COMPARATIVE ECONOMIC ANALYSIS OF CONSERVATION AND CONVENTIONAL AGRICULTURAL PRACTICES IN SOUTHERN ULUGURU MOUNTAINS, MOROGORO, TANZANIA

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ABSTRACT

The improved technologies and other practices in agricultural production are often recognized as critical in addressing food insecurity and poverty. Conservation agriculture has emerged as an alternative to conventional agriculture as a result of losses in soil productivity due to soil degradation. This study was conducted in order to determine the economic performance of conservation as compared to conventional agricultural practices in Southern Uluguru Mountains in Morogoro region. The analysis specifically aimed at establishing differences in farmers' profitability between conservation and conventional agricultural practices and determining productivity of inputs for conservation as compared to conventional agricultural practices. Purposive sampling was used to get three wards and two villages in each ward. Simple random sampling was used to get 200 farmers (100 from each group; conservation and conventional agriculture farmers). The mean gross margin per hectare for conservation and conventional agricultural practices were TZS 526 800 and TZS 200 360 respectively. This implies that that the returns for conservation agriculture are higher than that of conventional agricultural practice. The marginal productivity of land for conservation agriculture farmers was 366 kg/ha while that of conventional agriculture farmers was 248 kg/ha. Marginal productivity of labour for conservation agriculture famers was 90 kg/man day while that of conventional agriculture farmers was 46 kg/man day. This shows that the marginal productivity of inputs for conservation agriculture farmers was higher than conventional agriculture farmers. Generally the study suggested that Conservation agricultural practices have potential to improve the income and livelihood of farmers in the study area if properly managed. The government through close collaboration with agricultural research institutions, development agencies, project implementers, district extension officers and farmers

organizations should put more efforts on disseminating the benefits accrued from the practices for easy adoption as farmers are reluctant to adopt the technology.

DECLARATION

I, Mahenge Jackson, do hereby declare before the Senate of Sokoine University of Agriculture, that this dissertation is my own work done within the period of registration and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

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The above declaration above confirmed

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DEDICATION

To my God and my Lord Jesus Christ, To my parents Seth and Veronica Mahenge who sent me to school on time regardless of their financial position.

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LIST OF ABBREVIATIONS

AP	Average Product
BCR	Benefit Cost Ratio
CA	Conservation Agriculture
CARE	Cooperative for assistance and relief everywhere
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GM	Gross Margin
HICAP	Hillside Conservation Agriculture Project
KNCU	Kilimanjaro Native Cooperatives Unions
MICCA	Mitigation of Climate Change in Agriculture
MP	Marginal Product
NPV	Net Present Value
SNAL	Sokoine National Agriculture Library
SPSS	Statistical Package for Social Sciences
TR	Total Revenue
TVC	Total Variable Costs
TZS	Tanzanian Shillings
URT	United Republic of Tanzania
VSL	Village Savings and Loans
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture is the backbone of the economy of many developing countries. Typically, it is the largest source of employment; often two-thirds or more of the population of developing countries are dependent for their livelihood on farming. In Tanzania agriculture is the leading sector of the economy, it contributes significantly to the country's gross domestic product (GDP); it accounts for about half of the national income, three quarters of merchandise exports and employs 80 per cent of the country population especially those in rural and peri-urban areas (URT, 2011).

Agricultural production in Tanzania is in most cases smallholder subsistence. Yields are generally low for example, averaging below 1.19 tone/ha for maize, being held back by such factors as low and generally declining soil fertility, soil and water loss through erosion, erratic and unreliable rainfall (Msuya *et al*., 2008). In many arable lands, nutrient mining is severe, with cropping activities estimated to be depleting nutrients at a rate of six to seven times greater than the rate at which they are being replenished (Shetto *et al.*, 2007). Practicing conventional agriculture which involves burning and removing crop residue and intensive tillage leads to more deterioration of the nutrients in the arable land.

Management of natural resources in a sustainable way is one of the important agenda that is included in Tanzania for agricultural productivity (URT, 2003). The adoption of improved technologies in agriculture and practices which are concerned with managing natural resources sustainably is often recognized as critical in addressing food insecurity

and poverty. Conservation agriculture has emerged as an alternative to conventional agriculture as a result of losses in soil productivity due to soil degradation (FAO, 2011). It is centered on three basic principles: minimizing soil disturbance, maintaining a permanent soil cover and practicing crop rotations.

The main reason for conservation farming practices is to conserve, improve natural resources and use them more efficiently. This is achieved by integrated management of soil, water and biological resources in combination with external inputs. Conservation farming includes conserving the environment and natural resources and increases sustainable agricultural production.

1.2 Problem Statement and Justification

Conservation agriculture is an important farming practice since it aims at conserving, improving and making more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs (Erwin, 2007). It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource efficient or resource effective agriculture (FAO, 2006). This is one of the technologies that farmers are adopting in order to have a sustainable and environmentally friendly agricultural production.

As a modern agricultural practice in agricultural production scholars have different views and arguments concerning conservation agriculture as compared to conventional agriculture which is the traditional way of crop production. In some previous studies regarding the adoption of minimum tillage technology or conservation agriculture it has

been found that there is no economic difference between conservation and conventional agriculture, therefore there is no economic incentive to switch technologies (Janosky *et al*., 2002). Some authors (Ribera, 2004 and Janosky *et al*., 2002) argued that there is no significant difference in the economic performance between conventional agriculture and conservation agriculture. Lal (2001) explained the historical development of agriculture with tillage being a major component of management practices and therefore switching to conservation agriculture can eliminate this component.

In recent years, there has been demonstrated evidence of the advantages of practicing conservation agriculture in enhancing food and livelihood securities (Bloem *et al*., 2009). There are also some studies that suggest that yields from conservation agriculture may be as high, if not higher, than conventional or traditional agriculture practices (Govaerts and Sayre, 2006). This have been justified by the data collected from Mwangaza B farmer field school in Arusha, Tanzania where by the yields under conservation agricultural practice increased from 1.25t/ha in 2004 to 7.0t/ha in 2009 (Owenya *et al.*, 2011). There are also significant savings of agricultural labor through reduced demands of tillage and weeding which are the practices in conservation agriculture (Bishop-Sambrook, 2003).

In considering these views and arguments still there is a debate on whether conservation agriculture or conventional agriculture is economically performing well and is beneficial to the farmers' livelihood. The existence of the debate creates an information gap on the economic performance and incentives of conservation agriculture as compared to conventional agriculture that need to be filled.

This study is therefore, focused on analyzing the economic performance of conservation agriculture as compared to conventional agriculture. Results of this study will help to

provide useful contribution to the debate among scholars on the economic performance of conservation agriculture as compared to conventional agriculture. Furthermore the results of the study will provide useful information to policy makers in order to formulate appropriate and effective agricultural and food security policies, project implements, development agencies, extension officers and various stakeholders in the Agriculture sector.

1.3 Objectives of the Study

1.3.2 Overall objective

The overall objective of this study is to determine the economic performance of conservation as compared to conventional agricultural practices in Southern Uluguru Mountains, Morogoro, Tanzania.

1.3.3 Specific objectives

i. To determine the differences in farmers' profitability between conservation and conventional agricultural practices.
ii. To compare the farmers' input productivity between conservation and conventional agricultural practices.

1.3.4 Research hypothesis

i. There is no significant difference in farmers' profitability between conservation and conventional agricultural practices.
ii. Farmers' input productivity for conservation agricultural practice is not statistically different from conventional agriculture practice.

1.4 Conceptual Framework

A conceptual framework provides understanding of the theoretical relationships between important variables and the economic performance of the agricultural practices. In Fig. 1 the variables such as knowledge and information on agricultural practices, farmers' attributes and farm enterprises influence the perception on conservation agricultural practice. The perception on conservation agricultural practice leads to the either uptake or rejection of the conservation agricultural practice. The uptake of conservation agricultural practice may lead to increase in crop yields, increase in cost and labour savings, improvement in soil fertility and diversification of enterprises. The non uptake of it may lead to decrease in crop yield, decrease in cost and labour savings, decline in soil fertility and non diversification of enterprises.

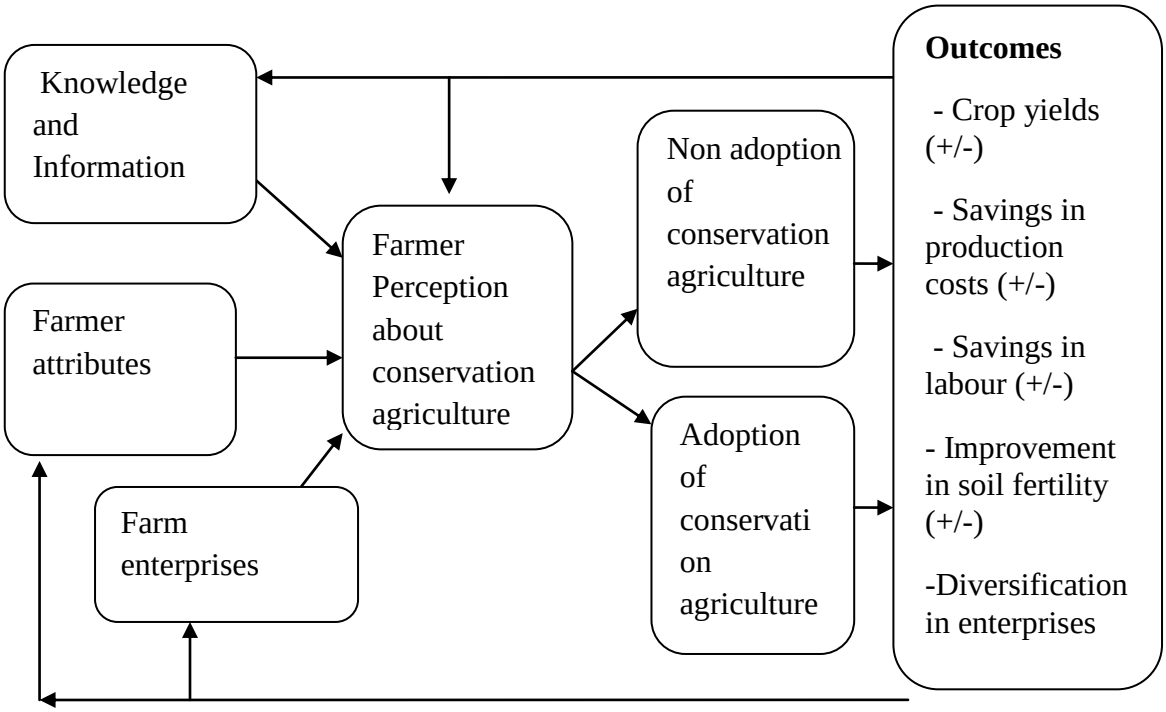

Figure 1: A Conceptual framework for conservation agricultural practices

1.5 Organization of the Study

The study has five chapters. The first chapter provides a general background of the study. The second chapter presents a review of literature relevant to the study. Chapter three presents a detailed description of the study area and study methodology employed. A detailed description of results and discussion is provided in chapter four. The fifth chapter presents conclusion and policy recommendations emanating from the study. The last section of the study contains a list of appendices and the literature cited in this study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Concepts

2.1.1 Conservation agriculture

The term conservation agriculture refers to farming practice which aims at resource-saving agricultural production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. This is the agricultural practice that enhances the sustained agricultural production and also contributes to environmental conservation. It can also be referred to as resource efficient or resource effective agriculture (FAO, 2004).

Conservation agriculture in most cases base on three main principles which are permanent soil cover, minimal soil disturbance and crop rotations (FAO, 2001). All these principles (permanent soil cover, minimal soil disturbance and crop rotations) enhance the agricultural productivity and conservation of the environment which are the main arguments for Conservation agricultural practice. In other words conservation agriculture is based on optimizing yields and profits, to achieve a balance of agricultural, economic and environmental benefits (Dumanski *et al.,* 2006). It advocates that the combined social and economic benefits gained from combining production and protecting the environment, including reduced input and labor costs, are greater than those from production alone. With conservation agriculture, farming communities become providers of more healthy living environments for the wider community through reduced use of fossil fuels, pesticides, and other pollutants, and through conservation of environmental integrity and services

2.1.2 Conventional agriculture

This is referred as a traditional way of agricultural production which does not conform to the key principles of the conservation agricultural practice like minimum soil disturbance, permanent residue soil cover and crop rotation. Conventional agricultural practice involves tillage. Tillage is the act of disturbing the soil with an implement powered manually or by animals or tractors. Other names for tillage include ploughing, cultivation and digging. This agricultural practice does not consider minimization of the environmental effects through environmental conservation and enhancing sustainability of the agricultural production.

2.2 Theoretical Review

Conservation Agriculture is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. It is characterized by three linked principles, namely; minimum mechanical soil disturbance, permanent organic soil cover and diversification of crop species (ACT, 2008). Conservation Agriculture functions best when all three key features are adequately combined together in the field (Derpsch, 2001).

Minimal disturbance of the soil by tillage reduces land and water pollution and soil erosion, reduces long-term dependency on external inputs, enhances environmental management, improves water quality and water use efficiency, and reduces emissions of greenhouse gases through lessened use of fossil fuels (FAO, 2011). Keeping the soil covered is a fundamental principle of Conservation Agriculture as cover crops and it improves the stability of the Conservation Agriculture system, not only on the improvement of soil properties but also for their capacity to promote an increased

biodiversity in the agro-ecosystem. Crop rotation involving different species lead to increased soil fertility and reduction of the vulnerability to diseases.

2.2 Ways in Which Conventional Agricultural Practice Differ From Conservation Agricultural Practice

Conventional agricultural practices are considered as the traditional ways of crop production. Ploughing the land is the basic element of production in conventional agriculture. In intensive production systems farmers do practice tillage which disturbs the soil without considering the soil fertility improvement strategies.

In conservation agricultural practices the minimum soil disturbance is the one the key principles by which farmers do not disturb soil in their production systems. According to Kassam *et al.* (2009) the disturbed area must be less than 15 cm wide or 25% of the cropped area (whichever is lower). The soil is covered throughout the year by mulching and the cover crops like lablab and beans. Also Conservation Agriculture systems demand the adoption of crop rotation as a way to reduce external inputs for increasing soil fertility and control of pests and diseases.

2.3 Conservation Agriculture in Tanzania

Before 1980 in Tanzania occurred a collapse of the conventional soil conservation system and increased land degradation due to the increased livestock and human activity. In 1980s, the government initiated the programs to combat land degradation like agroforestry, water catchment protection and environmental conservation in general (Shetto and Lyimo 2001). This programs initiated by the government lead to the

emergence or existence of Conservation agriculture in Tanzania. Conservation agriculture is practiced in some districts of Tanzania like Karatu, Arumeru Mbeya and Morogoro.

2.4 Adoption of Conservation Agriculture in Southern Uluguru Mountains

Adoption of technology is defined as a decision to apply an innovation and continue to use it (Van De Ban and Hawkings, 1996). Adoption is conceptualized as a multi-stage decision process involving information acquisition and learning by doing by farmers who vary in their risk preferences and their perceptions of riskiness of an innovation (Dina, 2006). For the case of this study, the adopters are farmers who practice conservation agriculture and hence adoption refers to the multi stage process which involves sensitization of farmers to replace the conventional agricultural practice with conservation agricultural practice as introduced by Hillside conservation agriculture Project (HICAP) under CARE International in Tanzania.

2.5 Labour Saving Through Conservation Agricultural Practices

The use of conservation agriculture leads to more labour saving due to the fact that little labour force is needed in the farming operations (Owenya *et al*., 2011). In land preparation with conventional agriculture, labour are used in slashing, burning and ploughing while with conservation agriculture labour are used in slashing only. Conservation agriculture use mulching and cover crops which have got a significant impact in reducing weed pressure and hence reduce number of labour used in weeding. Weed control is costly and labourious which means it need more labour, time and money to have a good control of weeds in the farm (Wall, 2007). Through the use of mulch, cover crops and reducing some of the farming operations with conservation agriculture labour saving is possible especially to smallholder farmers.

2.6 Costs of Production in Conservation and Conventional Agricultural Practices

2.6.1 Costs associated with conservation agricultural practice

The cost of production in conservation agricultural practice is relatively low, this is caused by the little use of the highly mechanized implements like tractors and the use of small labour force in the agricultural production activities. According to Hobbs and Gupta (2004), one of the major benefits of conservation agriculture, which makes it popular with farmers, is that it costs less in terms of money and time. In land preparation few labour are used since conservation agriculture does not involve land cultivation which uses large number of labour and high costs. Also the conservation agriculture reduce the number of weeding operations in the farm since the farm is covered with mulch and cover crops which in most cases reduce the weeding pressure in the farm and hence the reduce the costs associated with weeding.

2.6.2 Costs associated with conventional agricultural practice

Conventional agricultural practice involves a number of farming operations which lead to the use of high costs in the production activities. The farming operations involved in land preparation are like slashing and burning, collection of the remaining after burning, ploughing and hallowing. All these operations involve costs of labour used which lead to high costs of production. Also with conventional agriculture, farmers are required to have a number of weeding operations due to the high weeding pressure in the farm which lead to the increase in the costs of production in the farming operations with conventional agricultural practice. According to Hobbs (2006), conventional agriculture which involves tillage costs money in the form of fuel for tractors, wear and tear on equipment, and the cost of the operator. If animals are used as the power source, the costs of feeding and caring for the animals over a full year are also high.

2.7 Conservation Agriculture and Food Security in Tanzania

Food security is the situation where all people at all times have physical and economical access to safe, sufficient and nutritious food to meet the dietary needs and food preferences for an active health life (FAO, 1996). Food security exist when all people at all the time have access to sufficient, safe, nutritious food to maintain a healthy and active life, it include both physical and economic access to food that meet people dietary needs as well as their preference. This definition consists of three pillars: availability (sufficient quantities of food available on consistent basis), access (having sufficient resources to obtain appropriate foods for nutritious diet) and utilization appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation (WHO, 1996).

2.8 The Role of Conservation Agriculture in Sustainable Agriculture

The food production needs to keep pace with demand and the productivity of land. This will enable the preservation of land as a natural resource for future generations. According to Hobbs *et al.* (2007), Crop production in the next decade will have to produce more food from less land by making more efficient use of natural resources and with minimal impact on the environment. Conservation agricultural practice is essential in sustainable agriculture since it involves crop and soil management systems that help improve soil health parameters (physical, biological and chemical) and reduce farmer costs. Improvement of the soil health makes farmers to produce more crops from the small piece of land but also the conservation of the land is crucial for the benefit of the future generation.

Conservation agriculture can sometimes be referred the practices that when adopted will contribute to achieving the goals of sustainable production systems. The systems that will be more profitable to farmers, environmental friendly and suitable to social economic conditions. In the simplest way conservation agriculture is the route to sustainable agriculture.

2.9 Conservation Agriculture and Sustainable Farmers' Livelihood

A livelihood can be referred as "the capabilities, assets and activities required for a means of living" (Chambers and Conway, 1992). The term livelihood is often preceded by 'sustainable' which as Chambers *et al.* (1992) explain, being one which "can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation..."According to Owenya *et al.* (2012), Assessing impact on livelihoods therefore must take into consideration the assets owned by an individual, household or community and the activities by which these assets are gained, retained and protected.

In many parts of Tanzania agricultural productivity has decreased due to unreliable rainfall (erratic precipitation and lower annual totals) and poor soil fertility leading to a decline in yields and growing food insecurity amongst smallholder farmers (Owenya *et al.,* 2012). The decline in yields lead to negative impacts on the livelihoods of smallholder farmers including decreased food that can be taken by a person and a lack of income to invest in assets such as farm inputs, education for children and household improvements. This limits a household's ability to improve their livelihoods, increases the level of poverty and vulnerability amongst farmers' communities. These labour shortages lead to problems

such as a further decline in agricultural productivity, falling income, reduced purchase of farm inputs and children dropping out of school.

The use of conservation agriculture in production systems help to improve the use of the scarce resources in a profitable manner. Conservation Agriculture practices lead to improvement in the fertility of the soil which increase farmers yield and eventually improve their income. The use of Conservation agriculture is a panacea to the declining productivity and the high levels of poverty among farmers' communities.

2.10 Productivity

Productivity is a measure of the efficiency of production. It is a ratio of total output per one unit of a total input. Inputs include labor and capital, while output is typically measured in revenues and other GDP components such as business inventories. Measures of productivity may be examined together (across the whole economy) or viewed industry by industry to observe trends in labor growth, wage levels and technological improvement (FAO, 2007). However for the case of this study, productivity is measured as the ratio of agricultural outputs (yield of crops) to agricultural inputs. The output is measured in kilograms (Kg), Land is measured in Hectares (ha), Capital in Tanzanian Shillings (TZS) and labour in mandays.

2.11 The Production Function in the Agricultural Sector

The specification of functional forms to be used in agriculture is encountered with mainly two types of decisions. The first type of the decision is related to what variables to include in the functional form. The second decision is how these variables included in the functional form will relate to each other. In dealing with the first decision land, labour

capital and intermediate inputs have been used mostly in the functional forms related to agriculture as variables that are included. This is because of their importance in the agricultural production process. Land is included in the function because is the primary agent in the process of agricultural production. The intermediate inputs in most cases are the inputs that are purchased for example the seeds and fertilizer; these are included in the production function because they are important factors for technological progress in the agriculture production. Capital and Labour are crucial in the process of production in agriculture and this is why they are included in the production function when dealing with agriculture. According to Kaneda (1981), the factors that are considered important in choosing the functional forms are parsimony in parameters, ease of interpretation, computational easiness, interpolative robustness and extrapolative robustness.

2.12 Review of the Analytical Tools

Two analytical tools were used in this study namely gross margin, and Transdental logarithmic production model. This part reviews studies carried out by different Scholars on the same topic and justifies the choice of the analytical tools adopted in this study.

2.12.1 Gross margin analysis

The good way to comprehend the economic performance of the agricultural enterprises is to make the comparison of their gross margins. This arises due to the fact that most often new technologies and practices in smallholder agriculture aim at increasing the farm productivity. One of the immediate goals of farmers is to increase income (Mutayoba, 2005). Johnsen *et al*. (2003) stated that the cost which is involved in production might be one of the hindrances in adopting expensive but more rewarding technologies. In making the definition of the Gross margin one needs to know the distinction between variable and

fixed costs. Variable costs are the costs that increase or decrease with changes in output (Cramer *et al*., 2001). The most often variable costs in Conservation and Conventional agricultural production are the cost of factors of production such as seeds, fertilizer, pesticides, hired labour and herbicides. The Gross margin is the difference between gross income accrue and the variable costs incurred.

Gross margin has some limitations which include its inability to take into account the fixed cost structure and it fails to make allowance of the complementary and supplementary relationships among enterprises. Phiri (1991) and Mkude (2003) argued that although gross margin is not good measure of profitability, it remains to be most satisfactory measure of farmers' profitability in small scale agriculture. Gross margin analysis is simple, but in most cases is considered as sufficiently powerful tool for economic analysis (Joshua, 2008). In study gross margin will be used to measure the relative profitability of conservation and convention agricultural practices.

2.12.2 Transdental logarithmic production model

The transcendental logarithmic (translog) production function expresses the logarithm of output as a quadratic function of inputs in logarithms. This production function can be used for analysis of multi-input (more than two inputs) without imposing any restrictions on the elasticities of substitution between any pair of inputs. It permits, therefore, not only substitution relations but also complementarity relations in various input pairs. In other regions of interest, the translog production function may be poor approximation of the true function, and may even fail to satisfy basic properties of the true function such as monotonicity or convexity (Fuss *et al.,* 1978). In comparison to the other production function forms translog production function account for the diminishing returns of the

inputs used in the production. This is the reason of abandoning other forms of production function and using translog in this study.

Its general form is

$$\ln Y = \alpha_0 + \sum_i \beta_i \ln X_i + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln X_i \ln X_j + \varepsilon \quad \text{……………………………………(1)}$$

Where;

Y = Output, α_o = Constant,

β_i and β_{ij} are parameters

X_i and X_j are inputs used in the production and ε is a random error

CHAPTER THREE

3.0 METHODOLOGY OF THE STUDY

3.1 Description of the Study Area

3.1.1 The study location

The study was conducted in three wards Bungu, Kasanga and Kolero which are located in the southern side of the Uluguru Mountains about 120 kilometers from Morogoro Town. The Ulugurus are part of a chain of mountains referred to as the Eastern Arc Mountains. The three wards are in Uluguru South neighboring Sealus Game Reserve.

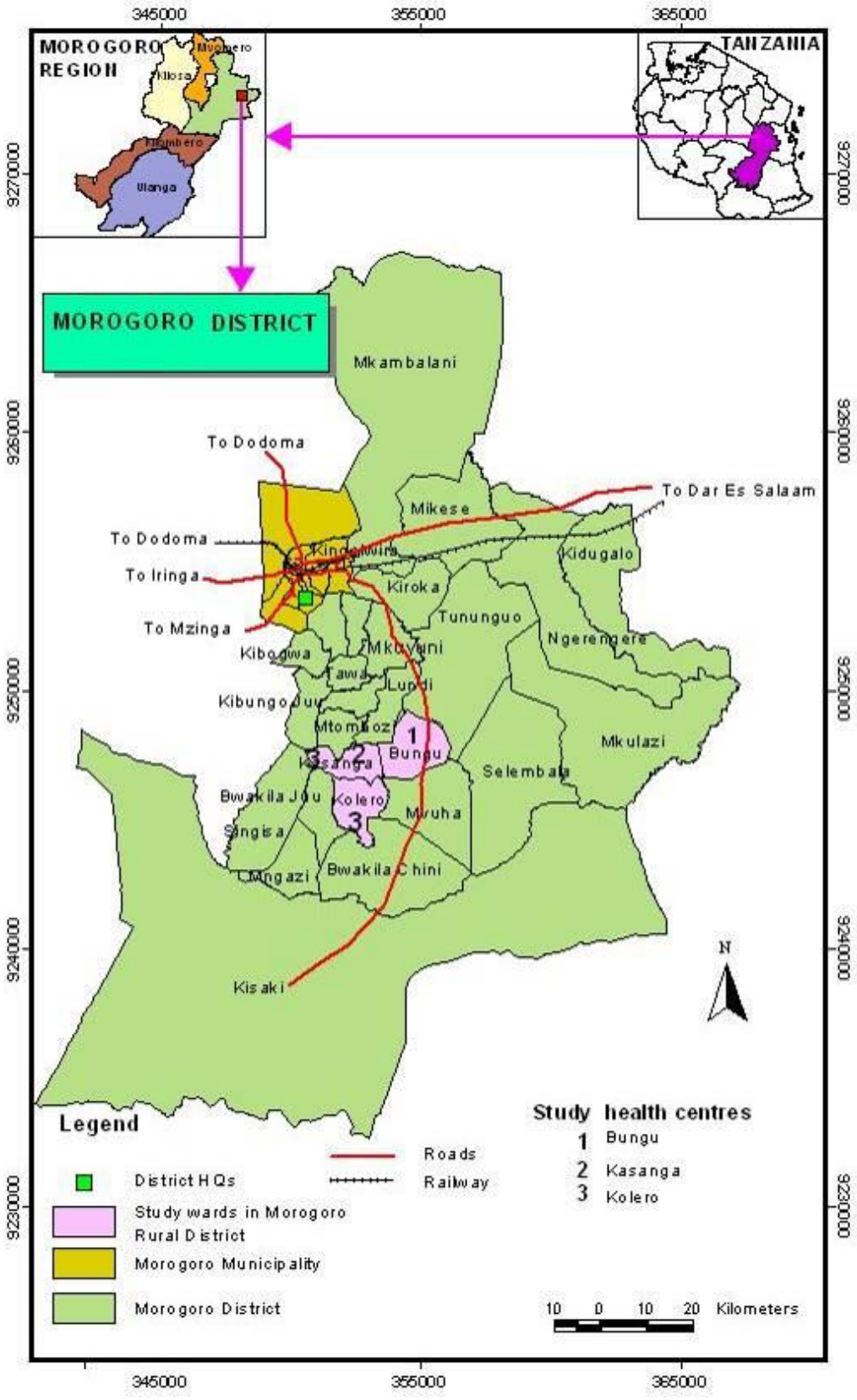

Figure 2: A Map of Morogoro Region showing Morogoro District and wards under the study

3.1.2 Climate

Uluguru Mountains are generally colder in higher altitudes and warmer in lower altitudes. Based on this reason high altitude areas such as Ukwama, Longwe and Temekelo, are generally characterized by lower temperatures than Kolero, Bungu and Mlagano which are located at much lower altitudes. The Uluguru Mountains capture moisture passing inland from the Indian Ocean thus making the east facing slopes such as Kasanga and Kolero wet, with rainfall estimated at over 3 000 mm per annum. Chamshama *et al.* (2008) and Lovett and Pocs (1993) indicated that rainfall varies between 1 200 to 3 100 mm on the drier western slopes and from 2 500 to 4 000 mm on the wetter eastern slopes. There is no marked dry season on the eastern slopes, but on the west, two rain seasons are distinguished, the long rains falling from February to June and the short rains are normally expected between October and January (Mvena and Kilima, 2009). The area is also characterized by cold weather with a mean maximum and minimum temperature of 22^{o}c and 17^{o}c respectively and much colder than this in high altitudes which occurs in July and August (Bhatia and Ringia, 1996).

3.1.3 Topography, vegetation and soils

The study area's topography ranges from about 600 metres on the mountain foothills to the highest peak, Mkumbaku, which is about 2 634 meters above sea level. The vegetation type in the study area varies with altitude. Lower altitude areas of Mlagano, Lukange, Lubasazi, Kolelo, Bungu, Balani, and Koloni have sub-montane and coastal rain forests. This type of vegetation occurs on the eastern slopes between 800 and 1 500 metres. On the other hand, the montane forest occurs between 1 500 and 1 900 metres, and finally, the upper montane forest above 2 000 metres altitude (Lovett and Pocs, 1993). High altitude villages such as Ukwama, Longwe and Temekelo also have black wattle or *Acacia*

mearnsii growing on fallow land. The soils of the project area can generally be described as acidic lithosols and ferralitic red, yellow and brown latosols that have developed over Precambrian granulite, gneiss and migmatite rocks (Lovett and Pocs, 1993).

3.1.4 Demographic aspect

The Waluguru constitute the major tribe in the two wards. Other tribes, if any, represent government employees or immigrants motivated to utilize natural resources principally in form of timber or minerals. In general, the population and population density especially in lower altitude areas are small as many of these villages have large areas with no houses and the distances between the villages are also long (Mvena and Kilima, 2009).

3.1.5 Agriculture and land use

Farming systems practised is unsustainable which ends up with land degradation (Bhatia and Ringia, 1996). Both food and cash crops are produced, which in turn boosts income and employment (Mattee and Innocent, 2006). Main food crops grown includes maize, rice, sorghum, cassava, sweet potatoes, banana, yams, beans, pigeon peas, peanuts, cow peas, chick peas, Soya beans and Irish potatoes. Varieties of vegetables and fruits are also grown (Bhatia and Ringia, 1996).

3.2 Research Design

The Cross section design was employed where by farmers with and without conservation agricultural practices were used to compare the performance of the convention and conservation agricultural practices. Comparison of the performance of the Conservation agricultural practices to selected group of farmers with Conservation agricultural practices

against farmers with conventional agricultural practices was done basing on indicators such as the relative profitability obtained and productivity of variable inputs.

3.3 Sample Size and Sampling Procedure

Both purposive and simple random sampling techniques were applied in this study. Three wards were purposively selected from Mvuha Division in Morogoro District and two villages were purposively selected from each ward. Random sampling was used to select 100 Conservation Agriculture farmers and 100 conversional Agriculture farmers making the total of 200 individual respondents who were used in this study. Total of 200 respondents was enough for my study as stated by Sudman (1976) as cited by Malipa (2012) that a minimum of 100 respondents is enough for each group when comparative study is conducted.

3.4 Data Collection

The structured questionnaires composed of closed and open ended questions were used as a main tool for data collection but also the interview and Focus group discussion (FGD) were employed to capture the important information of the study. The data were collected by using questionnaire as the main instrument for data collection and they were designed to capture both qualitative and quantitative data. The Focus group discussion (FGD) was used to capture information from different groups of leaders and experienced farmers.

3.5 Data Sources

Primary data were collected from selected households in study area; where secondary data to support findings from study area were collected from SNAL, MICCA project, HICAP project and District agricultural officers.

3.6 Data analysis

Data collected were processed using Excel and SPSS. Descriptive statistics, Gross margin and Translog production model were employed to analyze the data.

(i) The Gross Margin was used to compute the production costs and returns per acre (Gross margins) of conservation and conventional agriculture farmers

$$GM = TR - TVC \quad \text{.....} \quad (2)$$

$$PQ - TVC = PQ - TVC \quad \text{.....} \quad (3)$$

Where:

GM = Gross Margin TR = Total revenue TVC = Total variable cost P= Price of Output and Q= Quantity of Output

(ii) The Translog production function was used to determine the total factor productivity of inputs in the production process.

Model specification

$$Y = f(K, L, F) \quad \text{.....} \quad (4)$$

$$\ln Q = a_0 + \beta_k \ln K + \beta_l \ln L + \beta_n \ln N + 1/2\gamma_k (\ln K)^2 + 1/2\gamma_l (\ln L)^2 + 1/2\gamma_n (\ln N)^2 + \gamma_{kl} \ln K \ln L + \gamma_{kn} \ln K \ln N + \gamma_{ln} \ln L \ln N + \varepsilon \quad \text{.....} \quad (5)$$

Where;

Q = Output produced (kg), K = Capital used in production (TZS), L = Labour used (man days) and N = Land used/Size of farm (Ha), β_i and γ_j = Parameters of input variables and e = error term.

Marginal Productivity

The marginal productivity can be obtained by recalling that the marginal productivity is the product of the ratio of the inputs and outputs (taken as averages) and the elasticity.

$$\frac{\partial y}{\partial x} = \varepsilon(\frac{Y}{X}) \quad \text{.....(6)}$$

$$MP = \varepsilon * AP \quad \text{.....(7)}$$

Where;

∂Y = Change in Output (Y), ∂X_i = Change in Inputs (X_i)

ε_j = Elasticity of the variable inputs, Y = Output, X = Input

MP = Marginal Product, AP = Average Product

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents

The socio-economic characteristics presented under this section include: age of the respondents, gender, marital status of respondent, educational level of respondent, major activity of respondent, household size and household income. Most of these characteristics have a direct relationship with whether a respondent is practicing Conservation Agriculture or not.

4.1.1 Age of the respondents

The survey results for both Conservation Agriculture and Conventional Agriculture respondents indicate that, there is small number of people engaged in farming activities at the age above 61 years (Table 1). This can be attributed by inadequate strengths to perform agricultural activities and take care of the crop, they entrust them either to their children or grand children. According to Basnayake and Gunaratne (2002), age of a person is usually a factor that can explain the level of production and efficiency. Findings show that the majority of respondents' age is between 41-50 for both Conservation Agriculture and Conversional Agriculture farmers. The reason behind the observation could be explained by the fact that many people prefer to do off farm activities in towns and cities at young ages because of shortage of land for cultivation. Furthermore, results indicate that few people engaged in farming activities at the age between 21-30 and 31-40 for both groups of farmers as majority of them are students.

Table 1: Distribution of respondents by age

	Percentages (%)	
Age	**CA farmers**	**Non CA farmers**
21-30	7	17
31-40	29	32
41-50	46	36
51-60	17	13
61-70	1	2
Total	**100**	**100**

4.1.2 Gender status of the respondents

Findings indicate that majority of the respondents were males, who represents 66% and 73% for both groups of respondents respectively (Table 2). Moreover, females represent 34% and 27% for the two groups respectively; this implies that many farmers family are male headed-households. The low representation by women could be attributed by cultural barriers in the study area where women are considered household heads only when they are widowed, divorced or separated. Another reason could be that, involvement of women in farming is normally constrained by their intra-house division of labour, responsibilities and the control and use of income which have widespread implications in agricultural production. The findings are closely related to the one reported by (KNCU, 2009) where 96 and 4 percent of agro pastoralists were male and female respectively.

Table 2: Proportion of respondents by sex

	Percentages (%)	
Sex	**CA farmers**	**Non CA farmers**
Males	66	73
Females	34	27
Total	**100**	**100**

4.1.3 Marital status

The majority of respondents (67% and 61% of Conservation Agriculture and Conversional Agriculture farmers respectively) were married (Table 3) as observed in other studies like Teendwa, 2005 and Namwata *et al.*, 2010. There were very few not yet married, widowed and separated Conservation Agriculture farmers representing 3%, 5% and 25% respectively. Moreover, for Conversional Agriculture farmers 9%, 2% and 28% represented not yet married, widowed and separated respectively.

Table 3: Distribution of respondents by marital status

	Percentages (%)	
Marital status	**CA farmers**	**Non CA farmers**
Single	3	9
Married	67	61
Widow	5	2
Separated	25	28
Total	**100**	**100**

4.1.4 Education level of the respondents

From the results in Table 4, 78% of Conservation Agriculture farmers had primary school education, 14% had secondary education, 3% had high school education and 5% did not

attend to school. Furthermore, results show that about 54% of Conversional Agriculture farmers attained primary school education, 5% attained secondary education, no one attained high school education and 41% did not attend to school. From these findings, it can be realized that majority of Conservation Agriculture farmers attained primary, secondary and high school education level as compared to Conversional Agriculture farmers. This implies that, Conservation Agriculture farmers have more exposure and ability to understand and create necessary strategies for adopting improved technologies which lead to the increased productivity and hence income. According to Aman *et al.* (2005) education in agriculture contributes total output in Tanzania; in the other hand it has been observed that education is more important among the economic factors as determinant of technology adoption. Also Fernandez-Cornejo *et al.* (2001) and Wetengere (2009) reported that farmers with more education were also more likely to adopt new technologies. Thus prosperous agricultural development requires a broad education base of the rural population especially those who are engaged in agricultural production.

Table 4: Education level of the respondents

	Percentages (%)	
Marital status	**CA farmers**	**Non CA farmers**
Never attended school	5	41
Primary school	78	54
Secondary school	14	5
High school (Form six)	3	0
Total	**100**	**100**

4.1.5 Main occupation

From Table 5 it is shown that farming is the main occupation for majority of respondents. It has been observed that farming is the main occupation for 95% and 97% of conservation

and conversional agriculture farmers respectively. Results further reveal that 2%, 1% and 2% represents petty business, Carpentry and employment respectively as the main occupation of conservation agriculture respondents. Also 1% and 2% represents Petty business and employment respectively as the main occupation of conversional agriculture respondents.

Table 5: Distribution of respondents by their main occupation

	Percentages (%)	
Occupation	**CA farmers**	**Non CA farmers**
Farming	95	97
Petty business	2	1
Carpentry	1	0
Employed	2	2
Total	**100**	**100**

4.1.6 Household size

The average household size for Conservation Agriculture farmers was about 5 persons with a minimum of 1 person and a maximum of 9 persons per household. Conversional Agriculture farmers had an average household size of about 6 persons with a minimum of 1 person and a maximum of 11 persons. The average household size has got an impact on availability of labor, especially considering that most smallholder farmers depend on family labor (Edriss and Simtowe, 2003). The more the number of people in a household, the more the family labor supply is, all other things held constant. This implicitly affects the amount of hired labor that a farmer uses on his farm to undertake farming activities.

4.1.7 Household income

From Table 6, it has been observed that many farmers practicing Conservation Agriculture (47%) fall in the higher income category which is 400 001 to 500 000 whereby many

farmers with convention agriculture (46%) fall in the lower income category which is 200 001 to 300 000. This shows that farmers with conservation agriculture get more income per year as compared to farmers with conventional agriculture. The reason for having higher income range for farmers with Conservation Agriculture may be the higher yield obtained from the farming activities which take into consideration the Conservation Agriculture principles.

Table 6: Distribution of respondents by household income

	Percentages (%)	
Income	**CA farmers**	**Non CA farmers**
< 150 000	0	2
150 001- 200 000	1	31
200 001- 300 000	8	45
300 001- 400 000	23	15
400 001-500 000	47	2
500 001- 600 000	13	3
600 001-700 000	4	1
700 000 >	3	1
Total	**100**	**100**

4.2 Reasons for Adopting Conservation Agriculture

It was found that farmers had various reasons to adopt conservation agriculture (Fig. 3). It is shown that majority (35%) of the respondents indicated increase in farm yield as the reason to practice conservation agriculture. About 21% indicated labour saving as the reason, about 17% indicated that they adopted Conservation Agriculture after receiving training related to Conservation Agriculture practices. About 10% indicated that Conservation Agriculture practice is good for soil and environmental conservation, 8%

indicated low costs of production in Conservation Agriculture practice, while about 6% and 3% indicated the influence from relatives and other people practicing Conservation Agriculture and easy to practice respectively as the reason for adopting the Conservation Agriculture practice. These findings implies that farmers in the study area are interested to adopt Conservation Agriculture practices for its benefit that it provides more yield especially when all the principles are practiced.

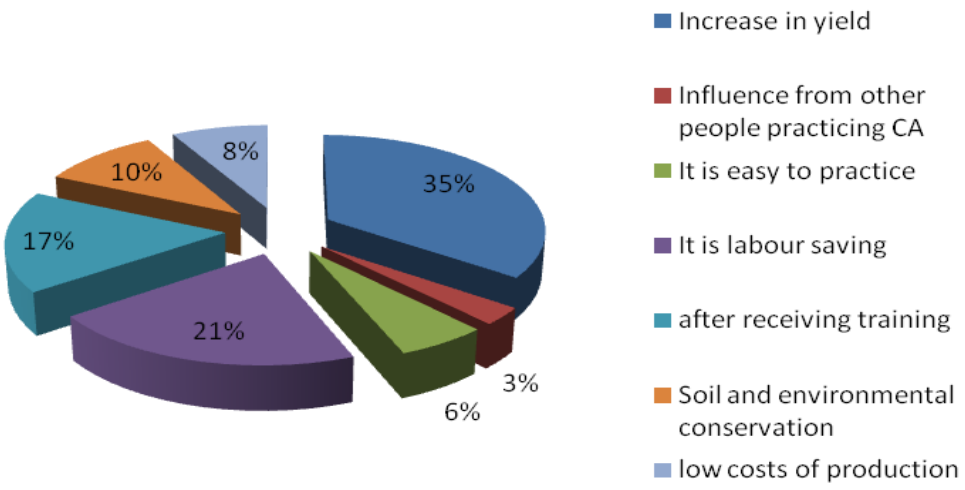

Figure 3: Distribution of respondents by reason for adopting Conservation Agriculture

4.3 Conservation Agriculture Principles Practiced by Farmers as Introduced by HICAP

From Fig. 4 it is indicated that most of the farmers practicing Conservation Agriculture have managed to practice all the key principles of conservation agriculture. 72% of the Conservation Agriculture farmers interviewed are practicing all the three principles of conservation agriculture which are permanent soil cover, minimum soil disturbance and crop rotation. 14% indicate permanent soil cover and minimum soil disturbance, 10%

indicate minimum soil disturbance and crop rotation and 4% indicate crop rotation and permanent soil cover. The findings implies that all Conservation Agriculture farmers interviewed have adopted at least two Conservation Agriculture principles as it has been argued that in order to be identified as Conservation Agriculture farmer there should be at least two principles practiced and the real tangible output of the practices.

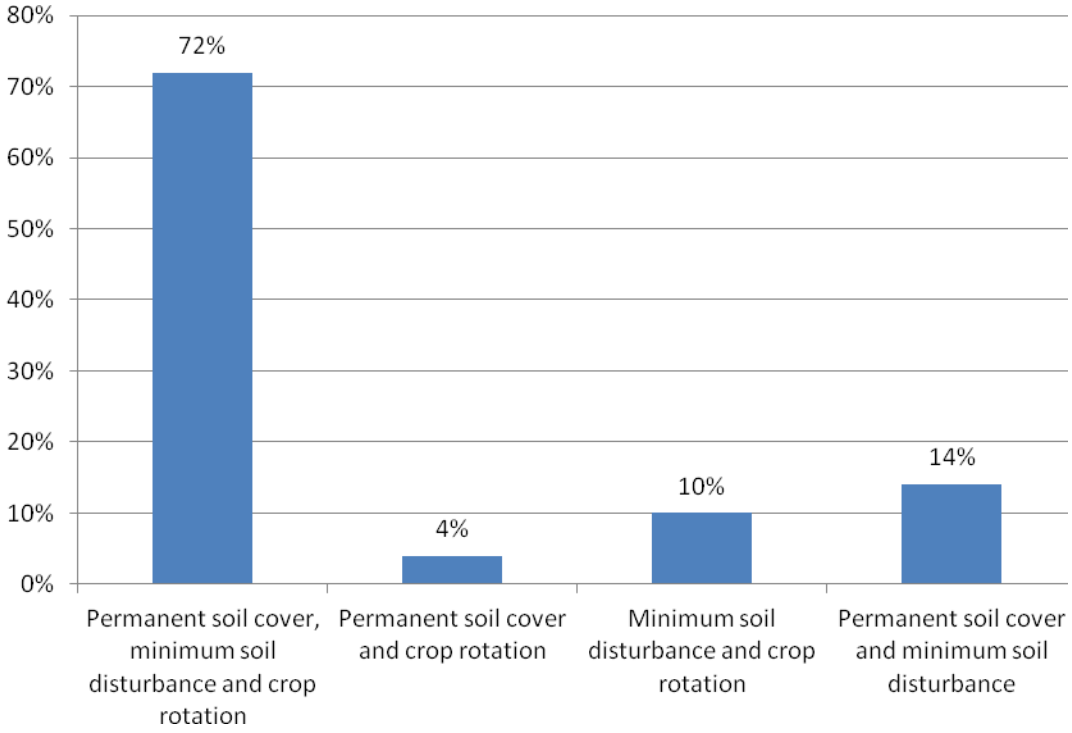

Figure 4: CA principles practiced by farmers as introduced by HICAP

Plate 1: Maize intercropped with lablab as one of the principles of conservation agriculture in the study area

Plate 2: A conservation agriculture farm at Kolero village prepared ready for planting maize (minimum soil disturbance and mulching have been applied)

4.4 Average Surplus (Surplus/acre) for Conservation Agriculture and Convensional Agriculture

The results from the survey shows that the average surplus (surplus/acre) obtained from farmers with conservation agriculture is 418 kg/acre while the average surplus (surplus/acre) obtained from farmers with conventional agriculture is 112 kg/acre. Farmers with conservation agriculture are likely to get more surpluses from the production

activities as compared to farmers without conservation agriculture. These findings depict that conservation agriculture practices provides more yield which enable farmers to get surplus for selling and generate more income. There are some factors that lead to higher surpluses in conservation agriculture than conventional agriculture and one of them is the knowledge of production since most of conservation agriculture farmers are more knowledgeable of the best agronomic practices.

4.5 Labour Use

4.5.1 Number of people and time used in conservation agriculture and convensional agriculture practices

In Table 7 it is indicated that farmers with conservation agriculture are using small number of labour and little time in farming operations than farmers without conservation agriculture. According to the results of the survey farmers with Conservation Agriculture use an average of 7 hours and 4people in the land preparation, 2 hours and 3 people in planting, 6 hours and 4 people in weeding and 5 hours and 3 people in harvesting. Farmers without conservation agriculture use an average of 11 hours and 5 people in the land preparation, 5 hours and 4 people in planting, 13 hours and 5 people in weeding and 5 hours and 3 people in harvesting. In land preparation, planting and weeding the number of labour and time used by conservation Agriculture farmers are lower than conversional agriculture farmers. In harvesting the time used with conservation agriculture farmers is higher than conversional agriculture farmers. This may be attributed by the high yield obtained by conservation agriculture farmers which need more time to harvest.

These results are similarly related to the one reported by Owenya *et al.* (2011) where conservation agriculture farmers use an average of 3 hours and 2 people in the land

preparation, 2 hours and 2 people in planting, and 24 hours and 2 people in weeding. Farmers without conservation agriculture use an average of 8hours and 4 people in the land preparation, 7 hours and 6 people in planting and 48 hours and 4 people in weeding.

Table 7: Number of people and time used in conservation agriculture and conventional agricultural practices per acre

	Conservation agriculture		**Conventional agriculture**	
Farming activity	**People (Number)**	**Time (hrs)**	**People (Number)**	**Time (hrs)**
Land Preparation	4	7	5	11
Planting	3	2	4	5
Weeding	4	6	5	13
Harvesting	3	5	3	5
Total	**14**	**20**	**17**	**33**

4.5.1 Average labour costs used in conservation agriculture and conventional agriculture per acre

From Table 8 it has been observed that conservation agriculture farmers incur low labour costs as compared to conversional agriculture farmers in their farming activities. The total labour cost per acre in conservation agriculture farm is TZS 175 000 while in Conversional Agriculture farms is TZS 265 000. Labour costs in land preparation is low in Conservation Agriculture because the process involves slashing and double digging (minimum soil disturbance) only while in conversional agriculture the cost is high because land preparation involves slashing, collecting, burning and ploughing the whole farm. This is also the case in weeding where as in conservation agriculture farms weeding are done

only once while in conversional agriculture farms weeding is done two to three times. The situation may be attributed by the weed suppressing tendency of the cover crops and mulching applied in the conservation agriculture farms.

Table 8: Average Labour costs used by conservation agriculture and conventional agriculture farmers

Farming activity	Labour Cost (TZS)	
	Conservation agriculture	Conventional agriculture
Land Preparation	45 000	60 000
Planting	30 000	40 000
Weeding	60 000	130 000
Harvesting	40 000	35 000
Total	**175 000**	**265 000**

4.6.1 Farmers' perception on the benefits of conservation agricultural practices

From Fig. 5, it has been observed that most of farmers have a positive attitude towards benefits obtained by practicing conservation agriculture. About 91% of farmers agreed that conservation agriculture increase their yields and hence lead to increase in food security and 86% agreed that conservation agriculture help to incraese the fertility of the soil in their farms due to the use of mulching and cover crops which are leguminous. Also about 70% agreed that conservation agriculture help to reduce the soil erosion since it encourage minimum soil disturbance and 89% agreed that conservation agriculture is more useful in reducing onfarm operational costs since it helps to reduce weeding pressure. From these results it has been shown that the benefits of conservation agriculture have

been positively perceived by farmers especialy those who have been practicing conservation agriculture from before.

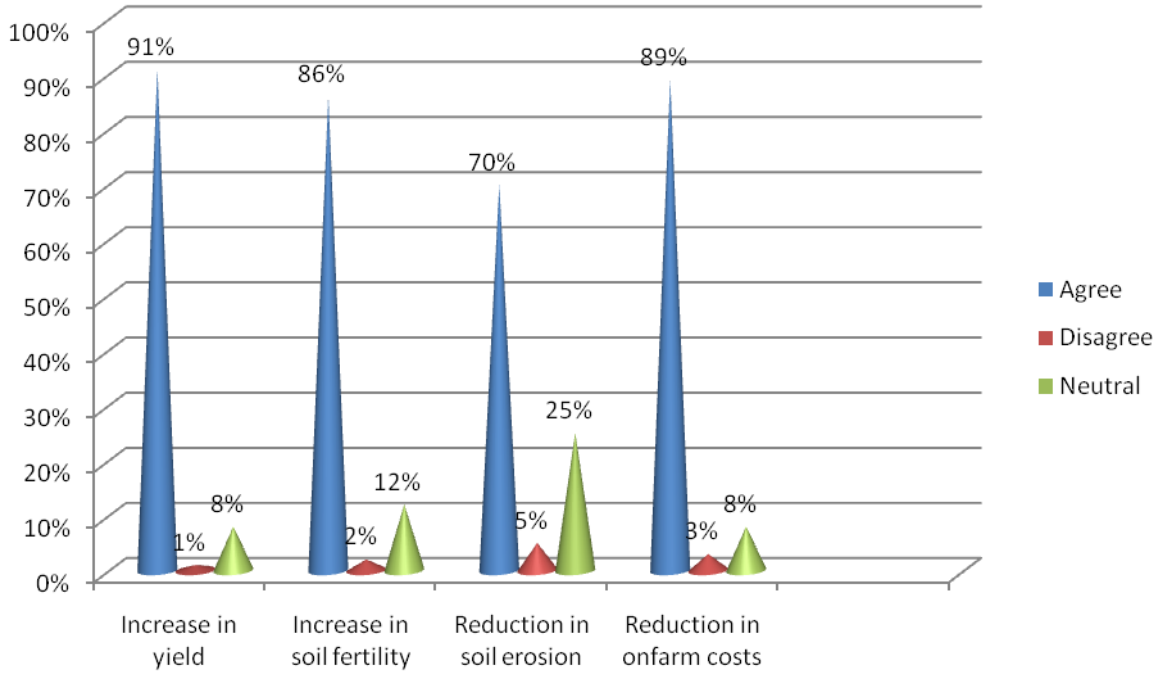

Figure 5: Farmers' perception on the benefits of conservation agricultural practices

4.6.2 Farmers' perception on the influence of conservation agricultural practices on livelihood improvement

A summary of the likert scale output on the farers' perception on the influence of conservation agriculture on livelihood improvement is presented in Table 9. The table shows that most of the respondents (89%) indicated that conservation agriculture had an influence on their income; this was the case because conservation agriculture provided them with more yields from farming activities which enabled them to get surplus for selling and getting more income. 78% indicated that conservation agriculture had an influence on their food security since it provided them with enough food, 77% indicated that it highly influenced their saving ability this is due to the fact that they had more money obtained from selling crops which enabled them to join VSL and save their money.

72% reported that, it highly influenced their ability to get clothes since their income raised, 68% indicated that conservation agriculture influenced their ability to acquire and own assets which has been attributed by increase in income from the production activities. While 61%, 60%, 48%,47 and 37% of the conservation agriculture farmers indicated that Conservation agriculture had an influence on sending children to school, starting up a business, getting health services, getting more time to rest and other developmental activities and increase in animal feed respectively

Table 9: Farmers' perception on the influence of conservation agricultural practice on livelihood improvement

Activity	No effect	Little effect	Moderate effect	High effect
Increase in income	**2**	**2**	**7**	**89**
Increase in food security	2	10	10	78
Joining VSL and Increase saving	1	8	14	77
Enough money for clothing	3	9	16	72
Increased assets	4	10	18	68
Sending children to school	5	12	22	61
Starting up a business	3	13	24	60
Improved health	9	19	24	48
More time for resting and other developmental activities	8	17	28	47
Increase in animal feed	3	29	31	37

4.7 Gender Participation in Agricultural Production

4.7.1 Involvement in agricultural production activities

The findings indicate that majority of conservation agriculture farmers' households (Table 10); both husbands and their wives (47%) are involved in agricultural production activities

while in conversional agriculture practices only women (49%) are mostly involved in the agricultural production activities. This may be caused by the differences in the knowledge related to gender issues on agricultural production activities. conservation agriculture farmers have more knowledge of gender issues on agricultural production activities as compared to conversional agriculture farmers that is why conservation agriculture farmers have good gender participation on the agricultural production issues.

Table 10: Involvement in agricultural production activities

	Percentages (%)	
Who is mostly involved in agricultural production?	**Conservation agriculture farmers**	**Conventional agriculture farmers**
Men	34	23
Women	29	49
Both (Men and Women)	47	28
Total	**100**	**100**

4.7.2 Decision making in agricultural production activities

Decision making is one of the key components in gender issues in agricultural production activities. In Table 11, it has been observed that for farmers with Conservation Agriculture practices both men and women participate in decision making by greater percentage (61%) on production activities. This indicates that there is a full participation of men and women in critical decisions related to agricultural production activities in most of the households. For conversional agriculture farmers only 8% of both men and women participate in the process of making decision related to their agricultural production activities and the greater percentage (87%) fall to the category of only men make decisions on behalf. This show that there is a domination in the process of making decisions that means only men

decide for the family on what, when and how to produce together with the use of the products obtained.

Table 11: Decision making in agricultural production activities

	Percentages (%)	
Who is mostly involved in decision making on agricultural production?	**Conservational agriculture farmers**	**Conventional agriculture farmers**
Men	22	87
Women	17	5
Both (Men and Women)	61	8
Total	**100**	**100**

4.8 Product Marketing

4.8.1 Market services access

From Table 12 it is indicated that the access of the market services by conservation agriculture farmers and conversional agriculture farmers in the study area. It has been observed that farmers do not have access to the market services like market information, storage facilities and transportation services. Only 33% of conservation agriculture farmers have access to market services while 67% have no access to market services. For convetional agriculture farmers only 32% have access to the market services and 68% have no access to market services. The results indicated that both conservation agriculture and conversion agriculture farmers are facing limited market services challenge. Lack of access to market by most of the farmers in the study area may be caused by the poor infrastructure and poor communication.

Table 12: Market services access

	Percentages (%)	
Do you access market services?	**Conservation agriculture farmers**	**Conventional agriculture farmers**
Yes	33	32
No	67	68
Total	**100**	**100**

4.8.2 Marketing problems faced by farmers

From Table13 it is shown that the marketing problems faced by farmers in the study area. It has been observed that farmers are faced with some problems in their attempt to sell their products produced. The highly mentioned problem was the low prices attached to the commodities where by 61% and 63% of conservation agriculture and conversional agriculture farmers respectively stated that they are mostly affected. Poor market information was also mentioned where by 19% and 15% of conservation agriculture and conversional agriculture farmers respectively stated that they are mostly affected. Other problems that farmers encountered were lack of storage facilities (9% and 7% of conservation agriculture and conversional agriculture farmers respectively), Poor transportation (8% and 10% of conservation agriculture and conversional agriculture farmers respectively), poor grading systems (2% for both conservation agriculture and conversional agriculture farmers) and poor scaling or weighing (1% and 3% of conservation agriculture and conversional agriculture farmers respectively). The market problems encountered may be the reason for the low productivity of farmers in the study area since farmers don't have good and conducive market to sell their products.

Table 13: Marketing problems faced by farmers

Marketing problems	Percentages (%)	
	Conservation agriculture farmers	**Conventional agriculture farmers**
Poor Transportation	8	10
Poor market information	19	15
Lack of storage facilities	9	7
Low prices	61	63
Poor grading systems	2	2
Poor scaling/weighing	1	3
Total	**100**	**100**

4.9 Gross Margin Analysis Results

Gross margin analysis was used in this research to establish the differences between gross income earned and variable costs incurred. As proposed by Hill (1990), financial prices, economic prices and opportunity cost principle are used to compute input costs and non-priced particulars such as family labour and the gross revenue are estimated at farm gate prices.

From the results, gross margins for farmers with conservation and conventional agricultural practices indicated that conservation agricultural practice is more profitable than conventional agricultural practice. The mean gross margin per ha for conservation and conventional agricultural practices are TZS 526 800 and TZS 200 360 respectively. These results show that the returns for conservation agriculture are higher than that of conventional agricultural practice. The difference may be attributed by high productivity and low costs of production in conservation agriculture.

T-test was used to compare the mean gross margins between the two groups of farmers (Table 14).

Table 14: Paired t - test statistics for mean GM between CA and non CA farmers

Paired samples	Mean difference	T value	N	df	sign.
GM of CA and non CA farmers	326 440	11.199	100	99	0.00

Note: $\alpha = 5\%$.

Paired t - test results show that the two mean gross margin/ha are statistically significant different from one another at 95% level of significance ($p = 0.00$), this reject the hypothesis (i) which says that there is no significant difference in profitability between conservation and conventional agricultural practices

4.10 Regression Output and Marginal Productivity of Inputs

On regressing yield from conservation agriculture farmers and agricultural inputs used (Land, Labour and Capital) the result on Table 15 indicated that:

Adjusted R square is 0.65 which is 65 percent, this indicate that yield from conservation agricultural practice is explained by regressors (Land, Labour and Capital) by 65 percent and the rest 35 percent is explained by other variable not included in the model.

From the production theory, the coefficients of the log – log production function are the elasticities of the respective variables. The Translog results show that the elasticity of land as a factor of production is 0.64. The variable is positively related to output and is significant at the 5 percent level. The elasticity of labour is 0.895 and carries an expected positive sign. The variable is also significant at the 5 percent level. Capital has an

elasticity of 0.83 and is significant at 10 percent level. From the translog estimation, it is evident that the squares of the factors that imply a monotonic increase in any of the factors yield negative and insignificant coefficients except the square of capital. The joint effect between labour and land (LN) and capital and land (KN) are insignificant and have coefficients of 0.36 and 0.35 respectively. A joint effect of capital and labour is significant at the 5 per cent level and has a coefficient of 0.04. Surprisingly, the joint coefficients are much smaller than the individual ones this signifies in part low levels of resource complimentarity.

Also on regressing yield from conventional farmers and agricultural inputs used (Land, Labour and Capital) the result on table 15 indicate that:
Adjusted R square is 0.62 which is 62 percent, this indicate that yield from conventional farmers is explained by regressors (Land, Labour and Capital) by 62 percent and the rest 38 percent is explained by other variables not included in the model.

The Translog results show that the elasticity of land as a factor of production is 0.63. The variable is positively related to output and is significant at the 5 percent level. The elasticity of labour is 0.76 and carries an expected positive sign. The variable is also significant at the 5 percent level. Capital has an elasticity of 0.56 but it is not significant. It would appear from these results that land and labour explain most of the variations in yield from conventional farmers.

From the Translog estimation, the squares of the Land and Capital yield negative and insignificant coefficients except the square of labour which positive and significant at 5 per cent. The joint effect between labour and land (LN) and capital and labour (KL) are

insignificant. A joint effect of capital and land (KN) is significant at the 5 per cent level and has a coefficient of 0.16.

Table 15: Regression results for farmers with conservation and conventional agricultural practices

Variables	Model 1 (Conservation)	Model 2 (Convention)
Intercept	0.1371**	0.8704**
	(0.3413)	(0.3709)
lnN	0.6417*	0.6326*
	(0.3275)	(0.3603)
lnL	0.8945*	0.7582*
	(0.3059)	(0.3344)
lnK	0.8316*	0.5587
	(0.1710)	(0.1712)
lnN^2	-1.0860	-1.1497
	(0.6605)	(0.8764)
lnL^2	-0.0312	0.1076*
	(0.1107)	(0.1207)
lnK^2	-1.0124*	-0.0288
	(0.4254)	(0.0278)
lnNL	0.3563	0.7956
	(0.1869)	(0.1767)
lnLK	0.0368*	0.0828
	(0.1003)	(0.1068)
lnNK	0.3538	0.1587*
	(0.0776)	(0.4732)
Adj R^2	0.6454	0.6179

N = Land, L = Labour, K = Capital,

*Significant at 5% and ** significant at 10%

4.10.1 Marginal productivity of Inputs

Based on the elasticities derived from the regression analysis, it is possible to evaluate the marginal productivity of Land and Labour since they are significant in both models. The Marginal productivity for conservation and conventional agricultural practices can be obtained as indicated (Table 16).

Table 16: Marginal productivity of labour and land for conservation agriculture and conventional agriculture farmers

	Conservation			Convention		
	(Y/X)	ε	MP	(Y/X)	ε	MP
Land	571.555	0.64	365.79	394.431	0.63	248.47
Labour	101.4538	0.89	90.293	62.435	0.74	46.21

From Table 16, the marginal productivity of land for conservation agriculture farmers is 366 kg/ha while that of conventional agriculture farmers is 248 kg/ha. Marginal productivity of labour for conservation agriculture famers is 90 kg/man day while that of conventional agriculture farmers is 46 kg/man day. These results indicated that the productivity of factors (Land and labour) for conservation agriculture farmers is higher than that of convention agriculture farmers, this reject the hypothesis (iii) which says productivity of inputs for conservation agricultural practice is not statistically different from conventional agricultural practice.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

As the study aimed at determining the economic performance of conservation as compared to conventional agricultural practices, the following conclusions can be drawn:-

(i) From the social economic point of view, the results indicated that most people engaged in agricultural production are aged between 41 to 50 years, majority of the respondents were male who represented 66% and 73% of the conservation and conventional agricultural farmers respectively. But also most of the respondents were married and their main occupation was farming. In regard to farmers' income it has been observed that majority of farmers with conservation agriculture have higher incomes as compared to farmers with conventional agriculture.

(ii) The results indicated that, average gross margin/ha were TZS 526 800 and TZS 200 360 for farmers with conservation and conventional agricultural practices respectively. This implies that farmers with conservation agricultural practice earn more profit than farmers with conventional agricultural practice, the two means were compared using t-test, and the results indicate that they are statistically different from one another at 95% ($P = 0.00$)

(iii) The study concluded that the productivity of inputs for farmers with conservation agricultural practice is higher than the productivity of inputs

for farmers with conventional agricultural practice. The marginal productivity of land for farmers with conservation and conventional agricultural practices were 366 kg/ha and 248 kg/ha respectively and also the marginal productivity of labour for farmers with conservation and conventional agricultural practices were 90 kg/man day and 46 kg/man day respectively.

(iv) Even if conservation agriculture is more profitable and it has higher productivity but farmers in the study area are producing less quantities. This has been caused by lack of enough land for production due to land ownership problem. The other reason is lack of market for the products produced by farmers which have been caused by poor infrastructure like roads, poor communication and lack of market facilities.

5.2 Recommendations

(i) The study indicated that, conservation agricultural practice has potential to improve the income and livelihood of farmers in the study area. Therefore, the government through close collaboration with agricultural research institutions, development agencies, project implementers, district extension officers and farmers organizations should put more effort on disseminating the benefit accrued from the practice as some farmers are denying adopting the technology because of lack of awareness which led them to end up with low yield and hence low profit margins.

(ii) Since conservation agricultural practice more useful in agricultural production sustainability then the government should include it in Kilimo kwanza as the national strategy. This will benefit farmers from household income generation without deteriorating the soil and environment.

(iii) The government should make efforts to improve the infrastructure especially the road condition, communication and the market facilities in the study area. This will help to attract more buyers from different parts of Tanzania to buy crops from the area and hence the production of crops will be improved.

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APPENDIX

Appendix 1: Farmer's questionnaire for economics of CA and non CA in Southern Uluguru Mountains, Morogoro Tanzania

I am_____ from Sokoine university of Agriculture, Morogoro, I am part of a research team conducting research on economics of conservation agriculture and convention agriculture in Kolero, kasanga and Bungu wards. I would like to assure you that the information provided in this interview will be used solely for purposes of research, and that your identity as well as your answers will be treated with confidentiality. In answering my questions, please remember that there are no correct or wrong answers. Your honest opinion is important and valued most.

Enumerator's name……

Date……

Ward ……

Village ……

1.0 Household composition characteristics

1.1 Respondent name ……

1.2 What is your position in the household? (Husband / wife / child)?

[1] Husband [ ]

[2] Wife [ ]

[3] Child [ ]

1.3 Age of the respondent ……..

[1] Below 20 [ ]

[2] 20-30 [ ]

[3] 30-40 [ ]

[4] 40-50 [ ]

[5] 60-70 [ ]

[6] Above 70 [ ]

1.4 Gender of the respondent ……..

[1] Male [ ]

[2] Female [ ]

1.5 Marital status

[1] Single [ ]

[2] Married [ ]

[3] Divorced [ ]

[4] Widowed [ ]

1.6 Education level of the respondent ……..

[0] none [ ]

[1] Primary school [ ]

[2] Secondary school (Form four) [ ]

[3] High school (Form six) [ ]

[4] College Education [ ]

1.7 Occupation of the respondent ……..

[1] Farming [ ]

[2]Livestock keeping [ ]

[3]Business [ ]

[4] Others [ ] specify ……..

1.8 Household size (Number of people)… ……..

1.9 The household total annual income for the last 12 months (Please put a tick)

..... 1. ≤ Tshs. 150,000/=)

..... 2. Tshs. 150,001-200,000

.....3.Tshs. 200,001-300,000

.....4. Tshs. 300,001-400,000

.....5.Tshs. 400,001-500,000

.....6.Tshs. 500,001-600,000

.....7.Tshs. 600,001-700,000

.....8.Tshs. 700,001-800,000

.....9.Tshs. 800,001-900,000

.....10.Tshs. 900,001-1,000,000

..... 11. .>1,000,000

2.0 Project involvement

2.1 Are you practicing CA in your faming activities?

[1] Yes [ ] [2] No [ ]

If No skip to question 2.5 and 2.6

2.2 If yes who decided for you to adopt the technique

[1] Myself [ ]

[2] My wife [ ]

[3] My husband [ ]

[4] My Parents [ ]

[5] Others [ ] specify ……

2.3 What are the reasons for adoption?

[1] It is profitable

[2] I was influenced by my friends or relatives

[3] It is easy to practice

[4] Others …….

2.4 In which of the following principles (as Introduced by HICAP) are you practicing?

[1] Permanent soil cover and crop rotation [ ]

[2] Minimum soil disturbance and crop rotation [ ]

[3] Permanent soil cover and minimum soil disturbance [ ]

[4] All of them [ ]

2.5 Why did you decide not to adopt CA practices?

[1] They are so expensive [ ]

[2] I have no knowledge on them [ ]

[3] I am used to old practices and I have no interest on them [ ]

[4] They are not profitable [ ]

[5] Others Specify ……..

2.6 If you are provided with knowledge and other assistance will you be willing to practice?

[1] Yes [ ] [2] No [ ]

2.7 Which of the practices you will be willing to practice?

[1] Permanent soil cover [ ]

[2] Minimum soil disturbance [ ]

[3] Crop rotation [ ]

[4] All of them [ ]

[5] Two of them [ ] specify ……..

2.8 Are you able to get surplus from production?

[1] Yes [ ] [2] No [ ]

2.9 How much you get as surplus after selling your production per acre? ……. (In kg)

2.10 Please share with me the labour usage and costs incurred in your farming activities

2.10.1 Labour usage

Farming Activity	**CA**		**Non CA**	
	Labour (No. of people)	Time used (hrs)	Labour (No. of people)	Time used (hrs)
Land preparation				
Planting				
Weeding				
Harvesting				
Total				

2.10.2 Labour costs Incurred per Acre

Farming Activity	**CA**	**Non CA**
	Costs incurred	Costs incurred
Land preparation		
Planting		
Weeding		
Harvesting		
Total		

2.11 In your Household who is mostly involved in the agricultural production activities?

[1] Father [ ]

[2] Mother [ ]

[3] Children [ ]

[4] Father and Mother [ ]

[2] All [ ]

2.12 Who is mostly involved in decision related to agricultural production in the household?

[1] Father [ ]

[2] Mother [ ]

[3] Children [ ]

[4] Father and Mother [ ]

[2] All [ ]

3.0 Input use, Costs and Output Information

(For CA and non CA farmers) Please share with us more information about your inputs, costs and output for the last 12 months

3.1 Input use

Type of Crop	**Farm size(Acres)**	**Instruments used (eg. Tractor, Plough, Hoes)**	**Fertilizer used (Kgs)**	**Pesticides and other chemicals**	**Amount of Labor (Man days)**

3.1 How big is the overall size of your land used for agriculture?

Overall size of the land used ……..in acres

3.2 Input costs

Type of input used	**Price per unit**	**Transport cost per unit**	**Other costs (example Transaction costs)**	**Total cost per unit**
Land				
Instruments used(eg Tractors , Hoes etc)				
Fertilizer				
Labour				
Pesticides and other chemicals				
Others …….. …….. …….. …….				

3.3 Output and Price information

Type of crop	**Annual yield**	**Price per unit**	**Able to sell? [1=yes/ 0=No]**	**Annual quantity sold**	**Annual revenue obtained**

4.0 Market information

4.1 Do you sell you products?

[1] Yes [ ] [2] No [ ]

4.2 If yes where do you sell your products? .....

4.3 Can you approximate the distance to the market …… (Km's/Walking hrs)

4.4 What type of market is that?

[1] Seasonal Market [ ]

[2] Auction Market [ ]

[3] Normal/Daily Market [ ]

[4] Other……. [ ]

4.4 Do you have access to the market services?

[1] Yes [ ] [2] No [ ]

4.5 Which type of marketing problem do you face among the following (Please tick the required)

[1] Poor Transportation [ ]

[2] Poor market information [ ]

[3] Lack of storage facilities [ ]

[4] Low prices of products [ ]

[3] Poor grading systems [ ]

[4] Poor scaling/ weighing [ ]

[4] Others, specify…… [ ]

5.0 Benefits and Costs of CA

5.1 Benefits of using CA

(*Rank according to the following order **1**. Strongly disagree, **2**.Disagree **3**.Neutral **4**. Agree **5**. Strongly Agree*)

No.	**Benefits**	**Rank**
1.	Reduction in on-farm costs: savings in time, labour and mechanized machinery	
2.	Yield increase due to Increase in soil fertility and soil retention	
3.	Increasing food security due to decrease in yield	

	variations	
4.	Increase in soil stability and reduction in soil erosion	
5.	Reduction in air pollution resulting from soil tillage machinery	
6.	Conservation of terrestrial and soil-based biodiversity	

5.2 Costs of CA

(*Rank according to the following order **1**. Strongly disagree, **2**.Disagree **3**.Neutral **4**. Agree **5**. Strongly Agree*)

No.	**Cost**	**Rank**
1.	Purchasing specialized planting equipment	
2.	Spending time when farmers learn new management skills	
3.	CA involves additional herbicides	
4.	Formation and operation of farmers groups	

6.0 Farmers perception on effect of CA on livelihood improvement

Code	**Effect**	**High Effect**	**Little effect**	**Moderate effect**	**No effect**
1.	Increasing Income				
2.	Improvement of Nutrients for health				
3.	Increasing food security				
4.	Increased knowledge				
5.	Protected environment for sustainable livelihood				
6.	Increased animal feed				

7.0 Challenges and opinions in Practicing CA and non CA

7.1. What have been major challenges in your practice (conservation agriculture/Conventional agriculture?

Code	Challenges
1.	
2.	
3.	
4.	
5.	
6.	
7.	

7.2. What are your opinions concerning Conservation Agriculture

[1] Opinion 1…….

[2] Opinion 2…….

[3] Opinion 3…….

[4] Opinion 4…….

[5] Opinion 5…….

Thank you for your cooperation

Appendix 2: Checklist for key informants (Government officials/ famous elders/ CARE staffs)

1. Name of the respondent……..
2. Title of the respondent……..
3. Location……..
4. Date……..

ISSUES TO BE COVERED

1. What do you understand by the term conservation agriculture?

   ……

   ……

2. When was it introduced in your area (Study area)?

   .....

   .....

   What are the benefits of practicing conservation agricultural practice?

   …..……

   …….

3. What are the challenges you are facing in practicing conservation agriculture?.....

   .....

4. Why some other people don't adopt conservation agricultural practice?

   .....

   .....

   .....

5. Do you face any market challenge

   ……

   .....

   What are those challenges you are facing?

   .....

   .....

6. Is there gender balance in practicing conservation agriculture in your area?.

   .....

   .....

   What are your opinions concerning conservation agricultural practice?

   ……

   ……

   ……

   ……

Thank you for your cooperation