Farm level cost-benefit analysis of conservation agriculture for maize smallholder farmers in Okhahlamba Municipality in Kwa-Zulu Natal Province, South Africa

By

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ABSTRACT

Land degradation is a serious problem that many poor communities face and this worsens their vulnerability and therefore, poses a threat to food security, as it reduces yield, forces farmers to use more inputs, and disproportionately affect the smallholder farmers in remote communities that also suffer diverse infrastructure disadvantages. In response to that, the international development agencies, donors, and Non-Governmental Organizations (NGOs), especially faith-based organizations have turned towards sustainable farming approaches. Much attention has been paid to a combination of sustainable farming measures which are packaged under the "Conservation Agriculture" (CA) banner. The previous work in the KZN Province and elsewhere has demonstrated that CA has the potential to improve the soil structure, thereby reversing the effect of soil degradation. Consequently, many of the farmers in the areas in which these demonstrations have been conducted appreciate the ecological and economic value of adopting CA. However, the on-farm financial benefits of adopting a CA specific tillage practice are not as well known or thought to be as pronounced. By means of integrating field survey, reviewed literature, and econometric analysis, this study assessed the farm level cost-benefit analysis of conservation agriculture for smallholder maize farmers in OLM, specifically in one demonstration village of Bergville town. The analysis is based on the case study of the NGO's work in which they had selected a community and participating households who received assistance in a number of ways such as maize seed, soil preparation, and CA planters. To analyse the farm level cost-benefit analysis, descriptive, linear regression, gross margin (GM) and appraisal indicators such as Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were used. The descriptive analysis, used to analyse the factors affecting the extent of adoption of CA revealed that socio-economic characteristics have the influence on the level to which a farmer responds to incentives. Linear regression model used in this study showed that years in farming, involvement in joint farmer's group, and use of cover crops have the significant effect on the extent of adoption of CA. Moreover, the calculated gross margins of the two tillage systems were different, revealing higher Gross Margins for CA plots than for conventional plots. The major cause of the difference was found to be differences in the variable costs. When using appraisal indicators (NPV, BCR, and IRR) the study projected a 10-year period at 8% and 10.5% discount rates. The study *also revealed positive NPVs for both CA and conventional agriculture. The positive sign implies that there are positive pay-offs for investing in both trial and control plots. However, trial plots have larger NPVs compared to control plots, meaning that there are less additional returns for investing in control plots compared to trial plots. Results also reveal that with 10.5% discount rate, the NPVs are lower than with 8% discount rate, showing that* lower discount rates are consistent with higher performance over the long term. *This therefore means that at lower discount rate, it is more viable to produce maize using CA than using conventional tillage system. In the case of BRC presented in the study, it was revealed that at both low and high discount rates, the trial plots were more viable than the control plots. Finally, the IRR presented in the study reveal that the trial plots would be able to pay their way much faster than the control plots. Overall, the study found that there are incentives to adoption of CA compared to conventional farming. The message from the different results arising from the use of different discount rates is that farmers should receive assistance at low cost of capital in order for their operations to be viable and this works out well over the long term as shown by the 10-year period projections.*

Key words: Benefit Cost Ratio, Conservation Agriculture, Conventional Agriculture, Gross Margin, Internal Rate of Return, and Net Present Value

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LIST OF ACRONYMS

BCR	Benefits Cost Ratio
CA	Conservation Agriculture
CBA	Cost Benefit Analysis
DAFF	Department of Agriculture Forestry and Fisheries
FIP	Farmer Innovation Programme
GM	Gross Margin
IRR	Internal Rate of Return
KZN	Kwa-Zulu Natal
NGO	Non-Governmental Organisation
NPV	Net Present Value
OLM	Okhahlamba Local Municipalitty
PVB	Present Value of Benefits
SSA	Sub-Saharan Africa

CHAPTER ONE

INTRODUCTION

1.1 Background

In response to general concerns about global food security, farm profitability and agricultural land degradation, international development agencies, donors, and Non-Governmental Organisations (NGOs), especially faith-based organisations, have turned towards sustainable farming approaches (Du Toit, 2007; Giller *et al*., 2011; Baudron *et al.*, 2012;). Much attention has been paid to a combination of sustainable farming measures which are packaged under the “Conservation Agriculture” (CA) banner (Pannell *et al.*, 2014). Conservation Agriculture package is based on three principles viz. “zero tillage (or minimum soil disturbance), retention of crop residue for soil cover (also known as mulching)”, and “crop rotation” (Brouder & Gomez-Macpherson, 2014). Retention of crop residues under the CA banner is associated with the increased soil carbon, in contrast to conventional tillage method (Andersson & D’Souza, 2014). Hence, many of its proponents argue that CA increases soil productivity over time compared to the conventional tillage systems. Besides the experimental evidence of increased water productivity under sub-optimal rainfall conditions, CA has been associated with the potential to promote different livelihood strategies, resilient ecosystems and efficient food systems even under negative future climate change and unreliable rainfall (Mnkeni & Mutengwa, 2014).

Sims and Kienzle (2015) stated that about 155 million hectares (10% of global arable land) in the world are being farmed under the CA system. In 2010, the adoption growth rate was estimated to be 9 million hectares per annum with South America having the highest rate of adoption (Derpsch *et al.,* 2012), followed by United States of America (USA) and Canada with about 39%, Australia with about 9%, while the rest of the world account for about 3.9% (Du Toit, 2007). Du Toit (2007) further revealed that the most notable African countries that have adopted CA to some extent include Angola, Benin, Ghana, Ivory Coast, Kenya, Mozambique, Niger, South Africa, Tanzania, Zambia and Zimbabwe.

Pannell *et al.* (2014) stated that not all the principles embedded in CA package have been fully adopted. For instance, most of the African farmers who have adopted the CA package, have focused on the principle of minimum soil disturbance (Pannell *et al.*, 2014). The study conducted by Giller *et al.* (2009) suggested that given the present situation, the whole CA package may not be appropriate for most resource-poor farmers, especially Sub-Saharan African farmers. The major concerns are more related to the poor performance of CA during the early years of adoption, bearing in mind that adoption of CA has the greatest impact on yields and returns to labour with the latter largely dependent on the farmer.

This has led some researchers to come up with questions regarding the potential of CA to achieve some of the stylized benefits that the proponents claim it entails (Andersson & D'Souza, 2014). One of the arguments is that CA is not a "one-size-fit-all" package, especially within the majority of smallholder farmers in Sub-Saharan Africa (SSA) (Corbeels *et al.,* 2014). In their research, Giller *et al.* (2009) verified that although CA can provide commendable benefits to some farmers in certain locations at certain times, there is a need to identify where and how particular CA practices may fit and which farmers given in any community are likely to harvest more benefits than costs.

1.2 Problem statement

The livelihood of rural households in Bergville town of the Okhahlamba Local Municipality (OLM) in Kwa-Zulu Natal Province of South Africa is directly related to their natural resource base (Barney & Mthembu, 2012). Specifically, the "land", which receives high rainfall with large areas covered with medium to high potential soils, making it a substantial part of the Province suitable for cultivation, for both commercial and subsistence purpose (Stronkhorst *et al.*, 2010). However, steep slopes and high degradable soil due to high rainfall, combined with conventional agriculture, pose a serious threat to this important resource and consequently to the entire agricultural community in the region (Stronkhorst *et al.*, 2010).

In response to that, in the year 2000, the Agricultural Research Council (ARC) introduced the CA in the area in order to minimize the effects of soil degradation while improving the soil structure, thus improving farmers yield. When the CA project was introduced, the response to the adoption was positive to the point that the number of participants in the programme increased from the 20 trained lead farmers to 85 farmers. However, when the ARC-project came to an end in 2005, the farmers that adopted the CA did not continue. There was the anecdotal evidence that farmers did so because benefits were not sustained but no systematic study has been carried out to ascertain the facts.

In 2013, the programme was revived by the Mahlathini Organics, the Non-Governmental Organisation (NGO) based in Pietermaritzburg in KZN, under the Grain-South Africa Conservation Agriculture Farmer Innovation Programme (Grain-SA CA-FIP) and SaveAct Trust (Kruger, 2014). According to Kruger (2014), the Mahlathini Organics re-introduced the CA practices in the area as a pilot study to the organized smallholder farmer groups from six different villages. The NGO took note of the corridor talk and designed the new intervention to control for the things that may have caused the previous project to fail. However, there is a lot of optimism now and it seems that they have addressed the concerns and this is likely to influence public policy in respect to support for CA. So, this study seeks to apply cost-benefit theory to ascertain that this enthusiasm and optimism will be sustained.

1.3 Objectives

The broad objective of this study is to assess the farm level cost-benefit analysis of conservation agriculture for maize smallholder farmers in Okhahlamba Local Municipality (OLM) in KZN Province of South Africa. To be more specific, this study seeks to:

i. Assess the factors affecting the extent of CA adoption among the maize smallholder farmers in the study area.
ii. Compare the yield levels of CA over the conventional farming in the study area
iii. Assess the cost of CA over conventional agriculture in the study area.
iv. Evaluate the sustainability of CA against conventional farming over time.

1.4 Research questions

By briefly looking on the criteria to be considered in this study, the following questions are crucial:

i. What are the factors affecting the extent of CA adoption among the smallholder maize farmers in the study area?
ii. what is the level of yield of CA compared to conventional farming?
iii. Is the CA cost effective solution when compared to conventional agriculture?
iv. Can CA be sustainable compared to conventional farming over time in the study area?

1.5 Significance of the study

The rationale behind cost benefit analysis (CBA) is that investors or policy makers have seen themselves being confronted with difficult choices, of which it is hard to shirk. In South Africa, for example, arable lands are being degraded due to poor land management. Therefore, among all the land sustainable management practices, CA is regarded as the best panacea for the predicament of smallholder farmers. However, adopting this farming method is accompanied by uncertainties and this has been daunting the interest of susceptible adopters. Similarly, government has to make accurate decision if it has to finance the adoption of this farming method in other parts of South Africa, as it is well known that the adoption of this farming practice is very low in some other parts of the country.

Nonetheless, the probable outcomes of the analysis can help to reduce the level of uncertainty and improve the decision-making process. By briefly looking on the criteria to be considered by farmers include these questions: will the CA provide the farmers the best benefits; is the CA cost effective solution when compared to conventional agriculture; can the CA provide the earliest returns to the investor, and can CA be sustainable over a period of time.

The chosen criteria by the farmers usually capture the CBA as the only economic analytic tool in the midst of alternative decisions, especially when the financial data is uncertain. The advantage of using this method is that it is good in: Identifying alternative options; Defining alternatives in a way that allows fair comparison; Adjusting for occurrence of costs and benefits at different times; Calculating dollar or money values for things that are not usually expressed in dollars; Coping with uncertainty in the data; and Summing up a complex pattern of costs and benefits with a view to guide decision making.

Therefore, this dissertation chooses to use CBA due to its ability to weigh alternative costs and benefits in monetary terms.

1.4 Limitations and delimitation of the study

One of the limitations of this research study was the constitution of the sample. First, farmers were not randomly selected from a larger population to participate in the study. Sample was based on the smallholder farmers who managed to monitor and record the yield results ever since Mahlathini Organics began to promote CA adoption in OLM. Hence, the sample was based in one village out of almost 15 participating villages. This might have biased the sample. However, the members of Mahlathini Organics commented that average yield level for each village were recorded. The average of each village was not far from individual yields recorded in this dissertation. The sample was also relatively homogeneous with mostly women farmers. Therefore, the results might not generalize to other smallholder farmers, particularly those who can read or write.

1.6 Outline of the dissertation

Following this first chapter that delivered an overview of the study, underlining the background, problem statement, and the research questions of the study, the next chapter begins the formal way of reviewing the literature by assessing the conservation agriculture in economic perspective. Chapter three mainly focuses on the description of sampling procedures, conceptual framework and the overall research process of the project. The section describes the sampling procedure followed during the study and the survey instruments used to extract data at each section. Qualitative and quantitative data will be collected and relevant analytical techniques will be used to analyze the data. Chapter four presents the results and discussion of the research. Chapter five presents the discussion, conclusion and recommendations. The following chapter presents the literature review of the dissertation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Since conservation agriculture is the subject of this dissertation, it will be useful to throw some light on the extent to which this practice has been adopted. It is worth noting that the extent of innovation adoption depends on who is the decision maker of the farm. The theoretical perspective on adoption of an innovation reveals that innovation adoption depends on various aspects including the knowledge about the innovation, persuasion on the credibility of the innovation, and whether it has been implemented by other farmers. This chapter continues to discuss the factors that would affect the CA adoption.

2.2 Basic concept of conservation agriculture

Definition used by the Food and Agriculture Organisation (FAO) (2001) in defining CA states that it is the set of technologies, including, minimum tillage, permanent soil cover, crop rotation and integrated weed management. The three principles embedded in the CA system include:

- Continuous minimum soil disturbance;
- Permanent soil cover and intercropping;
- Crop rotation.

2.2.1 No-till (Or reduced tillage)

No-till involves not disturbing the soil from harvesting to planting, save only for nutrient injection (FAO, 2001). However, it appears in different forms for different contexts (Pannell *et al.*, 2014). For example, in mechanised farming, common to commercial farmers, no-till involves the use of implements that create a narrow slot for the seed without disturbing and turning the soil over, while less mechanised farming, which is common to smallholder farmers, involves the use of manual “hand hoes” or simple using stick (Madondo, 2017). Uri (2000) and Madondo (2017) further asserted that in most cases when practicing zero-tillage, a farmer usually sprays the field with herbicide in two to three weeks’ time before planting. Having sprayed the field, furrows are opened by hand hoe or with the “knapik animal-drawn planter” which is community owned by most smallholder farmers in South Africa (Sterve, 2008). Knapik animal-drawn planter is also essential for injecting the seeds while spontaneously releasing the fertiliser inside the same furrows which it has opened with approximately 30 cm in between (Sterve, 2008).

In most cases, the rationale behind following the zero-tillage component of CA is to reduce production cost (Pannell *et al.*, 2014). Beside the cost reduction, Sterve (2008) stated that zero tillage helps the soil to reduce the oxidation processes which lead to the increased soil organic matter. This therefore means that the content of earthworm is higher in zero tilled soil compared to tilled soil (Kladivko *et al.*, 1997). However, reduced planting costs do not guarantee positive return to yield.

2.2.2 Mulching and intercropping

Mulching involves the application of plant residues or suitable materials for covering the soil (Kosterna, 2014). The material suitable for mulching can either be organic or inorganic. However, for agricultural purposes, the most preferable mulch is the organic mulch because it decomposes and get used by the soil.

The sole purpose of placing the mulches on the soil surface is to maintain soil moisture and improve soil conditions.

Amongst the three components of CA, mulching is the most contextual components (Sterve, 2008). Meaning that, it depends on specific factors such as cropping intensity, community tradition, type of land ownership, non-agricultural income, etc. (Pannell *et al.,* 2014).

2.2.3 Crop rotation

Crop rotation one of the determinants of the success in the crop production enterprise, especially when all the conservation principles are applied. Crop rotation is the biological way of addressing the problems associated with insects, pests and diseases (Siddique *et al.*, 2009).

2.3 Benefits of CA

From the technical point of view, CA has the number of proven environmental and economic benefits. However, it is noted that a farmer who chooses CA over any alternative agricultural practice does so hoping that it will maximise net farm profit (Uri, 2000). For that reason, in assessing the cost benefits of CA against the alternative agricultural tillage, which is the conventional agriculture in this case, it is expedient to consider each constituent that is making the significant contribution to the farmer's adoption. Each benefit will be briefly assessed.

2.3.1 Yield level of CA

The study on the meta-analysis of CA on maize grain yield under rain-fed conditions was conducted by Rusinamhodzi *et al.* (2011) around the world. They noticed that maize yield under rain-fed conditions are characterised by fluctuating yield levels, hence it was deemed worthy to identify factors influencing crop yield under CA and rain-fed conditions. Fair enough, the study revealed an increase in maize yield over time with CA farming practices in moderate and low rainfall areas. Knott (2015) confirmed Rusinamhodzi *et al.* (2011) results in the study he conducted in Western Cape on the analysis of the financial implications of different tillage systems within the crop rations saying that crop rotation, which is one of the principles of CA, leads to the improved soil fertility by using legumes. Improved soil fertility therefore results to higher yields over time which cannot be achieved through conventional agricultural practices. Another study which aimed at identifying the significant economic benefits from a variety of CA related systems in India by Prabuddh and Suresh (2013) revealed that conservation practices in some states of Haryana and Rajathan recorded the yield increase in millet pearl at 23% while in soybean CA increased yields at 15-18%. These research results have been confirmed by different authors stating CA can result to yield improvements with less time (Sterve, 2008; Giller *et al.*, 2009; Balana *et al.,* 2012; Atampugre, 2014; Daujanov *et al.,* 2016).

Uri (2000) justified the yield increase from CA by asserting that yield is a function of many site-specific factors that include local climatic conditions, cropping patterns and soil characteristics. Soil characteristic is thus affected by CA in such a way that organic matter content, and soil micro-organisms improve their functioning, consequently resulting to yield increase. Moreover, CA enhances the water infiltration which is associated with mulching, one of the three principles of CA, provides additional moisture content that benefit crops during the low rainfall seasons (Giller *et al*., 2009; Sterve, 2008).

However, the acclaimed consequent yield increase associated with CA take a relatively long time to materialise (Giller *et al*., 2011), which is making it hard for rural subsistence smallholder farmers to adopt (Pannell *et al.,* 2014).

2.3.2 Reduced environmental degradation

According to Stronkhorst *et al.* (2010), soil erosion and environmental degradation occur through the impact of raindrops on bear soil surface as well as when rainfall fails to infiltrate into the soil, but instead flows over the soil surface (Derpsch *et al.*, 2010). The advantage of applying CA principles such as minimising soil disturbance and maintaining a permanent cover on the soil, the effects of high rain drop impact and crusting or compaction of the soil surface is removed (Giller *et al*., 2009). Moreover, the cover crops help in minimizing the erosive effects of wind by forming a protective blanket over the surface to secure topsoil in place.

2.3.3 Improved soil structure

Generally, when one uses the terms soil fertility, he/she refers to the concentration of nutrients in the soil (Rusinamhodzi *et al.*, 2011). However, the concentration does not end with soil but it has to be available to plant roots. Crop rotation and soil cover practices in CA increase the amount of organic matter in the sub-soil (Knott, 2015). Moreover, soil aggregate stability is also improved as plant matter decomposes naturally in the soil minimised tillage, creating a biologically rich zone of activity and diversity (Uri, 2000). Furthermore, earthworms and beneficial insects are also found due to the groundwater cover and mulch. This mulch also acts as an insulator between sun and soil (Prabuddh & Suresh, 2013). Organic matter provides low to medium concentrations of nutrients, but more importantly, these nutrients are available over several months or years in well-balanced quantities, via a slow-release mechanism (Knott, 2015). Conservation agriculture, incorporating no-till has sometimes been coined biological tillage, and serves to gradually improve soil structure.

2.4 The cost of CA over conventional agriculture

Production costs are important for consideration when conducting the cost benefit analysis of any tillage system such as CA (Uri, 2000). The production costs of most tillage systems usually include labour costs, fertilisers, pesticides, seeds and machinery (Zhou *et al.*, 2009).

2.4.1 Labour costs

Derpsch *et al.* (2010) associated the global expansion of the area under CA from 45 million ha in 1999 to 111 million ha in 2009 with the superiority of this farming system in relation to conventional agricultural practices such as time, labour and fuel saving. Because CA requires fewer machinery trips over the field compared to the conventional agriculture, less labourers are needed (Du Toit, 2007). In most regions around the world, farming performed under CA, labour requirement is reduced by about 50% (Friedrich *et al.*, 2012). However, Ngwira *et al.* (2014) asserted that CA reduces labour costs if and if only if, a farmer uses herbicides to control weeds but the case is otherwise when compared with conventional agriculture without the use of herbicides. For example, the study conducted by the Agriculture Research Council (ARC) (2014) in the Western Cape Province of South Africa on assessing the impact of CA practices on wheat production revealed that the impact of CA has resulted to reduced labour requirements while weed and pest control costs increased.

2.4.2 Fertiliser cost

Madondo (2017) stated that accurate soil assessment of the soil's available nutrients is vital before planting in order to know the needs of the crop to be planted which cannot be supplied by the soil that is going to be ploughed. Uri (2000) asserted that any planting site assessment has to include site factors such as climatic conditions, cropping patterns and soil characteristics in relation to the desired tillage practice. For that reason, CA, however, requires the improved fertiliser management. Most studies hypothesised that fertiliser use will increase with the adoption of CA compared to convention agriculture (Lai *et al*., 2012; Ngwira *et al.*, 2014), however, the results reported the opposite in the long-run. For example, (Lai *et al*., 2012) recommended the subsidee of fertiliser in the initial implementation stage of CA.

There is a hope that fertiliser costs will decrease in the long-run (Uri, 2000). This will be due to the crop residue cover that are said to increase organic matter and improve soil moisture retention. For example, the study conducted by Du Toit (2007) in the North West Province of South Africa revealed that participants seemed to have applied the less fertiliser amount in their CA system compared to the conventional agriculture practiced in the last 5 years where the average expenditure was reported to decrease by merely 0.27%.

2.4.3 Pesticide costs

There is a variety of weed problems among the tillage systems across the world (Uri, 2000). One of the advantages of soil tillage is to prepare the seedbed not only for crop but also for reducing the level of weeds. Therefore, it should be noted that if CA is adopted as the tillaged system to be followed, different species of weed would occur because of the reduced tillage. For example, research by Du Toit (2007) shows that crop remains usually facilitate fungi development such as *Stenocarpella maydis* and *Fusarium spp.* in the winter season and thus leading to decreased yield levels, forcing farmers to intensify in pesticide application to keep them under control. This therefore substantiate Du Toit (2007) research results which reported that the respondents involved in CA increased their expenditure on herbicides by 4.5%.

2.4.4 Seed costs

There is scanty literature on the seed costs in the context of CA. The question of whether seed rate varies under CA compared to conventional agriculture is not answered yet. The majority of studies that have conducted cost benefit analysis have maintained a constant seeding rate (Uri, 2000), while some studies have entirely omitted or casually considered them (FAO, 2001; Du Toit, 2007; Lai et al., 2012).

2.4.5 Planting time

Mazvimavi (2010), conducted the research on the socio-economic analysis of CA in terms of practice, adoption viability, gender dynamics and scaling out strategies in three Southern African countries, namely, Zambia, Zimbabwe and South Africa. The study results revealed that the introduction of CA farming practice into the smallholder farming sector was primarily aimed at improving the food security status of the household vulnerable to poverty. Moreover, the results showed that the respondents from the 12 districts of Zambia, 17% of the households practicing CA were orphans. It was then reported that the households which were vulnerable to poverty were benefiting from CA through its capacity to enable timely land preparation and subsequent planting. These results were confirmed by Hobbs *et al.* (2008) study which stated that CA production systems can be done closer to subsequent planting time.

This therefore means, CA does not need a farmer to wait for the ideal planting seasons to till and prepare the land.

2.5 The economic potential of CA compared to the conventional farming in the long-run

There is a long and rich tradition of empirical research that seeks to explain the cost benefit analysis of conservation agriculture. As outlined by Zhou *et al.* (2009), researchers typically select a number of potential variables for inclusion in their analysis based on their theoretical framework and test, more often using Net Present Value (NPV) to determine which farming practice yields positive net gains. For the purpose of this study, the literature was based on the variety of studies around the world (see Table 2.1). Selection of the reviewed studies was consistent with conservation agriculture as defined by the FAO (2001) of the United Nations. Of these studies, some were *ex ante* while other studies were *ex-post.*

Table 2.1: Studies from different regions of the world with positive NPV for CA

CA Region	Total number of analysis	Number with + NPV	% with + NPV
Sub-Saharan Africa (SSA)	11	10	90.9
Latin America	18	16	88
Developed countries	40	34	85

Adapted from FAO (2001), and Knowler and Bradshaw (2007)

Out of 40 reviewed studies from the developed world by FAO (2001), about 34 studies revealed that NPV would be positive for CA. Moreover, the studies conducted in Sub-Saharan Africa and Latin America were reported with positive NPV value at 90.9 and 88 percent, respectively. These benefits revealed by Knowler and Bradshaw (2007) and FAO (2001) studies were also validated by various studies around the world such as those of (Mazvimavi, 2010; Giller *et al.,* 2011; Thierfelder *et al.,* 2013; Wall *et al*., 2013; Pannell *et al.*, 2014) . For that reason, many research institutions and NGOs have invested massively in efforts to transfer this farming practice to smallholder farmers (Pannell *et al.,* 2014). However, sometimes this enthusiasm for CA might not yield the expected results in every region around the world (Knowler and Bradshaw, 2007). For one to reap evident and expected benefits, CA must be adapted to local conditions such as socio-economic setting, soil type and climatic conditions (Giller *et al*., 2011).

2.6 Conservation agriculture in South Africa

During the initial trial stages of CA in in the 1980's, South African farmers were initially hesitant to adopt CA. The major hurdles to CA adoption were thought to be the following:

- Subsequent drop in yields in the initial stages of adoption;
- Increase in the need for the herbicide;
- Lack of interest in the concept;
- Intensive management need;
- The specialised equipment;
- Inadequate tillage equipment, (Knott, 2015).

The deregulation and liberalisation of maize and wheat which was in 1990's caused the decline in world price levels. That forced the farmers to reduce the quantities of inputs so that they will remain competitive at the global commodity prices. Conservation agriculture, extensively adopted in other parts of the world, provided the ideal components to achieve sustained production while steadily reducing input costs, and conserving the environment.

The pioneers of CA adoption in South Africa were predominantly in the Western Cape, which is a typically Mediterranean climate. Inspired by examples in Western Australia, producers searched for an effective method to reduce soil erosion. The knock-on effect of soil moisture retention and increased yields led to the spread of the concept. Problems with grass weeds were resolved with the introduction of broadleaf and/or pasture crop rotations (Knott, 2015).

In the late 1990's summer rainfall areas began to adopt no-till practices from examples and experience of the Brazilian farmers. The idea was to increase soil fertility and conserve soil moisture and it resulted in an average increase in 1 ton per ha in maize yields.

Tillage practices in South Africa vary between regions, areas and farmers. There is a wide range of practices varying from conventional tillage to no-till. It is estimated that only 20 percent of farmland in South Africa is still under conventional tillage, the remaining 80 percent falls under variations of minimum tillage and no-till (Knott, 2015). This is set to grow as knowledge of the concept is more readily transferred through farmer communities. Technological development continues to drive production in this sustainable direction.

2.7 The factors affecting the extent of CA adoption among maize smallholder farmers

Over the past ten years, CA has been one of the most highlighted sustainable agricultural developments in scientific and policy thinking (Andersson & D'Souza, 2014). Leading international research and policy institutes such as Food and Agriculture Organisation of the United Nations (FAO), European Conservation Agriculture Federation (ECAF), Consultative Group on International Agricultural Research (CGIAR). have dedicated numerous policy documents and development project to CA (Corbeels *et al.,* 2014). According to its proponents, the main objective of CA was to promote efficient use of agricultural resources through combined sustainable management of available soils, water and biological resource (Knowler & Bradshaw, 2007). In simple terms, the main objective of CA was to overcome obstacles and challenges faced by farmers due to conventional agricultural practices (Friedrich & Kienzle, 2008). It is featured by the minimal soil disturbance, permanent soil cover (mulching) and crop rotation (Andersson & D'Souza, 2014). According to Ngwira *et al.* (2014), the combination of the three featured CA practices is very key in addressing the soil erosion by excluding most of unsustainable practices such as mono-cropping, tillage, and removal of residue (especially through burning) of conventional agriculture.

Although the idea of Conservation Agriculture was conceived in 1930s, its adoption in commercial agriculture began in the early 1960s in United States of America (Kassam *et al*., 2014). The research was first conducted in the state of Ohio in 1962, where the innovative farmers including the no-till pioneers David Bandt and Bill Richards adopted the conservation practise (Islam & Reeder, 2014). The successful research and experiment conducted in Ohio research University prompted further research and experiments from other parts of the globe such as Australia in 1964, Germany in 1966, Belgium in 1967, Italy in 1968, West Africa in 1969 and finally, Brazil in 1970s (Basch, Friedrich, Kassam, & Gonzalez-Sanchez, 2015).

In 1999, 45 million ha of land was recorded to be under conservation agriculture, worldwide (Kassam *et al.*, 2014). Due to the recorded success stories of CA, the level of adoption among farmers increased from 45 million to 72 million ha in 2003 and further increased to 111 million ha in 2009. The growth rate is said to be 6 million ha per annum. However, the highest rate of adoption had been experienced in South America, whereby the current land under conservation agriculture is up to 70% of the total land area (Derpsch *et al.*, 2010).

Pannell *et al.* (2014) stated that not all the principles embedded in CA package have been fully adopted. For instance, some of the African farmers which have adopted the CA package, the majority have focused on the principle of minimum soil disturbance while other farmers have adopted the full package of CA but on a little piece land (Derpsch *et al.*, 2010; Giller *et al.*, 2011; Andersson & D'Souza, 2014; Pannell *et al.*, 2014). The study conducted by Giller *et al.* (2009) suggested that given the present situation, the whole CA package may not be appropriate for most resource-poor farmers, especially Sub-Saharan African farmers. The major concerns are more related to the poor performance of CA during the early years of adoption (Brouder & Gomez-Macpherson, 2014). For example, it may take up to 10 years to reap yield benefits of continuous use of conservation tillage (Uri, 2000). Therefore, this section seeks to assess the extent of CA adoption among farmers in South Africa.

2.7.1 Theoretical Perspective on Innovation Adoption

This part of the dissertation explains the factors that influence the farmers' decision to adopt CA through adoption theories. It is assumed that adoption process begins when a certain individual move from the state of ignorance to knowledge. Daniel Barnoulli came up with the Theory known as the Expected Utility Theory (EUT), which assumes that every decision maker is rational (Moscati, 2016). He or she has an ability to choose between risky and uncertain prospects. This is done through comparing their expected utility values, meaning that you multiply the weighted sums which are obtained by adding utility values of outcomes by their corresponding probabilities (Wu, 2005). This is exceptionally true for smallholder Southern African farmers because these farmers have to manage risks on an everyday basis in order to be food secure. In 1995, Rogers came with another Theory on adoption (Rogers, 1995). He named it as 'Diffusion of Innovation Theory' (Rogers, 1995). In this case, diffusion simple refers to the 'process by which innovation spread among the members of a social system over time' (Meijer *et al.*, 2014). In his explanation, (Rogers, 1995) stated that diffusion theory is under the umbrella of four major theories, viz. innovation decision process theory, the individual innovativeness theory, the rate of adoption theory and the theory of perceived attributes.

2.7.2 The theory of perceived attributes

Any innovation which is going to be adopted, it has to carry the following characteristics, viz. relative advantage over the already existing innovations, more compatible for use, complexity, an innovation which can be tried in a little space, the one which is easy to be observed and recommendable (Botha & Atkins, 2005). This is true for conservation agriculture, especially for smallholder farmers of Southern Africa.

2.7.3 The individual innovativeness theory

Nutley *et al.* (2002) pointed out that individual innovativeness theory is based on who adopts the innovation and when does he/she adopts it. Figure 2.1 shows a bell-shaped curve that illustrates the individuals who are adopting the proposed innovation. These adopters are expressed in percentages. This makes us understand that everything we see in this life was started by one person and the other persons followed. Hence, in Figure 2.1 we see the innovators taking up to 2.5% of the bell-shaped curve. These are trailblazers, visionaries and imaginative decision makers (Robinson, 2009). Innovators are the kind of persons who like to talk about what they are doing and planning to do. They joyfully sell their idea. Hence, the risk-takers can easily be influence by the innovators. For that reason, Figure 2.1 also shows early adopters as those who have believed the message sent by the innovators. These are the kind of decision makers who leap in after the benefits are apparent. These are early adopters who make up to 13.5% of the bell-shaped graph presented in Figure 2.1.

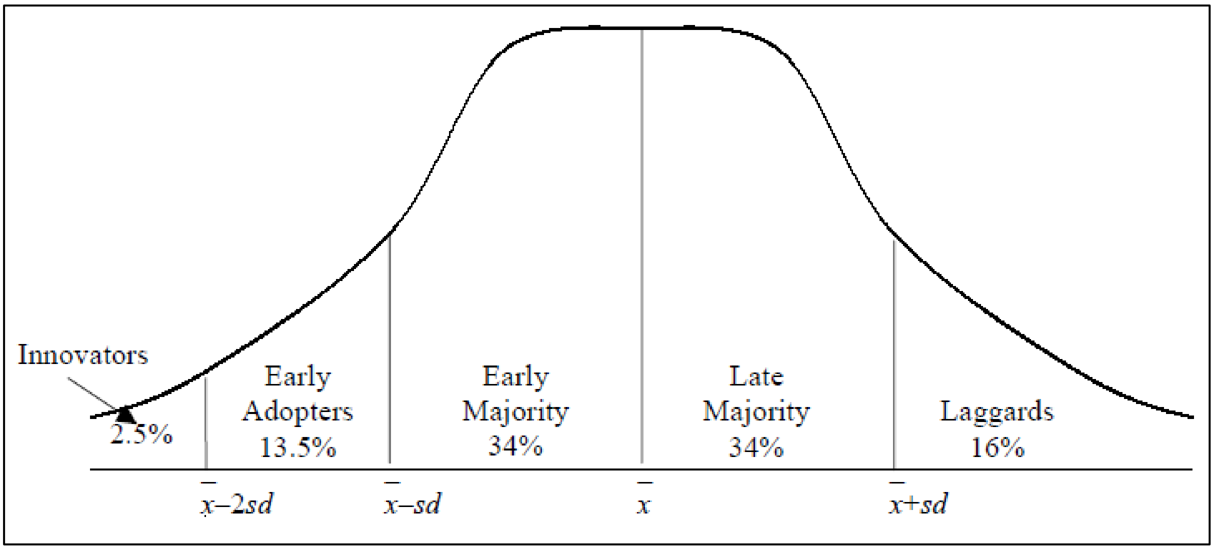

Figure 2.1: The individual innovativeness theory
Source: Nutley *et al.* (2002)

Figure 2.1 also shows that every innovation has early majority who adopt the idea. These make about 34% of the decision makers who have been depicted in bell-shaped graph of decision makers. These are the kind of decision makers who are looking for ways in which they can improve what they are already doing (Robinson, 2009), howbeit, they hate complexity. They are time conscious and they also value their money.

However, there are other decision makers who are risk-averse. These decision makers are presented as late majority. They make up to 34% of those who have adopted an innovation. These decision makers are afraid to see themselves as being irrelevant to the norm of the community. For that reason, when one wants the risk-averse decision to adopt the new innovation, he/she has to promote the social norm (Robinson, 2009).

Although the late majority can be reluctant into adopting a certain innovation, they are far better than the last group of people who are known as “laggards”. The last majority is better in this way that they go with the majority in the society, but the Laggards are always thinking about the alternative ways to dispute against the new innovation. These are the kind of decision makers who can confuse the innovator because at some point they might be right. Therefore, it is important to understand on how to work with them. An innovator has to find important ways of avoiding the failure of excluding these individuals. Robinson (2009) stated that the best way to work with these decision makers is to give them the testimonies of other Laggards.

2.7.4 Rate of adoption theory

Figure 2.2 is provided to represent the rate of adoption theory on the s-shaped curve on a graph. This theory holds on the assumption that the rate of adoption grows slowly, especially in the beginning (Botha & Atkins, 2005). It then gradually starts growing very fast for a certain period and later become stable. After the rate of adoption has come to be stable, it then begins to decline.

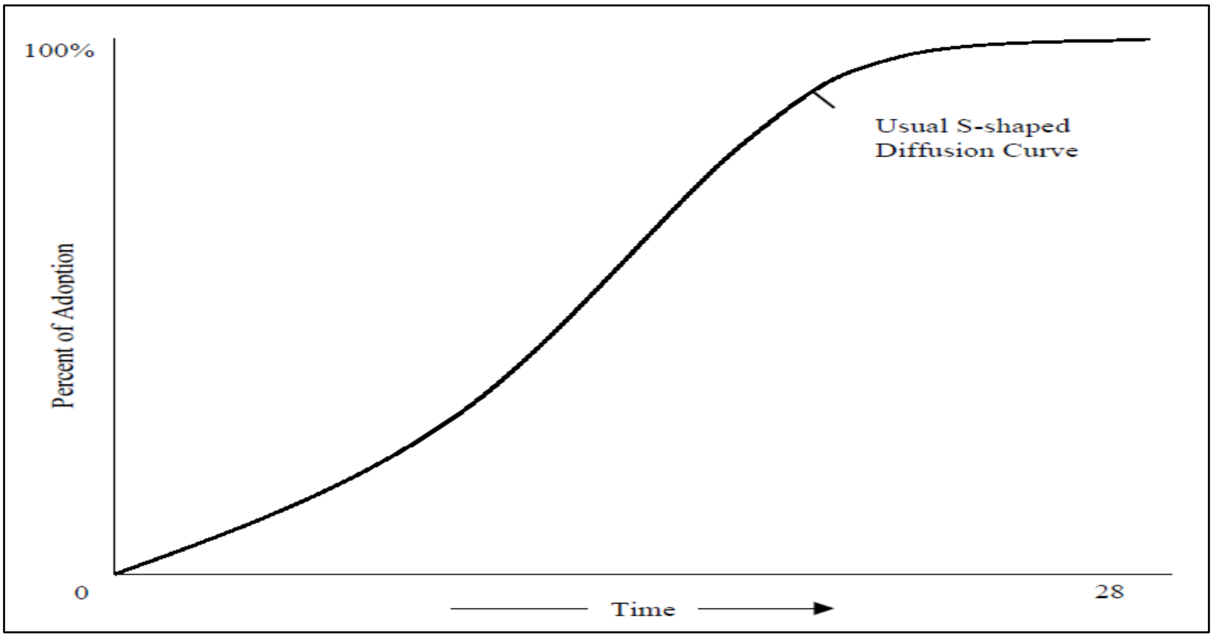

Figure 2.2: The rate of adoption theory
Source: Nutley *et al.* (2002)

Another face of importance is the time. Innovations are seen to be communicated across space and through time. Time has been distinguished as being important in the dissemination of inventions in three primary ways (Botha & Atkins, 2005). Firstly, the adoption of an invention is seen as a mental process that develops over time taking off and initial awareness and initial knowledge about an innovation which evolves into an attitude towards that innovation. This influences the decision of whether to adopt of rejecting the innovation. Secondly, the pace of adoption amongst individuals differs throughout the societal organization. This goes off slowly with only a minority of people taking the innovation, increasing over time, eventually reaching the rate where enough people have embraced the innovation and the rate of adoption becomes self-sustaining. Thirdly, time is involved in the rate of adoption or rather the relative speed that members of a social system adopt innovations. This is frequently quantified as the number of members of the system that adopt the innovation in a dedicated time

2.7.5 Common selected variables on the factors affecting the extent of CA adoption among the maize smallholder farmers

Research on the subject of factors affecting the extent of adoption of conservation practices can be traced back to 1950s (Ervin & Ervin, 2015). Several studies have reported noteworthy results. For example, Knowler and Bradshaw (2007) stated that, there are many factors that affected the adoption but there are factors that were statistically significant. The variables that were statistically significant are presented in Table 2.2.

Table 2.2: Six commonly assessed variable across the world with results

	Outcome	Age			Education			Land tenure			Income			Farm size			Rainfall		
		Sig (+)	Sig (-)	Insig.	Sig (+)	Sig (-)	Insig.	Sig (+)	Sig (-)	Insig.	Sig (+)	Sig (-)	Insig.	Sig (+)	Sig (-)	Insig.	Sig (+)	Sig (-)	Insig.
Method of analysis	1=logit	1	3	2	6	1	1	1	1	7	1	1	1	5	0	2	2	2	2
	2=other probability models	0	0	2	1	0	2	0	0	3	0	0	0	0	1	2	2	0	0
	3=OLS	2	1	3	0	2	3	0	0	1	1	2	2	0	0	4	0	0	0
	4=Other methods	0	1	3	0	0	5	1	1	0	1	1	1	1	1	2	1	0	1
Technology	1= No till	0	0	2	0	0	2	0	0	3	2	0	0	1	0	1	1	1	0
	2= conservation tillage	1	3	2	7	1	1	2	0	5	0	1	4	4	1	3	2	1	2
	3= other practices	2	2	6	0	2	8	0	2	3	1	3	0	1	1	6	2	0	1
	Total	3	5	10	7	3	11	2	2	11	3	4	4	6	2	10	5	2	3

Source: Knowler and Bradshaw (2007)

i. Age

Variety of studies have revealed that there is an inverse relationship between age of a farmer and soil conservation practices (Sureshwaran *et al.*, 1996; and Knowler &

Bradshaw, 2007). It is believed that older farmers tend to be risk averse in the adoption of soil conservation technology compared to younger farmers (Chambers, 1998). This is because that the benefits of soil conservation practices are not usually reaped within their short planning horizons (Sureshwaran *et al.*, 1996). For that reason, the co-effient of AGE in the analysis is expected to be negative. As it is presented in Table 2.2, out of 31 research studies reviewed by Knowler and Bradshaw (2007), 3 studies revealed a positive significance of age on the level of adoption of soil conservation practice while other 5 research studies revealed a negative significance and the insignificance.

ii. Education

Due to the ability of the education to enhance awareness of the new farming practice, the farmer's exposure to education positively affects the adoption decision of a new farming practice (Demeke, 2003). Hence, education level is hypothesised to positively influence the decision of farmers to adopt the improved soil practices (Chambers, 1998). This hypothesis was convincingly proven correct by the studies reviewed by Knowler and Bradshaw (2007), shown in Table 2.2. Table 2.2 reveals that studies that have used Logit or Probit models, tend to ascribe greater influence education variable in the adoption of conservation agriculture than do the studies using other methods of analysis (Knowler & Bradshaw, 2007).

iii. Land tenure

According to Sureshwaran *et al*. (1996), the literature does not reveal any consensus relationship between land tenure and the adoption of conservation practices. This is because that the relationship between land tenure and adoption decision of conservation farming practices is related to a variety of omitted socio-economic characteristics such as access to credit, technical information and input and product market. However, previous studies show that farmers who own their land are more likely to adopt soil conservation practices than those who do not own their land (Asafu-Adjaye, 2008). Meaning that the main point here is to do with the tenure security than land ownership.

iv. Income

Sureshwaran *et al*. (1996) asserted that farmers with considerable high-income levels are likely to adopt soil conservation practices compared with farmers with low incomes. This means that income levels pose financial constraints in the farmers' adoption decision. Nevertheless, Table 2.2 presents the contrary view, there are few studies that used Logit model and ascribe greater influence of income on conservation practice adoption decision (Knowler & Bradshaw, 2007).

v. Farm size

Table 2.2 reveals that studies that have used Logit or Probit models usually assert that farm size commands a greater influence on farmer's decision to adopt conservation farming practices (Knowler & Bradshaw, 2007). Larger farms are associated with greater wealth and increased capital which then increases the probability of investing in soil conservation practices (Sureshwaran *et al*., 1996). Contrary to the results presented by Sureshwaran *et al*. (1996) and Knowler and Bradshaw (2007), Chambers (1998) stated that there is no clear consensus on the influence of farm size on adoption of soil conservation practices. The adoption of soil conservation practices depend on the whether the farmer perceive the higher soil erosion problem (Chambers, 1998).

vi. Rainfall

Table 2.2 reveals that studies that have used Logit or Probit models usually assert that rainfall bids a greater influence on farmer's decision to adopt conservation farming practices (Knowler & Bradshaw, 2007). This is because that the endowment related to soil types and the prevailing rainfall has a bearing on the way the agricultural resources has been used (Chomba, 2004). Chomba (2004) further stated that farmers that live in high rainfall areas, where the soil are usually acidic, tend to shifting cultivation while those that live in moderate rainfall areas tend to semi-permanent hoes and animal drawn plough farming systems. Moreover, water shortage concerns in rainfall areas have tended to lead farmers to water harvesting method such as mulching.

2.8 Chapter summary

This chapter reviewed literature on conservation agriculture, specifically on the economic perspective. Starting from the factors that influences the adoption of conservation agriculture down to the indicators of the viable investment, such as Net Present Value and yield. Theory on adoption process is also briefly highlighted. The following chapter presents the methods used in conducting the research of this dissertation.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This subsection of the research project provides an overview of methods and planning procedures related to the other previous study methods used to collect and interpret gathered information. The main purpose of this chapter is to give an overview of the research planning technique which includes methods used for data collection and analysis of the data. It begins with the description of the selected study area. The map of the research area is also provided showing the close by areas surrounding the chosen study area. Sampling procedure, data collection techniques and the data analysis tool used in the research is also provided. According to Leedy and Ormrod (2010) planning for the research is important for the researcher not only to choose variable research problem but also to consider the types of data required to address the research problem, as well reasonable means of collecting and interpreting the data. Therefore, the researcher should know where the data can be found, how the data can be collected, when to collect and how to interpret the collected data.

3.2 Study Area

Okhahlamba Local Municipality (OLM) is one of the five Local Municipalities within the Uthukela District Municipality, located in the mountain region of KZN. To be more specific, this Local Municipality is between Lesotho, Free State Province, Alfred Duma, and the Inkosi Langalibalele Local Municipality and covers an area of about 3 971 km^2. Around the OLM are privately owned commercial farmland and smallholder settlement with urban areas which are Bergville, Winterton, Cathkin Park, Geluksberg.

In the year 2000, the ARC-project introduced a number of practices based on CA in Bergville town (Madondo, 2017). The project was introduced through participatory research and development strategy. The aim being to generate and diffuse sustainable land management practices for local farmers in order to address soil degradation and conservation issues while increasing farm productivity. The practices introduced were site specific, being chosen by the researchers and extension officers from the Department of Agriculture in the region.

Figure 3.1: the map of the study area, OLM in KZN Province, South Africa. Source: Stronkhorst (2010)

"Farmers participated through demonstration of research managed trials, farmer managed trials, trainings, learning forums, monitoring and evaluation" (Sterve, 2008). The main aim of the trials was to evaluate crop yield and gross margin for the farmers. Informal partnerships were also created in order to form input network that will facilitate access to market (Sterve, 2008).

In Bergville town, twenty lead farmers trained in CA and life skills by ARC to become trainer farmers and participated in farmer managed trials. They in turn formed learning groups and trained around more than 80 farmers in CA practices in the region through farmer to farmer extension" (Madondo, 2017).

However, when the programme came to an end, that was in 2005, the majority of lead farmers and the people whom they have trained dropped and stopped following CA principles. In 2013, the programme was revived again by the Mahlathini Organics, the Non-Governmental Organisation (NGO) based in Pietermaritzburg in KZN, under the Grain-SA CA-FIP and SaveAct Trust (Kruger, 2014). According to Kruger (2014), the Mahlathini Organics re-introduced the CA practices in the area as a pilot study to the organised smallholder farmer groups from six different villages. The size of the plot allotted was subjective to the farmer, however, CA plots were between 100-1000m² in size

3.2.1 Geographical features and climate of OLM

The OLM has a considerable variation in topogaphy. This variation includes the following; vast basalt and sandstone cliffs, deep valleys, intervening spurs and extensive plateau areas (Stronkhorst *et al.*, 2010). The scenic value is the results of the topographical variation. The Okhahlamba is one of the most watered areas in South Africa. Thus, makes the Okhahlamba least drought-prone area in the country. This is due to the good climate which is at both north-western and south-western boundaries.

There is considerable variation in topography, including vast basalt and sandstone cliffs, deep valleys, intervening spurs and extensive plateau areas. This topographical variation contributes to the outstanding scenic value. The Drakensberg is one of the best watered, least drought-prone areas of southern Africa, and has particular significance for catchments protection and the provision of high quality water supplies for surrounding communities. A number of rivers originate from the park.

The north-western and south-western boundaries which are part of the Drakensberg are characterized by relatively good climate. There are large areas of good climate along the foothills of the Drakensberg. Good Climate is prevalent in particular around Geluksburg in Ward 13, around Mont-Aux-Sources in the north-west and an area stretching from the southeast boundary towards Ward 12, including the Cathkin Park area. There is a very large area which has moderately good climate which extends over the central band from the south-west to the north-eastern boundary. This includes the towns of Bergville, Winterton and Khethani.

3.2.2 Rainfall and vegetation of Okhahlamba Municipality

According to Stronkhorst *et al.* (2010), the OLM Municipality experiences good rainfall. According to the Guideline on Integration of Agrohydrological Issues into Municipal Spatial Planning within KwaZulu-Natal (Stronkhorst *et al.*, 2010), rainfall is expected to increase throughout the province. In addition, temperatures will also increase which will result in higher atmospheric demands for water. The increase in precipitation will increase the risk of periodic and extreme flood events.

The municipality has a significant Protected Area Network and reasonably intact vegetation, which offers a high diversity of habitats, which support a large proportion of important faunal and floral species. The majority of Red Data plant species occur predominantly in the higher altitudinal areas of the Drakensberg, which are to the greatest extent protected (with exception of the Mnweni Valley).

The Drakensberg Alpine Region is considered a centre of plant diversity and endemism. A total of 2 153 species of plants have been recorded for the uKhahlamba Drakensberg Park World Heritage Site of which 29.5% are endemic and 109 are listed as threatened species. A large proportion of these species are found within the Okhahlamba area (Stronkhorst *et al.*, 2010).

3.3 Research Design

A research design is a specific and concrete procedure that the researchers apply in data collection and interpretation. These are sets of rules or guides that enable the researchers to conceptualize and observe the problems under examination. Therefore, the research design adopted in this study is cross-sectional design. It should be noted that Cross-sectional research studies are based on observations that take place in different groups at one time. The following three characteristics of cross-sectional were observed:

1. Takes place at a single point in time
2. Variables are not manipulated
3. Provision of information, and do not state why

3.3.1 Sampling procedure and sample size

Sampling frame of this research project is smallholder farmers that have adopted the CA. Smallholder farmer's definition varies across the studies. However, according to Thapa (2009), smallholder farmers are characterised by the following factors: land size and the type of labour employed. This means that they are known about the land size which normally does not exceed the size of 2 ha of crop land. In addition, the type of labour employed, usually is family labour, where the primary aim of production is consumption. Therefore, the sample size for the study will be 35 respondents (n=35). Sampling frame used in this study consists of the mixed approaches such as using the structured questionnaires, and informal interviews. Moreover, the sampling approach follows the CBA analysis approach. CBA required the researcher to use the farm cost budgets.

3.4 Data collection method

The research methodology for this study consisted of four main components:

1. Site visit to 6 different farmers' groups from Bergville. These visits were conducted in the first week of March, specifically the first 6 days.
2. At the time of site visit, GrainSA was hosting CA farmers' day and that paved the way for the researcher to meet with the Mahlathini Organics members. Farmers from different villages practicing CA were present at the CA farmers' day and about 5 farmers were interviewed.
3. The days following the CA farmers' day, approximately 10 interviews and group meetings were held with CA farmers from Stulwana, Potshini, Qeleni and Ezidulwini. The objective of these interviews was to explore wide range of agricultural practices in Bergville.
4. Analysis of qualitative and quantitative secondary data retrieved from the Mahlathini Organics collected in the 2013 to 2015 seasons was used.

3.5 Data analysis method

This part of the chapter focuses on the method used to analyse the data obtained in the study area to assess the farm level cost-benefit analysis of conservation agriculture for maize smallholder farmers in OLM in KZN. The data was analysed using different analytical tools.

3.5.1 The factors affecting the extent of CA adoption among the smallholder maize farmers in the study area

The extent to which the CA practice has been adopted depends on the socio-economic characteristics such gender, age, household size, household income, etc. These factors were analysed using the descriptive analysis. Linear regression analysis used plot size allotted to CA as the extent of CA in the farm and level of response to the incentives. Each socio-economic factor was interpreted according to the number of occurrences (frequency) and percentages. The analysis was done using the Statistical Package for Social Science (SPSS), STATA 13, and Microsoft Excel. The variables included in the model are presented in equation 1 and summarized in Table 3.1.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu_i \text{ ....(1)}$$

Table 3.1: summary of variables, definition and measurement type

Variables	**Definition**	**Type of Measurement**		**Expected signs**	**Literature**
Dependent variable(s)					
Y	Plot size of CA	Continuous			
Independent variable(s)					
X_1	Age of the farmer	Continuous		-	Knowler & Bradshaw, 2007
X_2	Gender of the farmer	Dummy	0 = Male	+	Demeke, 2003
			1 = Female	-	
X_3	Land tenure	Continuous	0 = Own land	+	Asafu-Adjaye, 2008
			1 = No land	-	
X_4	Level of education of the farmer	Continuous	-	Continuous	Chambers, 1998
X_5	Income	Continuous		+	Knowler & Bradshaw, 2007
X_6	Membership of farmer association	Dummy	0 = Yes	+	Sureshwaran *et al*., 1996
X_7	Farm size	Continuous		+	Sureshwaran *et al*., 1996
X_8	Livestock ownership	Dummy	0 = Yes	-	Knowler & Bradshaw, 2007
			1 = No	+	
X_9	Rainfall	Dummy	0 = Yes	+	Chomba, 2004
			1 = No	-	

Source: author's own computation (2017)

3.5.2 Comparison of the yield levels of CA over the conventional farming in the study area

It was important to estimate the amount of maize yield produced by the respondents in the case study. For that reason, the amount of yield was measured using average (mean) against the alternative tillage system. The average yield calculated by summing up the total yield and divided by the number of respondents.

3.5.3 The cost of CA over conventional agriculture in the study area

In assessing the cost of CA over the conventional agriculture, income and cost budget was used. These costs were useful in calculating the farm gross margin. Therefore, the GM was calculated as the difference between the total gross income and the total variable costs.

3.5.4 Evaluating the sustainability of CA over conventional farming in the study area

In evaluating the sustainability of CA in the long-run, project appraisal indicators such as Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Returns (IRR). The summary of the analysis is explained in section 3.5.5

3.5.5 Cost Benefit Analysis

The last objective will be analysed using the Cost Benefit Analysis tool. Ogunlade (2008) defined Cost Benefit Analysis (CBA) as a method used to compare the cost and benefits of one or more projects. Developmental projects, environmental programs and natural resources have been applying the CBA in order to find out the social economic information that can be useful in governmental decision making (Ogunlade, 2008). One of the following decision standards can be used:

- Net Present Value (NPV);
- Benefit Cost Ratio (BCR);
- Internal Rate of Return (IRR).

There are no restrictive rules in conducting CBA, however, the general flow of sequential steps was followed in this thesis. Figure 3.2 shows the general sequence which this dissertation was as follows:

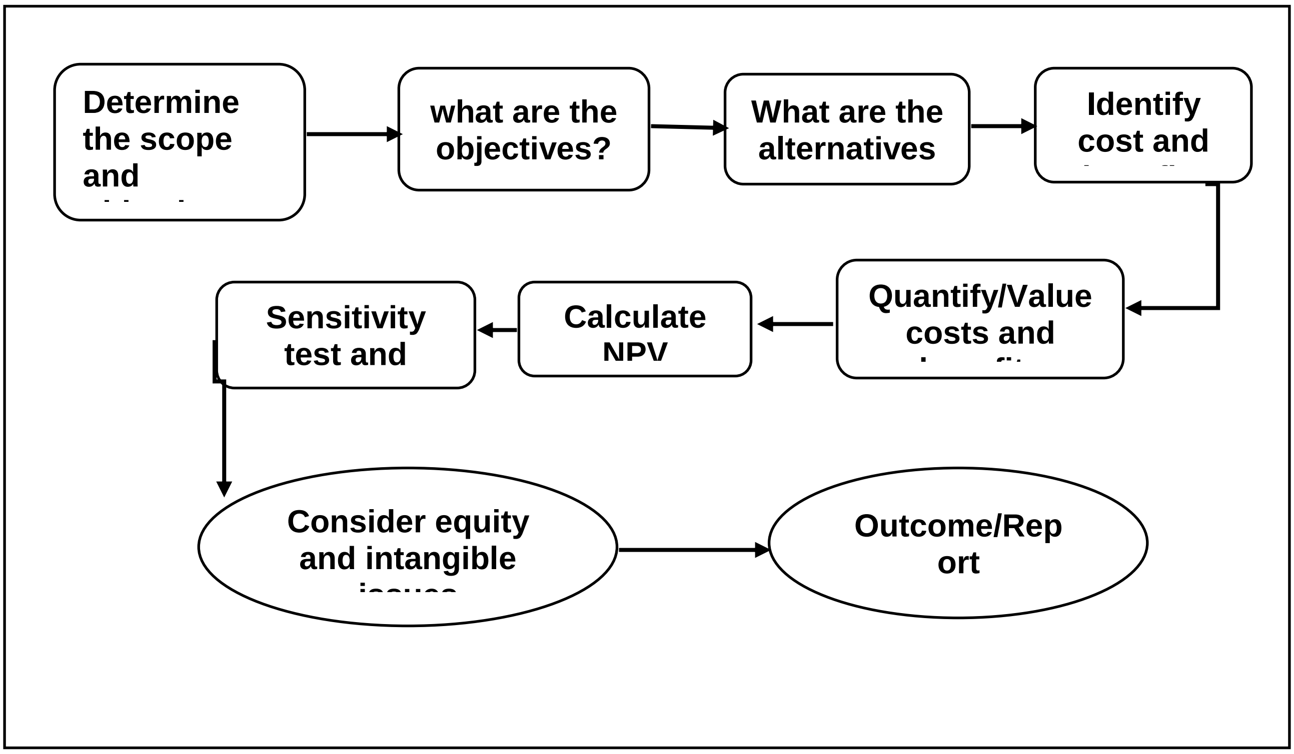

Figure 3.2: Sequential steps involved when conducting CBA
Adapted from Ogunlade (2008)

Step one: Problem identification

This step is meant to find out the needs, objectives, and design scope and the main targets. The first thing to do is to broadly define the benefits, then later specify them. This will also help in identifying those who will gain or lose due to the project formulation.

Step two: Possible constraints

Due to unlimited resources, every project has its own constraints. Therefore, this step is there in order to identify every constraint that may be encountered in meeting the objectives. Moreover, this will help in order to ensure that feasible alternatives exist. For that reason, it is very vital that the identified constrained be clearly defined.

Step three: Identify the possible alternatives

Every decision maker is normally faced with one or more alternatives. As is the case in choosing whether to adopt conservation agriculture or continue using the conventional agriculture system. Therefore, cost and benefit is very important in order to compare if what might have happened if the new innovation had not been adopted.

Step four: Identification of costs and benefits.

When taking a business decision, the decision maker has to draw up a list of all cost of the alternatives. For example:

- Cost of capital;
- The entire economic life of a project, maintenance and operation costs;
- Costs of labour;
- Costs of material;
- Herbicide costs;
- Costs of the research and development;
- Opportunity costs of choosing conservation agriculture over conventional agriculture.

Step five: Quantification of and valuing of costs and benefits

It is important to measure the costs using the monetary value, preferable Rands. In most cases, especially smallholder farmers, actual market prices are used to express the real value of both cost and benefits. These are usually expressed in social terms because whether intentionally or not, costs and benefits will be reflected in the entire economy of the community.

In financial terms, time preference is very important in all capital investment decisions. The present transaction costs are very important than the future transaction costs. This is so because that a Rand's value in the future is very less compared with today's value. Hence the future benefits and costs have to be discounted to the present value. This thesis has adapted the concept of discounting cost benefit analysis from the work of Ogunlade (2008) in "comparative cost-benefit analysis of renewable energy resources for rural community development in Nigeria". Equation 2 shows how the cumulative Present Value of Benefits (PVB) is determined. These benefits are payable in five-year instalments:

$$PVB = \frac{B_0}{(1+R)^0} + \frac{B_1}{(1+R)^1} + \frac{B_2}{(1+R)^2} + \frac{B_3}{(1+R)^3} + \frac{B_4}{(1+R)^4} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

and *B* represents the benefits in economic terms in each period, whereas *R* represent the discount rate. The general formula of equation 3 is expressed as follows:

$$PVB = \sum_{i=0}^{n} \frac{B_i}{(1+R)^i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

With n representing the considered period of present valued. For instance, in this case, $n = 3$

When using this format of determining the PVB that are payable in future, the initial period is not always discounted, although we write it in the formula. This is because mathematics rules still apply in this case which says that any exponent of zero always equal to one. The advantage of using illustrated way of discounting is that it has an accurate way of aggregating the future expected benefits using the present time benefits.

In the same way, the present value of costs (PVC) is mathematically expressed as:

$$PVC = \frac{C_0}{(1+R)^0} + \frac{C_1}{(1+R)^1} + \frac{C_2}{(1+R)^2} + \frac{C_3}{(1+R)^3} + \frac{C_4}{(1+R)^4} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

R has the same meaning as in equation 6 and C represents economic value of costs. The general formula for the PVC is presented in equation 5:

$$PVC = \sum_{i=0}^{n} \frac{C_i}{(1+R)^i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where

$n,$ is the present value of considered period, and C represents the cost of the project. It is important to note that equation 2 and 3 represent the present value of the costs of CA over lifetime cycle of the technology. The figure of the PV in this case is also known as the life cycle cost of the economic good.

Equation 2 and 3 provided the basis for the determination of the 3 criteria often used to determine if an investment is economically viable. These are Net Present Value

(NPV), Benefit-Cost Ratio (BCR) and the Internal Rate of Return (IRR). The formula for calculating NPV is as follows:

$$NPV = \sum_{i=0}^{n} \frac{B_i}{(1+R)^i} - \sum_{i=0}^{n} \frac{C_i}{(1+R)^i} \dots\dots\dots\dots\dots\dots (6)$$

Another criterion that is often used to measure the viable investment decision is the BCR. The formula for the BCR is shown below:

$$BCR = \frac{\sum_{i=0}^{n} \frac{B_i}{(1+R)^i}}{\sum_{i=0}^{n} \frac{C_i}{(1+R)^i}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

Lastly, the investment decision also depends on the use an IRR. Equation 8 shows the mathematical expression of an IRR:

$$IRR = \left[\sum_{i=0}^{n} \frac{B_i}{(1+R)^i} - \sum_{i=0}^{n} \frac{C_i}{(1+R)^i}\right] = 0 \dots\dots\dots\dots\dots\dots (8)$$

In interpreting the investment decision criteria, a proposed project can be reckoned feasible if the:

- NPV is positive
- BCR is greater than the digit of one
- IRR is greater than the applicable discount rate

Although there are difficulties in measuring the cost and benefit, this research thesis will employ all the three decision rules. This is to present the solid decision making. The rationale behind this chapter is to bring the in-depth discussion of these elements. However, the chapter firstly brings into light the historical background of CBA and later brings a review of methodological issues that need to be accredited before bringing-in the CBA.

3.5.6 Discount rate

The effects of discounting are important for any project that involves immediate expenditures while the benefits are not manifested until sometime in the future like in the case conservation agriculture. There are various factors that are used to explain the discounted rate, howbeit, this study will use the two which are as follows:

- Time preference of money: This simple means that having the cash on hand today is better than having it next year. This is due to inflation and future uncertainties. This also applies to smallholder farmer in that they are pressured to produce for subsistence purposes. So, adopting the CA will affect the level of production which will in turn affect the household food security.
- Opportunity cost of investment: Investing to the CA, gives a farmer an opportunity to gain the benefits of soil restructuring and recovering while there is an opportunity cost of immediate production from the conventional farming.

For the purpose of this study, the discount rates were based on the Water Research Commission Report No. TT 305/07 written by Mullins *et al.* (2012). In the report, it is argued that the discount rate that should be used for environmental projects in South Africa should be discounted at the official discount rate at 8%. Due to the unstable interest rate in South Africa, lending rate which is 10.5% was also used as alternative. These were discounted over a 10-year period.

3.6 Conceptual framework

Figure 3.3 presents the conceptual framework for the analysis of cost benefit of conservation agriculture. For discussion purposes, the literature on the CA adoption is used and related to this conceptual framework. The method of the CBA has to account for both the benefit and the cost of adopting CA innovation, which are both dependent to the time and risk which is subject to other constraints.

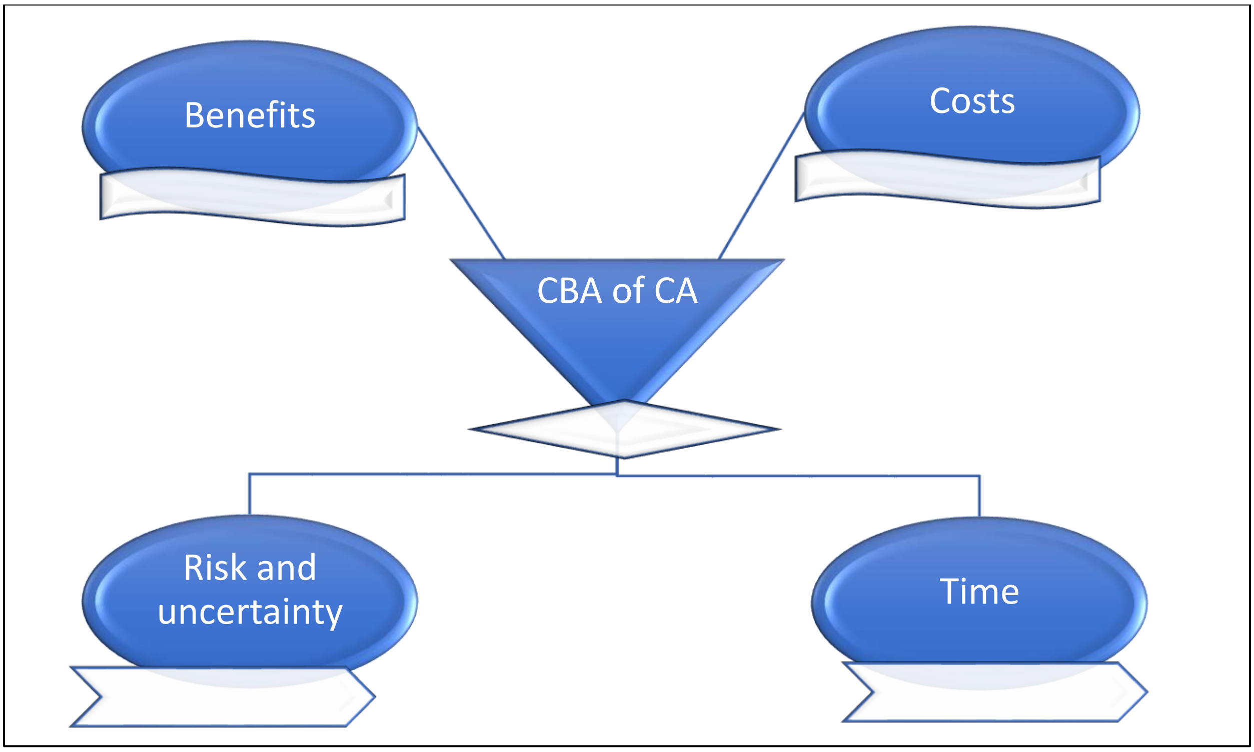

Figure 3.3: Conceptual framework for the CBA of CA
Source: Adapted from Pannell *et al*. (2014)

3.6.1 Benefits of CA

According to Uri (2000), the history in the literature tells us that farmers used to reflect productivity when considering the alternative production technologies. However, nowadays, profitability and the goals of the farmer have become the sole factors of consideration. This is because that yield increases do not guarantee the increase in profit; hence the central issue is to find whether the value of the yield increase justifies the costs.

The goals of farmers encapsulate the needs and the desires of the farmer. It is important to note that needs and desires of a farmer are very important, especially for the smallholder farmers. Hence, it is important not to limit the benefit and cost analysis in monetary value, rather considering the farmers' goals of production. For that reason, market prices might not be attractive to some farmers than the marginal value of some products (Pannell *et al*., 2014).

3.6.2 Cost of adopting CA

In broad terms, farmers will opt for a certain innovation if and only if, one of the conditions is met, i.e. yields increase, and decrease in production costs (Uri, 2000). However, costs can either be high or low. Moreover, the mentioned costs can either be in monetary value or non-monetary. The monetary costs of using CA include the direct financial inputs. On the other hand, non-monetary cost includes the opportunity costs of resource used in CA model. For example, one of the principles of CA is mulching. So, the crop residue which was supposed to be feeding livestock has no monetary value, however it is used as one of the production inputs. In summary, the cost mentioned in CA technology covers the financial inputs and the opportunity costs of resources (Pannell *et al*., 2014).

3.6.3 Risk and uncertainty

The term smallholder farmer has different definitions depending on context on which it is used, country and the ecological zone (Department of Agriculture Forestry and Fisheries (DAFF), 2012). The literature has revealed that many authors have used the term 'smallholder' interchangeable. They have interchanged it with 'small scale', 'resource poor', and 'peasant farmers'. Despite that, there are general characteristics that define smallholder farmers, such as limited resource endowment, owning small based plots of land, using outdated technology, low production returns and high seasonal labour fluctuations, etc.
Therefore, the attractiveness of CA to the smallholder farmers depends on whether it requires more or less of these limited resources compared to conventional agriculture (Pannell *et al.*, 2014). It is important to note that resource constraints depend on the local circumstances.

In this context, risk is related to the actual distribution of outcome whereas uncertainty is related to the lack of confidence to a certain new innovation. In terms of risk, if CA adoption has resulted to low variation, farmers will perceive it as a lower risk. Even if the objective risk is very low, the subjective nature of uncertainty might be very high at the early years of adoption. This is because some farmers are risk-averse while the other farmers are risk-takers (Koundouri *et al.*, 2017).

3.6.4 Time for planting under CA

One of the characteristics of smallholder farmer is that they mainly produce for subsistence reasons (DAFF, 2012). Therefore, if yield benefits take long time to materialise, smallholder farmers cannot afford income sacrifices in the short term even if there is a promise of greater benefits in the long run (Pannell *et al.*, 2014). According to Uri (2000), yield benefits related with the continual use of CA takes long time to materialise. Moreover, most smallholder farmers are facing land tenure challenges, meaning that they do not have full security to the land they use (Pannell *et al.*, 2014). Therefore, the risk of losing the land which they use reduces their willingness to invest on it.

Looking at these considered areas, the economic calculation can reflect them in one or two ways, viz. discount rate and variation in the planning horizon. The discount rate is mainly used to compare benefits and costs that occurred at different times while the planning horizon uses the number of years over which benefits and costs will be considered (Pannell *et al.*, 2014).

3.7 Ethical aspects relevant to the conducted research

Ethics Issues form a fundamental ground through which research is built. They guide the research to follow acceptable moral standards and acceptable code of conducts which does not compromise the well-being of the society and those directly involved in the study (Leady and Omrod, 2010). Hence it is important to consider ethical issues in the research as it influences the data obtained more precisely when the data required is a primary data by nature. Leedy and Ormrod (2010) stated that whenever human beings or other creatures with the potential to think, feel, and able experience physical or psychological distress are participating in the research, attention to detail must be given to the ethical implications of the planned research project, there are several important ethical issues to be considered in a research but they differ in the type of research being conducted. For this research project, ethical issues that were considered include:

Protection of the participants from harm participants: The researchers did not keep participants for a long time. This was accomplished by creating short and precise questionnaires. This is to follow the rule of thumb that the risk of participating in the study should not be appreciably greater than the normal risks of day-to-day living. This was made easy by the participants. They came in groups and that made easier for all of them to trust the researchers.

Informed consent: Arrangements were made with rural leaders and project members to get permission and the researcher explained the nature of the research in details. The researchers tried to explain the nature of the study and also revealed that participation was strictly voluntarily (Leemy and Ormrod, 2010). Participants were allowed to withdraw at any time during the survey if they feel so doing.

Right to privacy: Although the participants were gathered in groups, privacy about the information was assured. Although there were questions which did not require private information, the researchers understood that the issue of privacy was subjective. For that reason, one-on-one interviews were conducted. After the one-on-one interview, open discussions were also made.

Respecting participants: Because the researchers were not family with the culture, language and religion, precautions were made in order to respect the participants. For that reason, there were no complaints in the field. All the participants were very happy with the researchers and the way they presented themselves.

3.8 Chapter summary

The discussion presented in this chapter, conclude that the Okhahlamba Local Municipality is has a potential for farming. Also, in this chapter, the methods that were used to analyse the data were reviewed. Data were collected from 19 farmers in the rural areas of former Bergville town. To collect the data, informal interviews were made with farmers and the secondary data retrieved from the Mahlathini Organic. For data analysis, descriptive statistic, gross margin and cost benefit analysis were used and the results of the study follow in the next chapter.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results first and foremost. The objective was to assess the farm level cost-benefit analysis of conservation agriculture for smallholder maize farmers in OLM) in KZN Province of South Africa. The results of the analysis are presented in two different sections. The first section provides the descriptive statistics of the sampled households' demographic and socio-economic characteristics. The second section provides the empirical results of the study based on cost benefit analysis, using Net Present Value (NPV). NPV is used to calculate the economic viability of the two farming systems employed in two trial and control plots.

4.2 Demographic and socio-economic characteristics

The significance of demographic and socio-economic characteristic in a research study cannot be over-emphasised. Rehman *et al.* (2013) stated that socio-economic characteristics exert pressure on the decision making and behaviour. Socio-economic characteristics included in this study include gender, age, household size, household income and employment status (see Table 4.1). It is hypothesised that they have an influence on the level of response to the incentives that are believed to be imbedded in CA. Therefore, the plot size allocated to CA will be used to determine the level of response to incentives. The average farm size is 0.94 ha, approximately 9400 m^2.

Table 4.1: Summary statistics of the household characteristics and socioeconomic factors

Variable(s)		Trial plots (CA)			
		400m^2		1000m^2	
		Frequency	Percentages (%)	Frequency	Percentages (%)
Gender	Male	9	60	2	10
	Female	6	40	18	90
Total		**15**	**100**	**20**	**100**
Household head age (Years)	0-40	7	47	5	25
	41-60	4	27	5	25
	>60	4	27	10	50
Total		**15**	**100**	**20**	**100**
Household size	1-4	2	13	2	10
	5-7	5	33	4	20
	8-10	4	27	5	25
	>10	4	27	9	45
Total		**15**	**100**	**20**	**100**
Household Income (Social grant) (ZAR)	0-1500	0	0	4	20
	1501-2000	6	40	7	35
	>2000	9	60	9	45
	Total	**15**	**100**	**20**	**100**
Employment status	Employed	2	25	3	27
	Not Employed	6	75	8	73

Source: Based on SPSS data field survey (2017)

4.2.1 Distribution of households by gender

Gender is an important factor with regard to the response on incentives brought by the new farming technique. It is hypothesised that the response to incentives differs between males and females, having females with highest response. Table 4.1 reveals that on 400 m^2 plot, males were many (60%), while females were few (40%). On the other hand, on 1000 m^2 plot, females were about 90% while males were 10%. From the results presented in Table 4.1, it can be deduced that females had the highest response when it comes to the adoption of CA while males had the lowest response. These results confirm Paul and Fremstad (2016) findings stated that women always think about the sustainable food production for the family.

4.2.2 Distribution of households by age

Age of the household head was regarded as one of the crucial socio-economic characteristic in influencing the level of response to the incentives in the study. As indicated in Table 4.1, 400 m^2 and 1000 m^2 plots had age range from 0-40, 41-60 and above 60 years. It can be deduced that respondents that mostly allocated on 400m^2 were between the ages 0-40 years, followed by those 41-60 and above 60 years by 47%, 2% and 27%, respectively. On the other hand, age group that mostly allocated on 1000 m^2 was above 60 years, followed by those between 41-60 years and 0-40 years by 50%, 25% and 25%, respectively. From the results in Table 4.1, it is clear that the increase in age have influence on the farmer's response and on the amount of plot allocated for CA. The literature reveals that one of the benefits of CA is that it does not necessarily need a farmer to till the soil before planting (Giller *et al*., 2011), however, the farmer has to simple sow the seed without disturbing the soil. Having that background, any technology that will reduce the strain among the farmers will be highly welcome by the older farmers.

4.2.3 Distribution of households by household size

Household size is the major factor in determining the presence of family labour amongst the smallholder farmers. The response to the CA incentives differed based on household size. For example, in Table 4.1, household size is categorised into four different sizes, that is, 1-4, 5-7, 8-10 and greater than 10 memebers, while the level of response is categorised based on the plot size, that is, 400 m^2 and 1000 m^2. On 400 m^2, the response to incentives was high to households that have the household sizes that have 5-7 (33%) members followed by households which are between 8-10 (27%) greater than 10 (27%) and households which are between 1-4 (13%). On the other hand, on 1000 m^2, the response to incentives was high to households that have the household sizes that are greater than 10 (45%) members followed by households which are between 8-10 (25%) followed by households which are between 5-7 (20%) and households which are between 1-4 (10%). From the results presented in Table 4.1, it can be deduced that the response to incentives increase with the increase to household size. These results are contrary to those of Pedzisa *et al.* (2015), who reported that household size negatively affect CA adoption.

4.2.4 Distribution of households by household income

Income distribution amongst the rural households is one of the indicators of wealth. Moreover, income level is the indicator of affordability (Mittal & Mehar, 2016), hence it is one of the socio-economic factors that cannot be over emphasised in literature. Table 4.1, has categorised income level into three, i.e., 0-R1500, R1501-R2000 and greater than R2000, while the level of response is categorised based on the plot size, that is, 400 m^2 and 1000 m^2. Households that have the highest response to incentives (60%) were those that receive the monthly income which is greater than R2000, followed by those whose monthly income is between R1501-R2000 (40%) and R0.00-R15000 (0%). However, it should also be noted that the level of response differs amongst the plot size, as the income increased, the level of response also increased, as it can be seen that there were more respondents that recorded to be using 1000 m^2 than 400 m^2. It should be noted that these results reveal that income has the positive effect on the response to incentives, for both plots sizes. It should be noted that when a farmer adopts the CA for the first time, the use of pesticides and herbicides increases. For that reason, high income level is the indicator of the ability of a farmer to adopt and continue using CA (Gebreselassie, 1998).

4.2.5 Distribution of household by household employment status

Employment status of the farmer is one of the major determinants of the level of response to incentives. Table 4.1 has grouped employment status based on two categories, that is, the ‘employed’ and ‘not employed’, while the level of response is categorised based on the plot size, that is, the 400 m^2 and 1000 m^2. For 400 m^2, about 75% of the respondents are not employed, while the 25% is employed. Moreover, for 1000 m^2, up to 73% of the respondents is not employed while 27% of the respondent were employed. Without any further reference to the literature, it is generally known that the major source of employment in in rural areas, especially from the developing countries, it is agriculture. For that reason, it is not easy to make conclusive justification of the level of the highest response to the incentives based on employment status.

4.3 Results of linear regression analysis of the factors affecting the extent of CA adoption

Most studies have looked at the extent of adoption of CA in different regions without looking at the factors that influence the extent. However, as presented in the literature review of this study, the extent of adoption increases with time (Rogers, 1995). The factors that influence the extent of adoption in this study are presented in Table 4.2 from the linear regression model which was performed to determine the factors affecting the extent of CA adoption. The results of the model are presented in Table 4.2. The coefficient of determination (adjusted R^2) as presented in Table 4.2 indicates that 79% variation in the overall extent of adoption of CA was explained by 7 variables which were included in the model. It is important to note that not all the variables presented in Table 4.2 have been discussed, but those that are significant.

Table 4.2: Estimate of factors affecting CA adoption among maize farmers

Variable	Coefficients	Standard Error	T-value	Sig.
Constant	884.1121	186.4788	4.74	0.000***
Age	3.433202	2.800491	1.23	0.232
Household size	-1.384921	11.05459	-0.13	0.901
Cattle herd size	-69.53765	54.54372	-1.27	0.214
Years in farming	57.20155	30.58661	1.87	0.073*
Joint activity group	384.1408	90.44856	-4.25	0.000***
Land size	.0003699	.0069693	0.05	0.958
Cover crop	-539.8753	83.69652	-6.45	0.000***

R^2=0.8485; Adjusted R^2=0.7940, F=15.56; N=35; *** significance level at 1%, ** at 5%, and * at 10%.

Source: Author's computation (2017)

The coefficient for numbers of year in farming was found to be significant (p ≤ 0.073) and positively related to the extent of adoption. Controlling for other factors, the coefficient of 57.20 implies that the increase in number of years in farming would increase the extent of CA adoption by 57.20. This means that the more the number of years increase in farming activity, the more will be the extent to which the CA is adopted. Increase in the number of years in the farming activity, therefore, is associated with the farming experience. The high experienced farmers will know how much plots should be allotted for CA over conventional farming.

Participation in the joint activity group has a significant ($p \leq 0.000$) positive effect on the extent of adoption on CA practice. It is important to note that farmers in the study area work in groups. So, the results in Table 4.2 reveal that the participation in farmers' joint group increases the extent to which CA will be allotted to the ploughing land.

The literature also reveals the same results presented in Table 4.2 about the cover crops. Cover crop had a significant but negative effective on the extent of adoption. It has to be noted that there are costs associated with adoption of CA over conventional farming. Such costs can be monetary or non-monetary. The monetary costs of using CA include the direct financial inputs while non-monetary cost includes the opportunity costs of resource used in CA model. For example, one of the principles of CA is mulching/cover cropping. So, the crop residue which was supposed to be feeding livestock has no monetary value, however it is used as one of the production inputs. In summary, the cost mentioned in CA technology covers the financial inputs and the opportunity costs of resources (Pannell *et al*., 2014). Hence the use of cover cropping negatively affect the extent to which CA will be adopted.

4.4 Comparison of maize yield levels of CA against the conventional farming in the study area

Farmers will invest their time in the tillage system that promises to give the superior performance over the one they are used to. For example, farmers that are practicing CA are believed to be enjoying high yield levels compared to those that are practicing alternative tillage system such as conventional agriculture. In order to convince the farmers about the superiority of CA over their conventional farming practice, Mahlathini Organics found it necessary to compare CA and the alternative tillage system. Each farmer in the study area was allowed to have two separate plots, a trial and control plot. The trial plot was the plot in which CA was being experimented while the control plots were plots where farmers use their conventional farming practices in terms of tillage and fertility amendments (Kruger, 2016). Table 4.3 presents the average maize yield results from the two tillage systems. Average yield results presented are from the three different seasons, starting from 2013 to 2015. These yields were recorded by the Mahlathini Organic from seven different villages from Bergville town.

Table 4.3: The average maize yield from the sampled respondents of 2013-2015

Year	Trial Plot Yield (t/ha)	Control plot Yield (t/ha)
2013	3.26	3.39
2014	4.12	5.4
2015	4.45	3.05

Source: Kruger (2016)

Although yield is a function of many site-specific factors, it cannot be isolated when assessing the cost benefits of CA over conventional farming. Average maize yield results presented in Table 4.3 vary from one tillage system to the other. In 2013, the average yield from the trial plot was 3.26 tonnes per hectare while in the control plots, it was 3.39 tonnes per hectare. Table 4.3 also reveals that the average maize yield per hectare in the trial plots increased from 3.26 tonnes per hectare in 2013 to 4.12 tonnes hectare in 2014 and finally got to 4.45 tonnes per hectare in 2015. On the other side, the average yield in the control plots was 3.39 tonnes per hectare in 2013, 5.4 tonnes per hectare in 2014 and 3.05 tonnes per hectare. From every indication, it can be deduced from the results that the trial plots showed the positive increase while in control plots the average yield level showed the inconsistent yield levels. The inconsistence in average yield levels of control plots is attributed to poor land management practices that lead to soil degradation (Sihlobo, 2016). On the other side, the increase in average yield levels in trial plots over the control plots is attributed to many factors related to the introduction of CA in the farm such as increase in water retention and increased fertility level.

4.5 Assessing the cost of CA over conventional agriculture in the study area

Economic profitability is a vital requirement for the adoption of any agricultural tillage system. Thus, cost benefit analysis is an important tool for assessing economic viability of a project. Cost benefit method have been applied by various studies and these studies reveal that the benefits of CA over any alternative tillage system vary from one region to the other (Daujanov *et al.*, 2016). For this reason, this section presents the empirical results based on the cost benefit analysis of CA.

4.5.1 Investment cost

In summing up the financial evidence in support of CA, a few words of caution are in order. Although it is true to accept what FAO (2001), term as environmentally friendly and sustainable, this is not always the case. Several constraints such as investment costs, might result in low adoption levels. FAO (2001) stated that investment cost can discourage adoption. Table 4.4 is provided to compare the investment costs of typical smallholder farmer in the study area. The list of investment costs presented in Table 4.3 have not been exhausted. There are costs that have been omitted. For example, land price, storage costs, fencing. The costs presented in Table 4.4 are only site specific. Land tenure system, for example, it is communal land area where there is no cost incurred related to land.

Table 4.4: Investment cost for typical smallholder farmer from KZN

Equipment	**Trial Plot**		**Control Plot**	
	Quantity	**Price**	**Quantity**	**Price (R)**
Knapsack Sprayers	1	400		
Nozzles TEEJET	1	120		
Hand hoes	1	105	1	105
Hand planters (MBLI)	1	1052		
Gloves	1	32	1	32
Soil sample		80		80
Containers	1	2.5	1	2.5
tape measure	1			
Mask (box)	1	2.95		
Total investment cost/person		**1794,45**		**219.50**

Source: Author's own calculation from field survey (2017)

Table 4.4 reveals that the initial investment cost between the trial and control plots is different. Trial plot, which is the conservation agriculture in this study, have high investment costs compared to the control plot (conventional agriculture). The total investment costs for trial plot is R1794.45 while the total investment costs of control plot are R219.50. The major cause of this difference is that when one has adopted conservation agriculture, herbicide and pesticide use increases, hence Knapsack Sprayer and Nozzles TEEJET has to be bought. The spraying equipment are not necessarily used by smallholder farmers due to the belief that soil preparation is enough to remove weeds before and after planting.

Other costs causing major difference in investment cost between trial and control plots is the hand planter specifically used for CA. The hand planter costs about R1 052.00. This cost is not used in planting in the control plots. Control plots make use of the hired tractor. This cost is not included in the investment cost because it is regarded as the variable cost.

4.5.2 Production costs and gross margin of trial and control plots

Production cost and gross margin are very important variables when evaluating the feasibility of the project. Production costs include all the operating cost or variable cost such as fertiliser costs, pesticides, seeds machinery. (Zhou *et al.*, 2009). These costs are presented in Table 4.5, comparing between the trial and control plots

Table 4.5: Comparison of cost and benefits of trial and control plots

Variable cost	Trial Plots (Rands/0.14ha)				Control plots (R/0.8ha)			
	Q	P/Unit	Total Cost (R)	% of cost	Q	P/Unit	Total Cost (R)	% of cost
Maize seed	3.5	104	364	16%	4.8	104	499,2	11%
Fertiliser	35	9.2	322	14%	93	5	465	10%
Herbicide	0.42	109	45,78	2%				
Pesticide	0.014	875	12,25	1%				
Ploughing					0.8	645	516	11%
Labour	5	250	1250	56%	10	250	2500	53%
Discing					0.8	537.5	430	9%
Sowing	5	50	250	11%	0.8	376.25	301	6%
		Sub-total	**2244,03**	**100%**		**Sub-total**	**4711,2**	100%
Contingency at		4%	89,7612	Contingency at		4%	188,448	
Total Cost			**2154,2688**	**Total Cost**			**4522,752**	
Gross Revenue	3,94	2500	9850		3,35	2500	8375	
Gross Margin			**7695,7312**				**3852,248**	

Source: Author's own computation (2017)

4.5.2.1 Maize seed costs

Although there is scanty literature on seed costs in the context of CA (Uri, 2000), it was deemed important to include them amongst variable costs. This is due to the question of whether the seeding rate varies under the CA and conventional agriculture. According to the results presented in Table 4.5, the extent of each variable cost is quantified in relation to the sub-total costs in each tillage system. In trial plots, maize seed cost takes about 16% of the maize variable costs while in control plots, maize seed cost takes about 11% of the sub-total costs. It is very hard to make conclusions on this results due to the difference in the size of plots. However, Uri (2000) stated that it has been recommended that seeding rate increases with the adoption of CA when seeds are planted in a narrow rows or drilled.

4.5.2.2 Fertiliser cost

Since the advent of fertiliser in the farming sector, it has been one of the crop variable costs which cannot be ignored when farmers are considering to adopt a farming practice which is said to promise high yield levels. Results presented in Table 4.5 reveal that fertiliser use makes about 14% in the trial plots while in control plots, the fertiliser use make about 10% of the maize variable costs. These results confirm the hypothesis proposed by most studies which say that fertiliser use will increase with the adoption of CA compared to convention agriculture (Lai et al., 2012; Ngwira et al., 2014). However, there is a prospect that the demand of fertiliser will decrease in the long-run. Decrease in the fertiliser use will be accompanied by the decrease in cost. For that reason, Lai *et al.* (2012) recommended the subsidee of fertiliser in the initial implementation stage of CA.

4.5.2.3 Herbicide costs

Although not all smallholder farmers can afford herbicide, but they cannot be ignored when the farmer considers to adopt the tillage system. Results presented in Table 4.5 reveals that herbicides were used in the trial plots while they were not used in the control plots. It has to be noted that the control plots are the typically conventional agriculture system. The 2% revealed in the extent of herbicide cost amongst the total variable costs of the trial costs confirm Du Toit (2007) research results which reported that the respondents involved in CA increased their expenditure on herbicides by 4.5%.

4.5.2.4 Pesticide

One of the reasons pesticide costs cannot be ignored in the varible cost list is that most farmers, including the smallholder farmers, belive that herbicide application in two or three weeks before planting makes weeding easire in the CA tillage system (Gianessi, 2014). Table 4.5 reveals that pesticide use increase the variable costs by 1% in the trial plots while in the control plots, fertiliser costs are not detected. One of the major reasons for this is that control plots, which are conventional farming plots, involve soil preparation and turning of soil. So, soil preparation is believed to increase reduce the level of weeds in the farm, hence control plots do not have the pesticide costs.

4.5.2.5 Ploughing and dicing costs

Ploughing and dicing are soil preparation activities mostly followed by conventional farmers. These two activities cannot be excluded when comparing the costs of CA against conventional agriculture. It has to be noted that ploughing and dicing in the smallholder setting usually involves manual hoeing using hand hoes or animal-drawn plough. However, the smallholder farmers in the study area mostly hire tractors or animal drawn for ploughing and dicing activities. It is for this reason Table 4.5 reveals the cost of ploughing and dicing to be 11% and 9% in the control plots, while there are no cost incurred for ploughing and dicing for trial plots. There are no cost incurred for dicing and planting in the trial plots because CA involves the no-tillage or minimum tillage system.

4.5.2.6 Labour costs

Labour cost are very important in every industry. In agriculture, the number of labour hours devoted to each tillage operations are different between CA and conventional farming. According to the results presented in Table 4.5, labour cost differs between trial and control plots. In the trial plot, labour costs make about 56% of the total cost while in the control plots, labour cost makes about 53% of the total variable costs. These results contradicts the notion which says that CA saves considerable amount of labour (Friedrich *et al.*, 2012). One of the reasons for this increase in labour requirement is the small proportion of herbicide and pesticide costs in the variable costs. Hence, Ngwira *et al.* (2014) asserted that CA reduces labour costs if and if only if, a farmer uses herbicides to control weeds but the case is otherwise when compared with conventional agriculture without the use of herbicides.

4.5.2.7 Gross margin

Although gross margin is highly dependent on the variable costs incurred during the production season, it cannot be isolated when farm managers have to adopt the tillage system. The reason being that, yield increase alone cannot be the only justification for adoption decision. Gross margin calculated in Table 4.5 is different amongst the two farming systems. Trial plots made about R7695.73 of GM while control plots made about R3852.25. The major cause of the difference is the variable costs. It can be seen in Table 4.5 that control plots have higher variable costs compared to trial plots.

4.6 The potential of CA compared to the conventional farming in the long-run in the study area suing Appraisal Indicators

For a sound financial analysis, it was found important to properly identify cost and benefits of an investment activity. Separating plots as trial and control plot approach was used to capture the incremental costs and benefits associated with CA as an alternative to conventional farming. Trial plots involved the use of all CA principles while the control plots were the normal use of conventional farming practices.

The appraisal indicators used in this dissertation are Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Rate (IRR) (see Table 4.6). The appraisal indicators were used to quantify the net financial gains for investing in Trial and Control plots. Table 4.6 presents the results of the appraisal indicators, discounted at 8 and 10.5%.

Table 4.6: The results comparing CA and conventional farming over time from the appraisal indicators

Tillage system	Parameter	10-year period Discounted at 8%	10-year period Discounted at 10.5%
Trial plots	Net Present Value	52694	46550
	Internal Rate of Return	25%	25%
	Benefit Cost Ratio	3,85	3,78
Control plots	Net Present Value	20446	18177
	Internal Rate of Return	35%	35%
	Benefit Cost Ratio	1,56	1,55

Source: Author's own computation

4.6.1 Net Present Value

It is important to consider that the magnitude of NPV is also an additional factor which farmers take into consideration during the adoption decision of any kind of technology (Thierfelder *et al.,* 2013). The NPV is presented in Table 4.6 with 10-year period projections at 8% and 10.5% discount rates for both tillage systems. At 8% discount rate, the trial plots (CA plots) resulted in NPV of R52694.00 while the NPV for control plots (i.e., Conventional agriculture plots) is R20446.00. At 10.5% discount rate, results revealed that CA is more viable than conventional tillage systems because the NPV of trial plots is higher than that the NPV of control plot with R46550.00 and R18177.00, respectively.

This therefore means that at a lower discount rate, it is more viable to produce maize using CA than using conventional tillage system. The results also reveal that with a 10.5 % discount rate, the NPVs are lower than with at 8 % discount rate, showing that lower discount rates are consistent with higher performance over the long term. The positive sign implies that there are positive pay-offs for investing in both trial and control plots. However, trial plots have larger NPVs compared to control plots. This therefore means that there are less additional returns for investing in controlled plots compared to trial plots. The difference between NPVs for the two tillage systems is accounted for by the differences in the investment and variable costs incurred (Recall Table 4.4 and 4.5). Moreover, it is also accounted by very low yields achieved on the controlled plots that are associated with soil degradation.

4.6.2 Benefit Cost Ratio (BCR)

The BCR is one of the important appraisal indicators which the farmers cannot ignore because it makes it possible for farm managers to compare the performance of different investments (Street, 2014). The BCR is presented in Table 4.6 with 10-year period projections at 8% and 10.5% discount rates for both tillage systems. At 8% discount rate, the trial plots resulted in B/C ratio of 3.85 while the control plots yielded a ratio of 1.56. This therefore means that at 8% discount rate, it is more viable to produce maize using CA than using conventional tillage system.

Moreover, at 10.5% discount rate, results presented in Table 4.6 reveal that CA is more viable than conventional tillage system because the BCR of trial plots is higher than that of control plot with BCR ratio of 3.78 and BCR of 1.55, respectively. These results reveal that CA is more viable at the environmental project official discount rate (which is 8% in this case) than the lower rates which were used to test against it. Moreover, the results reveal that BCR is also viable at lending discount rate. The results confirm the report presented by ARC (2014) stating that CA is more viable than conventional farming.

4.6.3 Internal Rate of Return (IRR)

Atampugre (2014) stated that the internal rate of return cannot be isolated amongst the appraisal indicators because it allows the decision maker to know the ratio between the operating profit and the summation of costs and average working capital. It represents the maximum interest that a project could pay for the resources used if the project is to recover its investment and operating costs and still break even (Afari-Sefa *et al.,* 2010). The IRR is presented in Table 4.6 with 10-year period projections at 8% and 10.5% discount rates for both tillage systems. At 8% discount rate, the rate of return in trial plots is 25% while in control plots, the rate of returns is 35%. Furthermore, at 10.5%, the rate of returns of trial plots is 25%, while in control plots, the rate of returns is 35%. The results reveal that the investment rate of trial and control plots is the same for both discount rates. This means that they are growing at the same rate, although lower discount rates yield higher NPV than the other at that same rate. This means that the average yield for CA is in fact higher than that of conventional agriculture.

4.7 Chapter summary

This chapter presented the results and discussion of the study, showing household distribution by the level of response to incentives shown by trial plots size. It has been shown that socio-economic factors influence the adoption decision. The results from the linear regression revealed that years in farming, involvement in joint farmer's group, and use of cover crops have the significant effect on the extent of adoption of CA. involvement in the group and the use of cover crop appeared to be the most important factor in determining the extent of adoption of CA. The results from analysis made revealed that CA have high GM compared to conventional farming. Moreover, the study revealed positive NPVs for both CA and conventional agriculture. The positive sign implies that there are positive pay-offs for investing in both tillage systems. However, CA have larger NPVs compared to control plots. This therefore means that there are less additional returns for investing in controlled plots compared to trial plots. The following chapter presents the study summary, conclusion and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a brief summary of the main findings of the study. Moreover, the chapter brings the conclusion which shall be followed by the recommendations on the basis of the empirical results. The chapter discusses the extent to which the objectives and hypothesis discussed at the beginning of the study have been addressed by the analysis.

5.2 Summary

The main objective of this dissertation was to assess the farm level cost-benefit analysis of CA for smallholder maize farmers in OLM in KZN Province of South Africa. To accomplish that objective, it became necessary to reach some specific objectives. Assessing the economic analysis of CA assumed a high degree of importance during the literature review conducted for this dissertation. Related to that effort, it became necessary to reach an understanding of the factors affecting the extent of CA adoption among the smallholder maize farmers in the study area, to compare the yield levels of CA over the conventional farming in the study area, assessing the cost of CA over conventional agriculture in the study area, moreover, to know the earliest returns of CA over the conventional agriculture in the study area and evaluating the potential of CA compared to the conventional farming in the long-run in the study area. Once these fundamental steps were achieved, this research was able to go forward. So, this chapter provides the conclusions and recommendations that emanated from this study.

By means of integrating field survey, secondary data from the reviewed literature, and econometric analysis, this study assessed the farm level cost-benefit analysis of conservation agriculture for smallholder maize farmers in OLM, specifically in one demonstration village of Bergville town. The analysis is based on the case study of the NGO's work in which they had selected a community and participating households who received assistance in a number of ways such as maize seed, soil preparation, and CA planters.

In order to get the results from the collected data, data was analysed using descriptive statistics, linear regression model, gross margin and cost benefit analysis. Cost benefit analysis made use of the project appraisal indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit Cost Ratio (BCR). Appraisal indicators discounted the investment at 8% and 10.5%. The 8% is the one which is recommended for environmental projects while 10.5% is the bank interest rate in South Africa.

Descriptive analysis used plot size allotted to CA as the extent of CA in the farm and level of response to the incentives. The level of response varied amongst the farmers. Variation in responses was affected by the socio-economic factors as it was also presented by the linear regression model results. Results revealed varying gross margin with CA having high GM compared to conventional farming. The major cause of the difference being the investment and operating costs. Lastly, appraisal indicators also revealed varying magnitudes, with positive NPVs. Positive NPVs signifying the positive pay-offs for both investments (control and trial plots).

5.3 Conclusion

The threat posed to food security due to land degradation occurring around the world and in the study area was highlighted as the main concern for finding alternative production systems. High rainfall beating the bare and steep soil and continuous conventional agricultural practice are regarded as major causes of the soil degradation.

The livelihood of rural household of OLM is mainly dependent on land. The extent of degradation in the Land Use System (LUS) is more than 60% in the area and many of the farmers are resource poor (Stronkhorst *et al.*, 2010). For that reason, CA has been introduced in the area. At first, CA was demonstrated, people adopted and then discontinued. There was the anecdotal evidence that they did so because benefits were not sustained. Years later, the CA was revived and the NGO that revived took note of the corridor talk pertaining to discontinuation and designed the new intervention to control for the things that may have caused the previous project to fail. Now that the programme has been introduced for the second time, there is a lot of optimism and this is likely to influence public policy in respect to support for CA.

This study therefore, focused on an evaluation of farm level profitability of CA using the cost-benefit theory to ascertain whether the optimism will be sustained. There is however, a lack of information on the on-farm financial benefits of adopting CA specific tillage.

Conservation agriculture is an amalgamation of a number of sustainable practices developed over the last century, packaged under the three guiding principles; viz., no-tillage, mulching, and crop rotation. Conservation agriculture is a system that integrates the three guiding principles to operate concurrently and generate both physical-biological and socio-economic benefits to the farm system. However, these benefits of CA are not without challenges. For example, yield benefits take long time to materialize of which smallholder farmers cannot afford income sacrifices in the short term even if there is a promise of greater benefits in the long run.

The extent of adoption of conservation agriculture practices was assessed in Bergville town of KZN Province of South Africa. The key respondents were the farmers that have adopted the CA to some extent. The study was conducted in 5 villages to account for possible inconsistences in agro-ecological aspects. Although descriptive statistics was used to assess the socioeconomic factors that describe the farmers that have adopted the CA practices, linear regression was to determine the factors that affect extent to which CA has been adopted by farmers. It has to be noted that this approach differed to other studies in that it went to find out the factors that affect the extent. The key respondent interviews and informal discussions with the farmer joint groups also provided the desired information.

The results presented in this study suggest that years in farming, involvement in joint farmer's group, and use of cover crops have the significant effect on the extent of adoption of CA. involvement in the group and the use of cover crop appeared to be the most important factor in determining the extent of adoption of CA. Non-Governmental Organisations (NGO) along with the Department of Rural Developnent and Agrarian Reform agents. In the absence of NGO support in facilitating the adoption of CA, the agro-dealers have to be encouraged to facilitate the farmers' joint group.

The number of years in which the farmer has been involved in farming activities have proved to be one of the significant factors affecting the extent of adoption. The results revealed that farmers are likely to increase the extent of adoption with the increase in experience. When the farmers increase the extent of adoption with the increase with the level of experience reveal the value of being able to observe the productive agricultural practices.

Although cover cropping significantly affects the extent of adoption, it was revealed with negative coefficient. The main reason being that most smallholder farmers under review are livestock owners. Such owners do not have the fencing that will promote mulching and cover cropping. For that reason, their livestock usually feed on the mulch and the cover crops that would have been used on CA practice. It is therefore recommended if the extent of CA have to increased, the smallholder farmers be supported with fencing.

Although in the smallholder setting, CA has high initial investment costs compared to conventional agriculture, CA has high gross margin (GM) compared to conventional farming. There are many factors that contributed to the level of GM in all the tillage systems practiced, one being the low operating cost in CA compared to conventional agriculture.

When using appraisal indicators (NPV, BCR, and IRR) the study projected a 10-year period at 8% and 10.5% discount rates. All the appraisal indicators confirmed the viability of CA over the conventional agriculture.

5.4 Recommendation of the study

The study found that there are incentives to adoption of CA compared to conventional farming. One striking benefit of CA over conventional farming is low operating costs, although there are high investment costs compared to conventional farming. The message from the different results arising from the use of different discount rates is that farmers should receive assistance at low cost of capital in order for their operations to be viable and this works out well over the long term as shown by the 10-year period projections.

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APPENDIX: QUESTIONNAIRE

TOPIC OF DISSERTATION:

"Farm level cost-benefit analysis of conservation agriculture for maize smallholder farmers in Okhahlamba Municipality in Kwa-Zulu Natal Province, South Africa."

PLEASE NOTE: that the survey is completely non-discriminatory and the information that you are about to give merely helps in the interpretation of the results.

BACKGROUND INFORMATION

Date…………………………………………………………
Interviewer……………………………………………….
Province………………………………………….............
District...
Village...

***Fill in the relevant information and where possible mark with an X*.**

A. DEMOGRAPHICS AND SOCIOECONOMIC FACTORS

A.1 Gender

1. Male		**2. Female**	

A.2 Age

......................years

A.3 Marital Status

1. Single		**2. Married**		**3. Widowed**		**4. Divorced/Separated**	

A.4 Household Size

Age group	Number of Persor
1. Under 18	
2. Over 18	

A.5 Level of education

1. Primary		**2. High School**		**3. Diploma**		**4. Tertiatiry**	

A.6 Employment Status

1. Full-time farm		**2.Part-time farm**		**3.Pensioner**		**4.Formally employ**		**5. Unemployed**	

A.7 Monthly income?

R.................

B. THE EXTENT OF CA ADOPTION AMONG THE MAIZE SMALLHOLDER FARMERS

B.1 How many years have you been farming farming?

……………..

B.2 How many years have you been farming under CA practice?

………………….

B.3 Land size

……………………….

B.4 Land size allocated to CA practice

Farming Practice	Land size
1. CA	
2. Conventional	

B.5 Which component of CA package have you adopted?

CA Package	Mark (X)
3. Minimum soil disturbance (Or No-till)	
4. Maximum stubble retention (Or Mulching)	
5. Diversified crop rotation	

B.6 Why did you adopt CA

Reason	Mark (X)
1. Labour saving	
2. Higher yields	

3. Soil moisture retention	
4. Soil erosion control	
5. Enhanced soil fertility	
6. Other	

C. FACTORS RESTRICTING CA ADOPTION AMONG THE MAIZE SMALLHOLDER

C.1 Factors causing a direct cause of leaving CA.

Category	Factor	Mark (X)
Workload	work load health /age lack of labor	
	lack of equipment migration weeding	
	complicated	
	costs/	
	work load health /age lack of labor	
	lack of equipment migration weeding	
	complicated	
Costs	Herbicides	
	Fertiliser	
	Labour	
	Land size	
Yield/Benefits	Low yield increase	
	Grant dependence	
	End of subsidies	
	Conflicting requirements	
	Lack of evaluation	
Tradition	Traditions in farming	
	Habit	
Biophysical	Insufficient rain	
	Soil properties	

D. BENEFIT AND COSTS OF CA ADOPTION AMONG THE MAIZE SMALLHOLDER FARMERS

Following is the comparison of CA and conventional agriculture income and cost budgets for smallholder farmes. If only one practice is adopted, answer the relevant question to you, either D.1 or D.2. But if you practice both CA and conventional, answer both questions, D.1 and D.2.

D.1 ANNUAL CASH MAIZE INCOME AND COST BUDGET FOR CA FARMERS

Enterprise name	**Maize (2017)**
Indicate irrigated (I) or dryland (D)	**D**
Ecotope / soils	**Normal climatic conditions**

INCOME **(Gross Value of Production)**

	UNIT	QUANTITY	PRICE (R/unit)	AMOUNT (R/Ha)
A_1 Sales of grain (advance payment)	tonne			
A_2 Value of product consumed at home / donated				
A_3 Value of product fed to livestock				
A_4 Value of product used for seed				
A_5 GROSS INCOME ($A_1 + A_2 + A_3 + A_4$)				

VARIABLE COSTS OF CONSERVATION AGRICULTURE

		UNIT	QUANTITY	PRICE (R/unit)	AMOUNT (R/Ha)
Seed:	purchased	kg			
	farm produced				
Fertilisers	LAN (Transport included)				
	Organic manure (Transport included)				
Chemicals:	Weed control	litre			
	Pest control	litre			
	Crop spraying	litre			
	Other	litre			
Contract work:	Crop spraying	ha			
Casual labour :	Planting	hour			
	Manual hoeing	hour			
	Harvesting	hour			
Implements:	repairs etc. Pre-harvest	ha			
	repairs etc. harvest	ha			
Packing material:	50kg bags (Or 20 litre pail pack)	Bag/litre			
Marketing costs:	Transport	R			
Other					
B TOTAL VARIABLE COSTS					
CROP GROSS MARGIN above allocated costs (A_5 - B)					
Gross margin per R100 variable costs					
Breakeven Price (Price/ton)					
Breakeven Yield (Bags/ha)					

D.2 ANNUAL CASH MAIZE INCOME AND COST BUDGET FOR CONVENTIONAL FARMERS

INCOME (Gross Value of Production)

	UNIT	QUANTITY	PRICE (R/unit)	AMOUNT (R/Ha)
A_1 Sales of grain (advance payment)	tonne			
A_2 Value of product consumed at home / donated				
A_3 Value of product fed to livestock				

A_4 Value of product used for seed				
A_5 GROSS INCOME ($A_1 + A_2 + A_3 + A_4$)				

VARIABLE COSTS OF CONVENTIONAL AGRICULTURE

			UNIT	QUANTITY	PRICE (R/unit)	AMOUNT (R/Ha)
Seed:	purchased		kg			
	farm produced					
Fertilisers:	LAN (Transport included)					
	Organic manure (Transport included)					
Chemicals:		Weed control	litre			
		Pest control	litre			
		Crop spraying	litre			
		Other	litre			
Contract work:		Crop spraying	ha			
Casual labour:		Hired tractor for land preparation	hour			
		Hired tractor for sowing	hour			
		Hired tractor for weed control	hour			
Machinery:		fuel etc. Pre-harvest	ha			
		fuel etc. harvest	ha			
Implements:		repairs etc. Pre-harvest	ha			
		repairs etc. harvest	ha			
Packing material:		50kg bags (Or 20 litre pail pack)	bag			
Other						
B TOTAL VARIABLE COSTS						
CROP GROSS MARGIN above allocated costs (A_5 - B)						
Gross margin per R100 variable costs						
Breakeven Price (Price/ton)						
Breakeven Yield (Bags/ha)						