillage, about 42% had fertile soil, while 22% had moderately fertile soil and 5% with highly manured soils. On the other hand, respondents that were practising conventional tillage about, 22% had fertile soil, while 9 had moderately fertile soil. This indicates that both groups of farmers, zero and conventional tillage farmers had good soil fertility status which may lead to increased yields and more profit from their produce when marketed but under a well managed soil management system.

4.2.8 Distribution of household by household size of household head

Availability of labour to carry out “labour-intensive” agricultural operations is greatly influenced by household size. The household size values have an influence on marketing since they affect consumption and production (Randela, 2005). In this study, household size was considered as the number of individuals who resides with the respondents.

Table 4.1 above gives an indication of different household sizes. Results show that the average household size for conventional tillage farmers is 4 respondents per household; while zero tillage household size average is 5 respondents per household. These results show that both groups of farmers had small household sizes which may have negative implementation on the farm labour supply especially if the farmers dependent on family labour and agricultural production may also be affected negatively. Larger

household size discourages selling because the household needs to supply household consumption before it decides to sell. It becomes even more difficult to produce and sell where the household is comprised of either very old or very young members who cannot assist with farming.

Taking household size as a proxy for labour availability to carry out farming activities, it can be inferred that the study farmers in the area had no problems with labour. Larger families mean that a variety of labour is available in the form of young, middle and elderly members (FAO, 2008). Labour is an important factor when it comes to smallholder farming, because in most cases smallholder agriculture is labour intensive rather than capital intensive (Jat *et al*, 2004). The results from the study indicated that farmers in the area had access to family labour and this may increase performance of farmers.

4.2.9 Distribution of households by household/farm income of household head

Generally, farm income refers to the income gained from farming activities after all the farm costs have been deducted. The sources of farm income include income from all farming activities such as income earned from the sales of crops, livestock, etc. (FAO, 2007). This income contributes by at least 40% to the total household income in South African rural areas (Baker *et al*, 2003).

Table 4.1 shows that the distribution of farm income for conventional tillage is giving the households an average income of R3187.10 while zero tillage farming is giving the households an average income of R2305.80. These results go hand in hand with what the literature revealed in Figure 2.1. Figure 2.1 illustrated the general trend in net farm income after ZT is adopted. In the first two phases, a marginal decrease in net farm income can be expected. Thereafter, an exponential increase in the third phase can be expected and a levelling off in the fourth phase at a level higher than the initial starting point. According to Muscănescu, (2013) the initial decrease in yields and net farm

income in the early stages of adoption can be largely attributed to two processes. The first process is that of familiarisation and adaptation on the farmer's part. Mistakes and inefficiencies occur inevitably in the early days, but, as time goes by, the farmer becomes more familiarised with the techniques, improves their practices and management, and learns from previous mistakes. Secondly zero-tillage restores the biophysical environment's natural balance (FAO, 2007). As the soil is not tilled as much anymore, several soil conditions (fertility, porosity and soil moisture content for example) are improved and this normally results in greater yields and income (Muscănescu, 2013). According to Figure 2.1 in the literature, farm income generated from zero tillage is far better compared to conventional tillage. This was associated to the yield quantity which is usually higher for zero tillage farming than conventional tillage farming. This statement will be explained further in Figure 4.1. below:

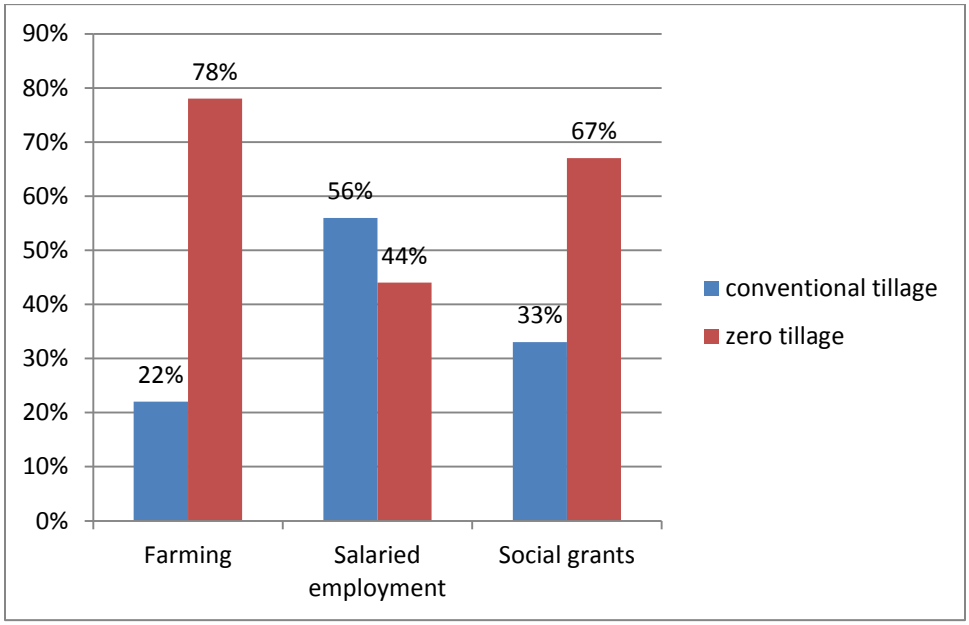

Figure: 4. 1 Distribution of household by income of the household head
Source: Based on SPSS data processing field data, 2017

4.2.10 Distribution of household by off-farm income of household head

Off-farm income is that portion of household income generated outside farming activities. This form of income includes remittances, social grants, family businesses, wages, etc. The contribution of off-farm income in South African rural areas is less than 40% of the total household income (Nkala, 2011). Figure 4.1 reveals that some of the respondents were not fully dependent on faming. For example, some of them were dependent on wage employment and social grants. About 56% of conventional tillage farmers generated income from salaried employment and 33% of conventional tillage farmers generated income from social grants while 44% of zero tillage farmers generated income from salaried employment and 67% generated income from social grants. From the survey, there were more conventional tillage farmers who generated high paying salaried employment than those of zero tillage.

When looked at Figure 4.1 above, and only concentrate on farmers who were only dependent on farming as they main source of income and exclude the off-farm income. Zero tillage farmers generated more income about 78% while conventional tillage farmers generated about 22% of farm income. These results reveal that the sources of income besides farming are contributing factor in decision making. This simply shows the importance of capital in zero tillage farming. This does not mean that there is no capital required for conventional tillage farming, but the amount is not the same when added with off-farm income. Therefore Figure 4.1 indicates that zero tillage generates more income than conventional tillage when we only focus on farmers who depended on farming only without the off-farm income.

4.2.11 Distribution of household by farm size of household head

In the rural areas of the Eastern Cape Province, where agriculture is mostly practiced, the size of the cultivated land is the most important factor that affects the level of

production. The results from the surveyed farmers shows that the average cultivated land size for conventional tillage farmers in the study area is about 1.77 ha while zero tillage farmers cultivated land is about 0.79 ha.

These results confirm the research result presented in KZN, (2008) from Tugela ferry in Kwa-Zulu Natal of South Africa. The study revealed that the landholdings for conventional tillage agriculture tend to be more compared to zero tillage agriculture. This is the usual case because it is believed that zero tillage farming allow the farmers to be able to practice intensive farming. Intensive farming sometimes makes farmers to shrink the land size cultivated. This follows the inverse relationship of land. Table 4.1 also confirms these results by the significant figures presented in the Table.

4.3 Empirical results

This section presents the results obtained from the propensity score matching model and gross marginal analysis. Gross marginal analysis was the major tool, which was used in the analysis to compare the returns between zero tillage and conventional tillage and assess the benefits of zero tillage. Propensity score matching model was used to determine the impact of zero tillage adoption on farm performance. In addition, the study used propensity score matching method (PSM) to estimate the average treatment effect (ATE) of cooperative membership on farm performance. This was done to overcome biasness that would have been made when running regression. The PSM and ATE were run using Stata version 13.

4.3.1 Performance of zero tillage and conventional

The main source of livelihood for the farmers in the Kieskammahoek rural areas is social grants and crop sales. The incomes are represented in the form of gross margins in Table 4.2 and Table 4.3 below, which are the incomes remaining after deducting the variable costs from the whole farm gross income.

Table: 4. 2 Profitability of zero tillage and conventional

Household production parameter	**Total cost (R)**	
	Conventional tillage	**Zero tillage**
Household income	R5695	R1064.88
	Conventional tillage	**Zero tillage**
Variable cost	416.26	38.41
	Conventional tillage	**Zero tillage**
Gross margin=HPP-VC	R5695-R416.26	R1064.88-R38.41
Gross margin	**R5278.74**	**R1026.47**

Source: Based on SPSS data processing filed data, 2017

Table: 4. 3 Gross Margin of zero tillage and conventional tillage

Parameter gross income	**Conventional tillage**	**Zero tillage**
Gross income	R5695	R1064.88
Total variable	R416.26	R38.41
Gross margin	R5278.74	R1026.47

Source: Based on SPSS data processing field data, 2017

The results presented in Table 4.2 and Table 4.3, indicated that smallholder conventional farmers generated significantly high household income of about R5695 and a gross margin of about R5278.74 respectively compared to zero tillage farmers having generated households income of about R1064.88 and a gross margin of about R1026.47. These results could be due to the fact that farmers who switch from using conventional tillage to zero tillage, know that in most of the cases, the yields and income decreases during the first few months or years of zero tillage adoption. This is because zero tillage processes restore the soil properties and all the damage that was caused by conventional tillage. Figure: 2.1 above illustrate how these variables are affected in the first few years after adopting ZT. In Figure 2.1, yield and income is shown to decrease temporarily during the first phase after adoption, gradually increasing in phases two and three and more or less stabilizing in the fourth phase. The farmers who practice conventional tillage farming are complaining that yields and income have decreased with time and they are continuing to decrease. As for the farmers who are involved in zero tillage farming, the farmers say their yields and income has improved very much and continues to increase with time. Thus, zero tillage support can be another factor that can be considered to improve incomes for rural households and reduce rural poverty.

In terms of variable costs, both groups of farmer's i.e conventional tillage and zero tillage farmers did not buy any inputs since the department of agriculture supplies the households with inputs. The maize producing farmers normally use seeds from the previous seasons. Both groups of farmers did not use fertilizers or chemicals for production. Only a few conventional tillage and zero tillage farmers made use of hired labour. Therefore, household that used zero tillage expected the sudden decrease on household income as shown in Figure 2.1.

4.3.2 Factors influencing the adoption of zero tillage

As stated in the introduction section, the first step of the econometric approach is to estimate the propensity score, i.e. the probability to participate in zero tillage is conditional based on observable variables. To generate the propensity scores for the matching process, the probability of a household to adopt zero tillage was estimated using the logit model.

The variables included in the model are gender of the household head, age of the household head, marital status of the household head, household size of household head, level of education of household head, land tenure system, soil fertility status, farm size, household income, source of income, and price of labour. The binary probit model was estimated to determine the household characteristics and resource endowments that affect household's participation in zero tillage farming.

Table 4.4 presents the results of the binary probit model. The results indicate that, collectively, all estimated coefficients are statistically significant since the LR statistic has a p-value less than 1%. The pseudo R value is about 67.96% which is high for cross sectional data. The model also correctly predicted about 60.3% of the cases, confirming that the model fits the data well.

Table: 4. 4 Factors affecting participation on zero tillage: Probit regression results

Variables	Coefficients	Standard Error	Z	P>|z|
Constant	4.861	2.678	3.295	0.070
Gender of HH head	0.641	0.782	0.673	0.412
Age of HH head	0.002	0.023	0.008	0.030***
Marital status	-0.763	0.437	3.048	0.041**
Household size	0.088	0.192	0.209	0.648
Level of education	0.149	0.520	0.082	0.775
Land tenure system	0.126	0.268	0.219	0.639
Soil fertility status	-0.148	0.567	0.068	0.794
Farm size	-2.185	0.810	7.266	0.007***
Household income	0.000	0.000	0.744	0.388
Source of income	-0.557	0.435	1.641	0.200
Price of labour	-0.008	0.002	16.627	0.000***
Probit model		Number of Observ =		100
		L R Chi2 (14) =		67.964
		Prob > Chi2 =		0.000
Log likelihood = 0.428		Pseudo R2 =		0.603

Notes: ***, ** and * means significant at 1% and 5% levels respectively

Source: Results from SPSS (Version 20) generated from field survey, 2017

The factors assumed to have influence on household adoption decisions for zero or conventional tillage in the study area are gender of the household head, age of the household head, marital status of the household head, household size of household head, level of education of household head, land tenure system, soil fertility status, farm size, household income, source of income, and price of labour. However, factors such as gender, level of education, household size, land tenure system, and household income affected participation decision for zero tillage positively but no statistically significant between zero and conventional tillage.

The model was statistically significant and the regression coefficients give the change in the z-score for a unit change in the predictors. Moreover; the value of Pseudo- R^2 (0.603) indicates that there was no systematic difference in the distribution of covariates between zero and conventional tillage in the study area. The probit regression revealed that variables such us the age, marital status, farm size and price of labour are eligibility to zero tillage positively affect the probability of participation in zero tillage farming significantly.

The probit model estimates indicate that age of household heads positively and significantly affects the probability of farmer's participation in zero tillage. This implies that there is a significant difference in terms of participation whether farmers are young or old. These results are similar to studies of (Nkala, 2011) which established that age was significant in the household head decision to participate in agricultural projects. However, on the contrary, a study of (Nkala, 2011) reported that younger household heads are more innovative in terms of technology adoption and are more likely to take risk than older household heads.

Marital status was found to be statistically significantly (at 10% level of significance) but negatively affects the probability of participation on zero tillage because marital status measures the likelihood of household heads participation in farming between single and married farmers. These results confirm the findings reported by MUSCĂNESCU (2013) stating that marital status of household head is very significant in African societies as it determines stability of families. The belief is that married household heads tend to be more stable in farming activities than unmarried heads.

The findings also show that, farm size was statistically significant but has a negative effect on probability of participation in zero tillage farming. The negative effect of farm size shows that households who have larger farm sizes are more likely to not participate in zero tillage as compared to households with small farm sizes. This implies that the households with large farm sizes, participation will decrease more likely by 2.18%.

Price of labour had a negative and statistically significant effect on zero tillage adoption (at 1% significance level), this simply suggests that the farmers which are partaking in conventional tillage have higher chances to engage in zero tillage farming because price of labour decreased with zero tillage farming as compared to conventional tillage.

Price of labour ensures that farmers can secure inputs in time. This leads to improved agricultural output, resulting in increased farm income. (Kidane, 2001) suggest that one of the most critical problems threatening the viability of zero tillage is the high costs that are incurred when the farmer changes from conventional tillage to zero tillage.

According to Table 4.4, household size, age, land tenure system, soil fertility status, source of income and household income are statistically insignificant but have a positive effect on zero tillage adoption. This means that the variables do not affect zero tillage adoption in any way.

4.3.3 The relative impacts of zero and conventional tillage on household income.

A propensity scores matching was done to select the balancing property. The use of the balancing properties ensures that a comparison group is constructed with observable characteristics distributed equivalently across quintiles in both the treatment and comparison groups (Nkala, 2011). The nearest neighbour and Kernel matching methods were used to estimate the impact of zero and conventional tillage methods on household income. Table 4.5 presents the results from the PSM model that was estimated for comparison purposes with the treatment effect model results.

Table: 4. 5 Propensity Score matching to measure the relative impact of zero tillage and conventional tillage on household income

Output variable	**Kernel Matching Method**		
	ATT	**Standard error**	**t-value**
Household income	5512.723	2860.551	0.054**
	Nearest Neighbours Matching Method		
	ATT	**Standard error**	**t-value**
Household income	6301.745	4539.107	0.165*
Model Summary	Number of observation =100 Matches requested =7 Treatment model =Probit		

Notes: ***, ** and * means significant at 1% and 5% levels, respectively.
Source: Results from Stata (Version 13) generated from field survey, 2017

The estimates for the average household income earned from zero tillage farming ranges from R5512.723 to R6301.745 depending on the matching method used. All estimates are significantly different from 5% and 10% critical level. It has been noted that for the nearest neighbouring method, the lower the number of observations the higher the significant level and the opposite is true for the Kernel matching method. The income effect from PSM is similar to the significant income mean difference between zero and conventional tillage farmers as presented in table 4.5.

From these results we conclude that participation in zero tillage farming has a significantly positive effect on household income. The household income shows significant mean difference (Table 4.2). Furthermore, the difference in the tillage systems used also contributes to the income difference between zero tillage and conventional tillage farmers.

The main challenge for smallholder farmers using zero tillage is record keeping which is crucial for traceability. Table 4.5 indicates that the household income of zero tillage production is low as compared to conventional tillage. In general, zero tillage farming can therefore be considered to be an interesting opportunity for farmers in the study area. Nevertheless, many zero tillage farmers in the study area are not familiar with the term “Zero Tillage” because the extension officers who educated them about the zero

tillage farming system introduced it as the “God’s way of farming” and are not fully aware of the benefits of zero tillage farming but still use zero tillage farming system.

As observed in Table 4.4, the impact of participation on zero tillage increases with age. This means that the older the farmers, the higher the likelihood of participation. These results contradicts the finding by Kidane, (2001) reported that as the age of the household head increases, the probability of using zero tillage is likely to decrease, because, with age, a farmer can become more risk averse and then tend to be reluctant to new technologies.

4.4 Chapter Summary

This chapter presents and discusses the results of descriptive analysis of zero tillage and conventional tillage farmers. Within this chapter, descriptive statistics such as frequencies, percentages, graphs and means were used. Demographic characteristics, age, gender, marital status, level of education and other socio-economic variables such as farm size, household size and land tenure systems were covered.

The study results indicated that the majorities of smallholder farmers in the area were females. This was found to be consistent with the results from statistics South Africa since they revealed that there are more females compared to males in the Eastern Cape Province and international.

In terms of education, the results indicated that the zero tillage farmers were more educated than conventional tillage farmers and household sizes from the sample respondents were found to have a median of five persons per household.

The results also showed that the majority of farmers in the study area fall in the category of farming as their primary occupation. However, it was found contradicting because most of the farmers relied on government support grants for their livelihoods. Farming was the second source of income for the study farmers. The farmers indicated that during dry seasons farming is bound to crop failure and this means that they will be left only with government support grants and other non-farm activities. Therefore, with

these unfavorable factors such as droughts and frost farmers in the study area are likely to perform less than expected.

Farmers in the study area grew a variety of crops. The main crops that were identified include maize, potatoes, cabbage, spinach, carrot and onions of which the majority of the farmers grew potatoes, cabbage, spinach, carrot and onions as a staple food. Cabbage, spinach and potatoes were also significant crops grown by all farmers in all communities studied. They indicated the reasons to grow such crops, but most importantly they said they grew crops for income. Crop diversification can be a very important factor for farm performance as farmers can easily switch to crops that can survive even under harsh conditions and not to waste resources on crops that are not adapting. Improving farm size and markets access increases chances of better performance as farmers become exposed to information about demand on the market and other external factors.

The gross margin analysis results for zero tillage and conventional tillage farmers suggested that the conventional tillage farming households generated more income than zero tillage farming households. The farmers which practised conventional tillage farming were complaining that yields and income have decreased with time and they are continuing to decrease. As for the farmers which practised zero tillage farming, the farmers said their yields and income has improved very much and continues to increase with time. Thus, zero tillage support can be another factor that can be considered to improve incomes for rural; households and reduce rural poverty.

Probit model indicated that participation in zero tillage farming is greatly influenced by age of the household head, marital status, farm size and price of labour. The results from PSM indicated that participation in smallholder zero tillage farming contributes to household income. This implies that participating on zero tillage farming can contribute to rural livelihoods, increased income and production yields. The study results showed that households chose different farming systems based on their knowledge, level of education and farming experiences.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMANDATIONS

5.1 Introduction

This chapter therefore gives the summary and conclusions arrived based on the findings of the study. Finally, the chapter puts forward some recommendations which are believed to be of future benefit to small scale farmers which may intend to adopt zero-tillage farming system.

5.2 Summary

The dissertation was divided into 5 chapters which covered the background of the study and problem to be address, the literature review, methodology and the presentation of results for this research. In this section, each of the foregoing chapters will be summarized, highlighting the main issues covered and how that links to the overall theme of the dissertation. These summaries are presented in the next several sub-sections.

5.2.1 Background and Problem statement

Over the years, many significant agricultural changes have occurred and the changes have mainly been associated with using conventional tillage. CT is normally based on soil tillage as the main operation of agriculture which results in the most disruptive form of soil tillage, “inversion tillage, where literally the soil is turned upside down, leaving no soil cover and destroying the soil structure and soil properties (FAO, 2008). This process leads in the long term to a reduction of soil organic matter, fertility, decreased crop yields and soil erosion. Therefore, most soils degrade under prolonged intensive conventional agriculture. For such reasons, farmers and agricultural researchers have been looking for alternative tillage practices which are going to be sustainable to the environment and more productive.

Among all agricultural sustainable tillage practices, zero tillage has been found worthy of every farmer's recommendation. Zero-tillage describes a form of cropping which does not use mechanical tillage of the soil for crop establishment. Soils in many areas of the Eastern Cape (EC) province of South Africa where smallholder farming is practiced are prone to erosion and rapid degradation due to high levels of conventional tillage (Mandiringana et al, 2005). A South African national state of the environment report (Dube, 2012) identified the EC province as having the second highest level of land degradation. Hence the Eastern Cape Province is characterized by poor soil fertility, land degradation and excessive soil erosion accompanied by the formation of large gullies (Fanadzo et al., 2010).

5.2.2 Literature review

The literature reviewed suggests that, zero-tillage has been long promoted in many developing countries including South Africa as a way of driving sustainable agricultural practice, agricultural growth and rural development. There have been a lot of scholarly views about the definition tillage. However, this study used the definition of FAO. Soil tillage systems are the sequences of all operations involved in producing crops. The aim of tillage is to prepare the soil environment favorable to plant growth. Soil tillage consists of all operations for seed sowing which improves soil, and environmental conditions for seed germination to crop growth. Tillage is the traditional method to control weeds. Generally, there are two types of tillage systems i.e. conventional, and conservation tillage systems. Conventional tillage practices refer to the use of a moldboard or animal drawn plough to incorporate residue into the soil by extensive tillage. Conservation tillage is a term used to describe a number of farming practices that are utilized in agriculture to conserve water and soil such as zero-tillage. Zero tillage is any system or practice which aims to conserve soil and water by using surface cover (mulch) to minimize runoff and erosion and improve the conditions for plant establishment and growth. Zero tillage is a practice used in agriculture to reduce the effects of tillage on soil degradation, poor soil quality, soil organic matter and erosion. The concept of zero tillage is not entirely new to smallholder systems of South Africa. In

the 1970's researchers tried to promote minimal tillage as an entry point to zero tillage in various provinces to address increasing land degradation problems but with limited success. Small scale farmers are constrained by a number of factors linked to the institutional environments and arrangements operating in the region. These factors are not only hindering zero-tillage adoption but agricultural sustainability.

5.2.3 Study methodology:

This study was carried out in Amahlathi local municipality. Eleven villages were purposively selected because they have farmers who applied both conventional tillage and zero-tillage. This study employed a cross-sectional research design. Data were collected at one point in time. Multi-stage sampling technique was employed to arrive at the sample size of the study. The main objective of the study was to compare zero-tillage and conventional tillage. In order to know if the model is applicable to the study, three specific objectives were analysed using descriptive analysis, propensity score matching and marginal analysis. Descriptive statistics were used to describe the types of tillage systems which were used and to explain the possible reasons on why the farmers would choose the tillage system they are using The propensity score matching model was employed to analyze the factors influencing adoption of zero and conventional tillage and to determine the relative impact of zero and conventional tillage on household income, gross margin analysis was employed to analyse performance of zero and conventional tillage in terms of quantity produced.

5.2.4 Research Findings

The findings have established that households for zero tillage are headed by women with (63.8%) and conventional tillage households are headed by males with (51.6%). This implies that farmers that are under zero tillage farming or conventional tillage farming should consider gender balance in Kieskammahoek so that farmers can share responsibilities. Family size is relatively small especially for zero tillage farmers as compared to conventional tillage farming which is used to increase labour supply.

Kieskammahork farmers have very small land sizes (between 0 and 1 ha) for zero tillage farmers. They operate below the recommended farm size threshold below which any form of agricultural production is not viable. The conventional tillage farmers are operating on between (0.5 and 2 ha) of land. This means that if they are efficient enough they could be viable. Both groups of farmer's zero-tillage and conventional tillage operate far below the potential production levels. This means that a lot has to be done for and by these farmers to improve their production efficiencies so that they can attain the potential levels of production for all the crops they produce.

As far as household income is concerned conventional tillage farmers overall household incomes has proved to be the mainstay of smallholder farmers in Kieskammahoek area. But when only concentrating on farmers who were only dependent on farming as they main source of income and exclude the off-farm income. Zero tillage farmers generated more income about 78% while conventional tillage farmers generated about 22% of farm income. These results reveal that the sources of income besides farming are contributing factor in decision making. This simply shows the importance of capital in zero tillage farming. This does not mean that there is no capital required for conventional tillage farming, but the amount is not the same when added with off-farm income. Therefore Figure 4.1 indicates that zero tillage generates more income than conventional tillage when we only focus on farmers who depended on farming only without the off-farm income.

5.3 Conclusion

Conclusions are formulated on the extent to which agricultural tillage systems adopted influence farm performance. The study showed that conventional tillage farming system and conservation tillage particularly zero-tillage farming systems are adopted in the Eastern Cape Province. Adoption of zero-tillage has made a positive contribution on farm performance of farmers, even though its contribution is not significant as compared to conventional tillage systems. The study results indicated that farmers which adopted zero-tillage farming system produce more crops per hectare than the conventional

tillage farmers. This could be attributed by the assumption that zero-tillage farming restores the soil prosperities such as degraded soils, soil nutrients, and soil fertility but conventional tillage farmers produce an equal amount or even a little bit more crops on overall because they have bigger plots of land than zero-tillage farmers and also receive farm inputs support. The study also indicated that there are some constraints that prohibit rural households from adapting zero tillage farming such as lack of knowledge, land, machinery and support services from both government and private sector. As far as household income is concerned conventional tillage farmers incomes has proved to be the mainstay of smallholder farmers in Kieskammahoek area but the farmers which are practising conventional tillage farming were complaining that yields and income have decreased with time and they continuing to decrease. As for the farmers which were practising zero tillage farming, the farmers said their yields and income has improved very much and continues to increase with time. Thus, zero tillage support can be another factor that can be considered to improve incomes for rural; households and reduce rural poverty.

Even though there has been so many arguments about zero-tillage failures in developing countries, the results of the study confirms that zero-tillage is still the solution to most of the problems faced by smallholder farmers. The study concludes that zero-tillage indeed improves the income of participating farmers. The implication of these findings is that zero-tillage can reduce rather than entrench rural poverty as some studies have suggested. Policies and strategies which will make it easier for smallholder farmers to adopt zero-tillage should be pursued. These include policies that target improvement of land issues in rural areas. The findings that small scale farmers are less likely to adopt zero-tillage farming due to risks involved calls for policies and strategies that target zero-tillage farming. All these programmes will positively contribute to better performance of the small scale farmers.

5.4 Policy recommendations

Based on the study results, the following recommendations are made so as to improve performance of farmers in Amahlathi Local Municipality of the Eastern Cape Province.

From the literature reviewed and also the results obtained, it suggests that the success of small scale farming depends on a series of factors which include the provision of farm inputs, government support, and socio-economic factors. There is a need for support programmes that would help to motivate individual farmers for better performance. The government and research institutes need to come up with workshops and extension programmes to train farmers about producing using zero tillage farming system. All these programmes will positively contribute to better performance of the smallholder farmers. There is a need for a strong extension support and advises to help people on how to diversify their production, provide market information thereby enhancing production and opening channels to the market.

Mentorship programmes should also be encouraged so that smallholder farmers can work closely with commercial farmers. They will enable smallholder farmers to have access to the new technologies and managerial skills of running their farms. Therefore promoting smallholder farmer's to profitable markets to improve their incomes. For rural households to exploit the opportunities in rural areas, the government, municipalities, non-governmental organizations and private sector need to take a leading role in providing farmers with technical support to increase their knowledge about zero tillage.

5.5 Implication for future research

1. The comparative analysis of zero-tillage and conventional tillage on small scale farmers was conducted in Amahlathi Local Municipality only. So it is suggested that more similar studies may be conducted in the whole Province of Eastern Cape as there are a lot of small scale farmers.

2. The study focus was on zero-tillage and conventional agricultural crop farmers. Further research can be conducted on all zero-tillage and conventional tillage farmers in the province, checking their impact on production and marketing.

3. It is also suggested that the study on the factors affecting the efficiency of zero-tillage small scale farmers could be conducted.

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APPENDIX: QUESTIONNAIRE

University of Fort Hare
Together in Excellence

FACULTY OF SCIENCE AND AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

COMPARATIVE ANAYLSIS OF ZERO-TILLAGE AND CONVENTIONAL TILLAGE PRACTICES IN THE AMAHLATHI LOCAL MUNICIPALITY EASTERN CAPE PROVINCE OF SA.

Please be aware that this survey is completely non-discriminatory, promises nothing and the information that you are about to give helps in the interpretation of the results. We want to assure you that by partaking in this survey, your identity shall be kept in strict confidentiality. There is no right or wrong answers.

Date of interview		Name of village	
Name of municipality		Name of distract municipality	
Interview		Ward number	

Section A: Socioeconomic Characteristics

No	Socioeconomic Characteristics	Responses	Codes for options
1.1	Gender		0=Female, 1=Male
1.2	Age(Years)		Write date of birth
1.3	Marital status		0=Married, 1=Single, 2=Widow/er, =Divorced
1.4	Household size		Total number of people living in household
1.5	Indicate household members age group below		
A	0-20		Write actual number
B	21-50		Write actual number
C	Above 50		Write actual number
1.6	Highest education qualification attained		0=no formal education, 1=primary education, 2=secondary education, 3=tertiary education
1.7	Source of income		0=farming, 1=salary employment, 2=social grants
1.8	Religion		0=Christianity, 1=traditional,

			2=other
1.9	Range of household income		Actual
1.10	How many animals do you have		
1.11	Types of animals		0=cattle…….. 1=goats…….. 2=sheep…….. 3=oxen's……. 4=other……..

Section B: Production, land ownership and allocation to different crops

2.1	Indicate the land tenure system		0=communal, 1=Rent/lease, 2=inherited, 3=Family 4=other
2.2	Indicate soil fertility status		0=infertile, 1=moderately fertile, 2=very fertile, 3=highly manured,
2.3	Which farming activities are you		0=crop production only,

	undertaking at the moment?		1=livestock production only,2=mixed farming
2.4	How much land do you own/have access to?		In hectares (Ha)
2.3	Part of land you cultivated (Ha)		
2.5	Which farming system do you use?		0=Conventional tillage, 1=Zero-tillage
2.6	Indicate the production assets you have?		0=tractor, 1=animal traction, 2=hand tools/implements, 3=land, 4=other
2.7	What is your aim for production?		0=sell, 1=own consumption, 2=other

2.8 Which crops did you grow this year and the yield quantities sold?

Crops grown	Area planted (Ha)	Yields (ton)	Price (R/Unit)	Quantity sold	Income (R)
Spinach					
Cabbage					
Potato					
Beetroot					

Carrots					
Onion					
Maize					

2.9 Based on the various activities listed below, indicate amount of labour and time (hours) spent on in completing the activities.

Farming activities		**Labour (number)**	**Time (hours)**
Ploughing			
Planting			
Weeding			
Harvesting			
Shelling and storage			
2.10	How did you obtain seeds?		0=Pervious harvest, 1=Local seed shop, 2=Government programs, 3=Co-op, 4=other
2.11	Do you have an option of varieties of seeds you mentioned above?		0=No, 1=Yes

Section C: Farmers knowledge about Zero-Tillage

3.1	Do you know about ZT?		0=No, 1=Yes
3.2	How did you learn about ZT?		0=media, 1=extension officers, 2=Neighbors, 3=family, 4=co-op, 5=farmers group/association, 6=other
3.3	How do you rate this information		0=not adequate, 1=adequate, 2=none
3.4	Do you think ZT is beneficial?		0=No, 1=Yes

Section D: Level of Zero-Tillage adoption

4.1	When did you start using ZT?		Write the year
4.2	For how long have you been using ZT?		Write number of years
4.3	Do you still use ZT?		0=No, 1=Yes
4.4	If no why did you stop using ZT?		0=its expensive, 1=not beneficial, 2=both
4.5	What influenced your adoption of ZT?		0=cheap, 1=saves costs and labour, 2=necessity, 3=beneficial, 4=easy to

			apply, 5=extension officers, 6= other
4.6	Do you need to know more about ZT?		0=No, 1=Yes
4.7	Has the yield performance improved since adopting ZT?		0=No, 1=Yes

Section E: Farmer perception towards Zero-Tillage and Conventional Tillage

Type of perception	**Perception on adoption**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Environmental risks	CT is the main problem in your area over ZT					
	CT leads to the loss of soil fertility and soil properties					
	CT threatens the environment?					
Benefits	Introduction of ZT has made farming easier					
	ZT has lead to					

	increased yields					
	Crops taste differently and are more nutritious on ZT					
	ZT products have better quality than CT					
	ZT high yields influence your adoption decisions					
	ZT is labour and cost saving					
Equity Concerns	ZT is beneficial over CT					
	ZT benefits small scale farmer					
	ZT restores soil properties over CT					
	ZT benefits unfertile soil					

Section F: Extension Services

Do extension officers visit?		0=No, 1=Yes
How frequent are the visits?		0=weekly, 1=fourth nights, 2=monthly, 3=once in six months, 4=once a year
During which farm operation do extension officers visit?		0=land preparation, 1=input provision, 2=sowing, 3=harvest, 4=other
Do extension officers educate you about ZT and CT benefits and disadvantages?		0=No, 1=Yes
Is the information provided by the extension officers adequate?		0=No, 1=Yes