ADOPTION OF CONSERVATION AGRICULTURAL PRACTICES AMONG SMALLHOLDER FARMERS: A CASE STUDY OF ULUGURU MOUNTAINS, MOROGORO DISTRICT

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ABSTRACT

Adoption of Conservation Agricultural Practices (CAPs) is fundamental for ensuring improved agricultural productivity. This study was conducted among Smallholder farmers to assess factors associated with adoption of CAPs for Land Management in Uluguru Mountains in Morogoro district. A purposive sampling was employed to select three villages where different CAPs are promoted and a sample size of 100 smallholder farmers was selected. Both quantitative and qualitative data were collected and analysed using Statistical Package for Social Sciences (SPSS) to obtain frequencies to describe knowledge level and attitude of farmers towards adopting CAPs. Chi-square test was used to determine the relationship of adopting CAPs to socio-economic attributes of the respondents. Multiple Regression analysis was used to determine the influence of socio-economic on adoption of CAPs. Findings show that smallholder farmers have adopted CAPs that include contour strip cropping, crop rotations, direct planting of crop seeds on the rip line, mulching, intercropping, crop rotation, cover crops, minimum tillage, no burning of crop residues and agro-forestry. Some CAPs were not adopted by smallholder farmers because they were never taught and some being not well understood, difficult to use, consume more time in application, and some CAPs were thought not beneficial. Sex, age, education, farm size, income, farming experience, availability of extension services, land ownership, plot site and presence of land use bylaws were highly associated with adoption of CAPs among smallholder farmers. Again, findings from multiple linear regression show that age, family size, income, farm size, availability of extension services and presence of bylaws highly influenced adoption of CAPs among smallholder farmers were statistically significant at $p \leq 0.05$. Therefore, adoption of CAPs should be enhanced through strengthening extension services, promoting CAPs targeting specific land sites, and those which yield more positive income to smallholder farmers

DECRELATION

I, MSANGI, IKRA RAZACK do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

Msangi, Ikra Razack — Date

(M.A. Candidate)

The above declaration is confirmed

Dr.Kizito K.Mwajombe — Date

(Supervisor)

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DEDICATION

This dissertation is dedicated to my family for their guidance throughout my life, to whom it should save as an inspiration for them to study hard and to do more than me and this is by abundant grace of God.

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LIST OF ABBREVIATIONS AND ACRONYMS

ARI Uyole	Agricultural Research Institute Uyole
ABACO	Agro-ecology based aggradations -conservation agriculture
CA	Conservation agriculture
CAPs	Conservation Agriculture Practices
CA-SARD	Conservation Agriculture for Sustainable Agriculture and Rural Development
CPAR	Canadian Physician for Aid and Relief
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
GEF	Global Environment Facility
ICARDA	International Centre for Agricultural Research in the Dry Areas
IDT	Innovation-diffusion theory
MAFSC	Ministry of Agriculture Food Security and Cooperatives
NSGRP	National Strategy for Growth and Reduction of Poverty
RECODA	Research, Community and Organisational Development Associates
SARD	Sustainable Agriculture and Rural Development
SUA	Sokoine University of Agriculture
TAMS	Tanzania Agricultural Mechanization Strategy
TAM	Technical Accepted Model
UMADEP	Uluguru Mountains Agriculture Development Project
WADEC	Women’s Agriculture Development and Environmental Conservation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Introduction and Background Information

Agriculture is central to the economy of Tanzania. The sector employs about 70% of the population and contributes nearly 28 percent to national gross domestic product (Mashindano *et al.,* 2010).Agricultural production in Tanzania has over the years been declining due to various reasons including the increasing extent of different forms of land degradation (FAO, 2002). Gathis (2009) observed that major forms of land degradation include soil erosion which is the most destructive process causing loss of soil. Others include water logging, loss of soil fertility, soil compaction through physical impact of heavy machine and livestock and loss of biodiversity of the ecosystem (FAO, 2002).

According to Hudson (2002) land management includes all measures, practise, amendments, and treatments involved in the use, development, reclamation, maintenance, and improvement of the land resources. The basic challenge for sustainable agriculture is to make better use of available biophysical and human resources, through minimizing the use of internal resources, or by combinations of both (Pretty, 1998). Principles of sustainable technologies in agriculture agree that, in order to be adopted, a farm must be economically profitable and the environmentally sustainable technologies in agriculture are frequently described as ecologically sound practices that have little adverse effects on natural ecosystems and relates to the quality of those who are and live on the farm, as well as those in the surrounding communities (Menale and Precious, 2009). Generally, farming practices tend to degrade the natural resource base and the challenge for modern agriculture is to minimize this degradation while increasing agricultural productivity (FAO, 2001).

The Poverty and human development report (URT, 2005) contends that if the National Strategy for Growth and Reduction of Poverty (NSGRP) are to be met, agriculture must grow at a sustained rate of at least six percent per annum which could be attained through ensuring high adoption of the promoted CAPs. Nowadays, people have understood that agriculture should not only result in high yielding, but also sustainable (Reynolds and Borlaug, 2006). In Tanzania Conservation Agriculture started in 1996 with the Selian Agriculture Research Institute (SARI) pioneering it. In 2001, FAO supported a visit by a team from Brazil to Karatu. In 2004 the Ministry of Agriculture Food Security and Cooperatives (MAFSC) –Tanzania in collaboration with FAO initiated a pilot project on conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD) in six Districts of Arumeru, Karatu, Bukoba, Kilosa, Mvomero, and Mbeya, (FAO, 2006; (TAMS, 2006). In Tanzania crop yield reduction due to land degradation is estimated to be over 60% in both mountain and semi –arid areas (Johansson, 2009). Thus, land degradation remains an important issue in different regions because of its impact on agricultural productivity, food security, environment, and general economic of the country (Eswaran and Reich, 2003).

Declining soil fertility, climatic extremes, high costs of inputs and lack of support for diversified income sources are all critical problems and are widely recognized as major factors responsible for declining agricultural productivity and increasing rural poverty (UNEP, 2009). Conventional farming practices such as intensive tillage and burning or removing crop residue often make these problems worse (Shetto *at el*., 2007). Attaining food security and development goals at the household and national levels requires a shift from conventional to more efficient, sustainable and climate resilient food production practices (FAO, 2010). Sustainable land management including conservation agriculture

(CA) holds that promise (ACT, 2008). Conservation agriculture, a three-pronged approach to farming, involving maintenance of permanent soil cover, practicing non-tillage planting methods to reduce soil disturbance, and implementing crop rotations/associations that break pest cycles and introduce nitrogen-fixing leguminous species to help restore soil fertility has shown potential for mitigating and adapting to impacts of climate change (Shetto *et al.,* 2007). Employing CA principles significantly increases and stabilizes crop yields while at the same time preserves the natural resources that are critical for food production (ACT, 2008).

In Matombo Division CAPs were taught to smallholder farmers and became in use and were promoted by different actors in Uluguru Mountains including the Global Environment Facility (GEF) project that aimed at management and conservation of forest biodiversity and the Eastern Arc Mountains that started in January 2004. Among the expected outputs was improved land husbandry practice in the Uluguru Mountains implemented by local communities and other stakeholders (URT, 2004). Since its initiations little is known on the extent to which the promoted CAPs have been adopted and re actually being applied by the targeted smallholder farmers. This study therefore sought to assess the adoption of the promoted CAPs among smallholder farmers in Morogoro District.

1.2 Problem Statement

Conservation agriculture is increasingly being promoted as an alternative to address soil degradation resulting from poor agricultural practices. The advantages of conservation agriculture in labour saving, cost effectiveness and sustainable soil fertility and environmental conservation have been well studied and documented, for example, Hensley and Bennie (2003), RELMA (1998), Baudron *et al*. (2003), Rockstrom *et al*. (2008) and Enfors (2009). Despite all the known benefits of conservation agriculture scaling up of the technology among smallholder farmers in Tanzania has remained low. The need for more land for agricultural production has led to pressure on land and competition among land users. This has resulted into different forms of land degradation (Johansson, 2009). Hence, some effort to identify and apply solutions to arrest the increasing soil fertility decline, land degradation and associated problems of increasing food insecurity and poverty with particular attention to prevent further nutrient mining. Among the consequences of loss in soil are; reduced livelihoods, reduced key ecosystem goods and services, negative effects of climate change and variability and increase in food insecurity and poverty (Voigt *et al*., 2011; Nkonya *et al*., 2012). Conservation Agriculture (CA) addresses the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil (Giller e*t al*., 2009; Boardman et al., 2009). However, the ability to adopt new conservation agriculture practices/measures is a function of many factors that are both internal and external to any social system (Isham, 2000; Byakugila *et al*., 2009).

To fully exploit the potential of promoting the scaling up of CA the existing knowledge gaps have to be addressed. Information is lacking on the drivers that have made some countries succeed in scaling up CA, the constraints they face and how they address them, lessons learnt and how to achieve impacts at a greater scale. Despite the demonstrated positive impacts of conservation agriculture, there has been a generally-low adoption rate in Tanzania (Shetto *et al.,* 2007). The reasons for not optimally adopting conservation agriculture have not been fully established. This study therefore, intended to assess factors influencing adoption of conservation agriculture practices for land management among smallholder farmers in Uluguru Mountains in view of obliging them to design policies and or strategies that will enhance adoption of CA and for advancing environmental and developmental goals.

1.3 Justification of the Study

Increased farm output and higher incomes for smallholder farmers will only continue to be realised if there is sustainability in land management. Despite the efforts by different actors in Uluguru Mountains in advocating land management practices among smallholder farmers, actors including the Global Environment Facility (GEF) project aimed at management and conservation of forest biodiversity and the Eastern Arc Mountains that started in January 2004 reported unaccomplished achievement of the set project targets. Among the expected outputs was an improved land husbandry practice in the Uluguru Mountains under the implementation of local communities and other stakeholders (URT, 2004).

Similar undertakings including the Sokoine University of Agriculture under the Uluguru Mountains Agriculture Development Project (UMADEP) was promoting sustainable mountain agriculture and improving agricultural practices for traditional crops through CA practices in Mgeta, Mkuyuni, Mvomero and Matombo Divisions, however little is known on the sustainability and adoption levels of the promoted practices and hence more data was required to ascertain the extent to which the smallholder farmers have been adopting and using the promoted land management practices.

This study therefore, assessed the adoption of CA practices among farmers in the study area and determine the levels of knowledge and awareness of smallholder farmers' towards CA in order to ascertain factors associated with use of different CA practices among farmers in the Uluguru Mountains. The information obtained forms a basis for informing the Government, NGOs, agricultural scientists and other stakeholders to help them in designing or improving effective agricultural extension programmes for Land Management and ultimately increasing productivity, regulating climate change, controlling soil erosion and increase income of smallholder farmers.

1.4 Objectives of the Study

1.4.1 Overall objective

The overall objective of the study was to assess factors associated with adoption of conservation agriculture measures for improved land management among smallholder farmers of Uluguru Mountains in Morogoro District

1.4.2 Specific objectives

The Specific objectives of the study were to;-

i. Determine the smallholder farmers' knowledge levels on the existing CAPs in Uluguru Mountains
ii. Determine attitude towards CAPs among smallholder farmers in the study area
iii. Determine adoption level of CAPs among smallholder farmers in the study area
iv. Determine relationship between socio-economic factors and adoption of different CAPs introduced in the study area

1.5 Research Questions

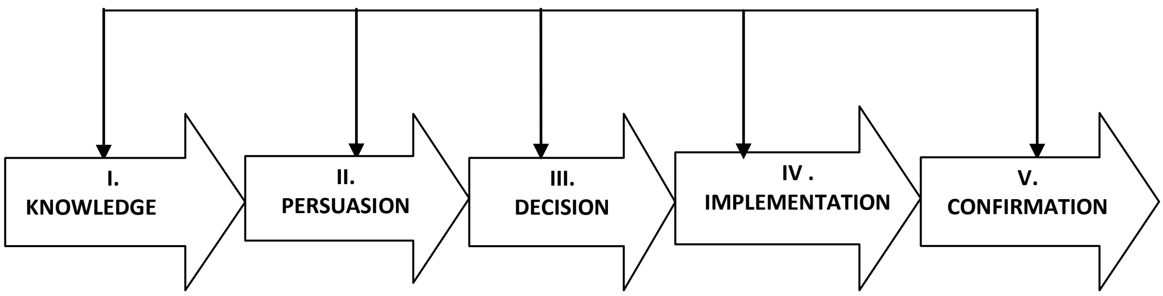
i. What CAPs were introduced in the study area?
ii. What is the current knowledge level of farmers on CAPs?

iii. What is the attitude of farmers towards the introduced CAPs in the study area?
iv. What is the farmer's attitude on using CAPs?
v. What is the adoption level among farmers on the introduced CAPs?
vi. What is the relationship between farmers' socio-economic factors and adoption levels and use of CAPs in the study area?

1.6 Theoretical Framework

Innovation-diffusion theory (IDT) explains how innovations are adopted and diffused within a population of potential adopters. IDT views innovation diffusion as a process of communication where people in a social system learn about a new innovation and its potential benefits through communication channels (such as mass media or prior adopters) and are persuaded to adopt it. According to this theory individuals pass through five stages on their way to adopting a new practice or behaviour (Rogers, 2003; Gregor and Jones, 1999). These stages are (i) knowledge whereby a person becomes aware of an innovation and has some idea of how it functions. In this step, an individual learns about the existence of an innovation and seeks information about the innovation. "What?," "how?," and "why?" are the critical questions in the knowledge phase, (ii) persuasion stage is when a person forms a favourable or unfavourable attitude toward the innovation after he or she knows about the innovation, (iii) decision whereby a person engages in activities that lead to a choice to adopt or reject the innovation, (iv) implementation - person puts an innovation into use, and (v) confirmation in which a person evaluates the findings of an innovation-decision already made and the individual looks for support for his or her decision. The model of five stages in the innovation adoption process is presented in Fig. 1.

COMMUNICATION CHANNELS (mass media/prior adopters)

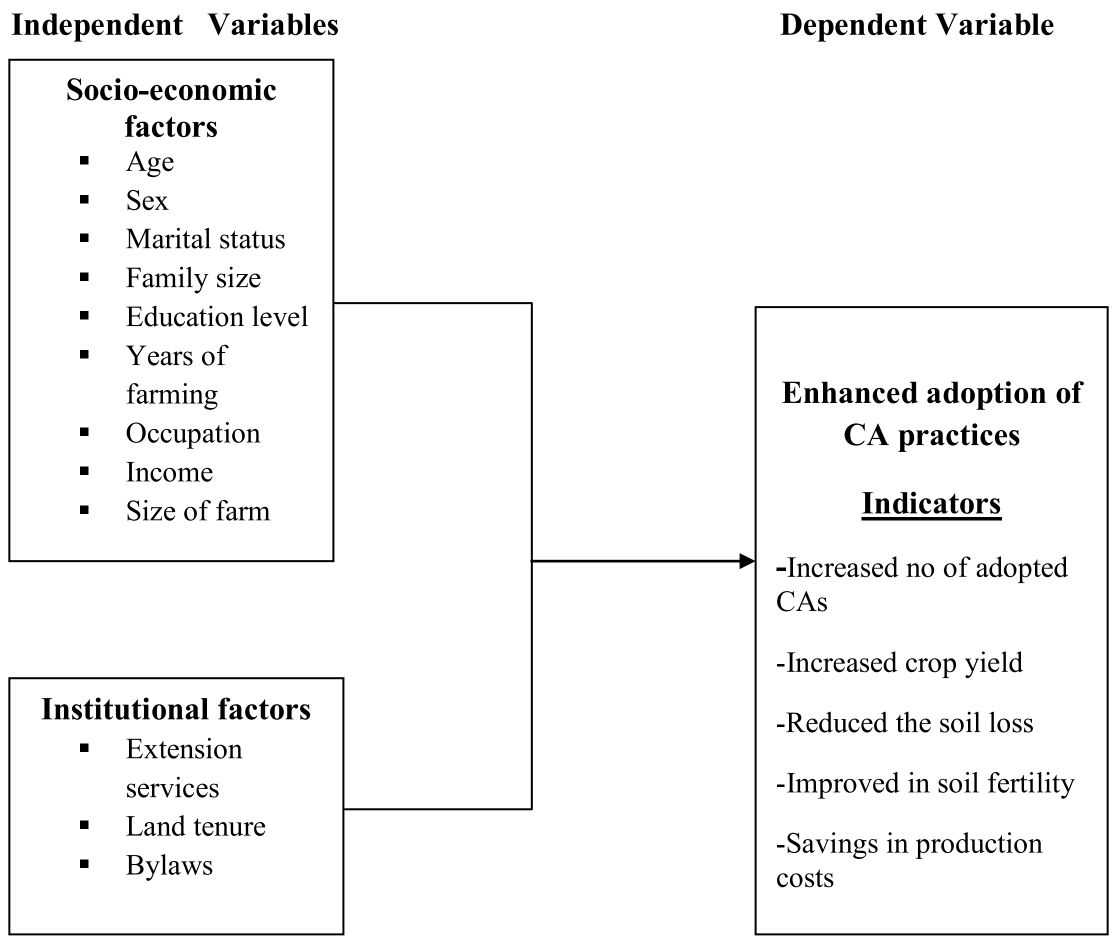


Source: Everett M. Rogers (2003).

Figure 1: A model of five stages in the innovation adoption process

1.7 Conceptual Framework

In this study, enhanced adoption of CA practices is influenced by independent variables like socio-economic factors such as age, sex, education level, years of farming, occupation, income, participation in decision making on CA issues and institutional factors such as extension services, land tenure, credit received for agriculture, subsidies, bylaws and size of farm. For the purpose of this study Technical Accepted Model (TAM by Davis, 1989) was modified to suit the study. The conceptual framework diagrammatically is presented in Fig. 2.



Source: (Modified from Davis, 1989)

Figure 2: The Conceptual framework

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The Concept of Adoption

Adoption is defined as a decision of full use of an innovation as the best course of action available while the process in which an innovation is communicated through certain channels over time among the members of a social system is known as diffusion (Rogers, 2003). Feder *et al*. (1985) defined adoption as "a mental process an individual passes from first hearing about an innovation to final utilization. Fisher *et al*. (2000) explain that diffusion differs from adoption in that it is the process by which new technologies are spread among users whereas adoption is said to be an individual internal decision.

The process of adopting new innovations has been studied for many years, and one of the most popular adoption models, diffusion of innovation theory, is described by Rogers (2003). According to this theory individuals pass through five stages on their way to adopting a new practice or behaviour (Rogers, 2003; Gregor and Jones, 1999). These stages are (i) knowledge whereby a person becomes aware of an innovation and has some idea of how it functions. In this step, an individual learns about the existence of innovation and seeks information about the innovation. "What?," "how?," and "why?" are the critical questions in the knowledge phase, (ii) persuasion stage is when a person forms a favourable or unfavourable attitude toward the innovation after he or she knows about the innovation, (iii) decision whereby a person engages in activities that lead to a choice to adopt or reject the innovation, (iv) implementation - person puts an innovation into use, and (v) confirmation in which a person evaluates the findings of an innovation-decision already made and the individual looks for support for his or her decision.

2.2 Conservation Agriculture Practices

Conservation Agriculture (CA) 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 and is characterized by three linked principles, namely (i) continuous minimum mechanical soil disturbance (ii) permanent organic soil cover (iii) diversification of crop species grown in sequences and/or associations (ACT, 2008). CA functions best when all three key features are adequately combined together in the field (Kassam, and Friedrich, 2011). CA experience worldwide, over the past four decades, has demonstrated how the simultaneous application of a set of practices of minimal mechanical soil disturbance, organic soil cover and diversified cropping can lead to greater and stable yields, better use of production inputs and therefore greater profitability while reducing production costs, enhanced crop, soil and ecosystem health as well as the associated ecosystem services, and improved climate change adaptability and mitigation (Kassam *et al*., 2009). Experience through a number of initiatives (Benites *et al*., 1998; Biamah and Rockstrom, 2000) has shown that the principles of conservation agriculture are feasible in the African environment, but it is important to be mindful of the fact that success in application and adoption will have to conform to the specific local socio-economic and cultural factors in addition to technical parameters.

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). Studies (Mazvimavi *et al*., 2010; Shetto *et al*., 2007) indicate that reduced tillage leads to lessened human inputs, in both time and effort. For HIV/AIDS affected regions minimum tillage practices ensure effective labour utilisation. Mixing and rotating of crops has been reported to replenish soil fertility through intercropping with nitrogen-fixing legumes which adds 'top-dressing fertilizer' to the soil; enable crops to use the nutrients in the soil more effectively; help to control weeds, diseases and pests by breaking their life cycles through the introduction of a new crop; and reduce the risk of total crop failure in cases of drought and disease outbreaks (ACT, 2008).

Keeping the soil covered is a fundamental principle of CA as cover crops improve the stability of the CA system, not only on the improvement of soil properties but also for their capacity to promote an increased biodiversity in the agro-ecosystem. According to the study conducted by Mazvimavi *et al.* (2010) among smallholder farmers in Zimbabwe farmers seemed knowledgeable about mulching although there were misconceptions that mulching can only be done using crop residues. Generally, there was low production of biomass in smallholder farms which may not allow farmers to meet the 30% mulch cover as a minimum recommendation for conservation agriculture (Giller *et al*., 2009). However, various other materials can also be used as mulch including leaf litter and grass. A recent study (FAO, 2011) on farm enterprises in Zambia demonstrated that conservation agriculture practices such as CA Planting basins and CA Magoye ripper had generally performed well as compared to conventional draft tillage practices in aspects of revenues, input costs and returns.

The origins and early roots of discovery, inventions and evolution of CA principles and practices are embedded in the farming communities and civil societies in North and South America who, out of necessity, had to respond to the severe erosion and land degradation problems and productivity losses on their agricultural soils due to intensive tillage-based production practices (Kassam *et al*., 2010). Initially, this occurred in North and South America, and later in other parts of the world such as Australia, and more recently Asia and Africa (ibid). Thus CA has largely evolved and spread bottom up, unlike the intensive tillage-based 'Green Revolution' practices whose evolution has largely followed a top down approach with the international and national scientific community setting largely a reductive research agenda and strongly influencing what innovations and technologies can be and are actually delivered to the farmers in the developing nations through a linear research- extension-farmer approach (Lugandu, 2013; Kassam *et al*., 2009; and FAO, 2001).

2.3 Adoption Conservation Agriculture Practices in Tanzania

In Tanzania, the practice of conservation agriculture is not new as it dates back many years ago when indigenous technologies were used (Shetto *et al.,* 2007). Most of these technologies have one or more features that reflect some of the principles of CA (accumulation of residues on soil surface, minimum soil disturbance, crop rotation, seeding on mulch) (McCall, 1994; Reij *et al.,* 1996; and Mutunga *et al.,* 2001). Mulching, for example, was commonly practiced although it has declined as a result of other competitive use of the crop residues such as feed for livestock, fuel and building materials (Shetto, 2011). Improved fallows consist of deliberate planting of selected fast growing trees or shrub, usually leguminous species to improve the fertility of the soil largely through Biological Nitrogen Fixation (Jama *et al.,* 1998). The Chagga home garden consists of a three storey arrangement, with large trees such as Albizia and Gravillea forming the upper most storey, banana and coffee canopies forming the next lower storey and fodder, herbs, and grasses forming the lowest layers (Fernandes *et al.,* 1981). This system provides a continuous ground cover protecting the soil against erosion, and a high degree of nutrient cycling through the accumulated mulch while the trees provide fodder, fuel wood and fruits. Although these traditional farming practices were purposefully done to protect the soil from degradation and improve its productivity the increased problems of deforestation, over-grazing and inappropriate tillage practices exaggerated the problem of soil degradation (Biamah and Rockstrom, 2000; Jonsson *et al.,* 2000; Elwell *et al.,* 2000).

In the wake of declining soil fertility and crop yields a number of institutions started to engage in finding out how the situation could be reversed. FAO, CYMMT and ACT are among the organisation that engaged in promoting of CA in Africa including Tanzania. In the late 1990s, several Agricultural Research Institutions under the Ministry of Agriculture initiated some activities on conservation agriculture. For example, Selian Agricultural Research Institute (SARI) and Agricultural Research Institute Uyole (ARI Uyole) have been undertaking some research activities in conservation agriculture which include promotion of animal drawn rippers and no-till direct seeders by using the Farmer Field School approach and dissemination of conservation agriculture technologies through establishment of both on station and on farm demonstration plots and selling of cover crop seed (lablab and mucuna) directly to farmers (Shetto *et al.,* 2007).

Implementation of CA projects also started taking shape in Tanzania in early 2000s (www.act-africa.org, accessed 2012). Conservation Agriculture for Sustainable Agriculture and Rural Development (CA SARD) was a pilot project aimed at empowering small scale farmers and farming communities to adopt conservation agriculture technologies through Farmer Field School (FFS) approaches. It was implemented in six districts of Arumeru, Karatu, Babati, Hanang, Bukoba and Moshi Rural in 2004-2010. The core activities in the CA SARD Project involved the training of farmers to enable them to apply CA practices to the farmer Field School plot and adapt the practices to their local technical and socio economic circumstances. Other areas where the project was implemented were Meru, Mbulu, Same, Kilindi, Mvomero, Kilosa, Njombe, and Singida districts through support of CA SARD. Other projects include the agro-ecology based aggradation -conservation agriculture (ABACO runs from 2011 to 2014 targeting innovations to combat soil degradation and food insecurity in semi-arid Africa. It is being implemented in semiarid areas of East (Kenya, Tanzania) Africa and other parts. There are also a number of nongovernmental organisations that are promoting conservation agriculture in Tanzania among them are Research, Community and Organisational Development Associates (RECODA), Women's Agriculture Development and Environmental Conservation (WADEC), Canadian Physician for Aid and Relief (CPAR) and others (ACT, 2008). Other activities that have been implemented regarding CA are the farmer field days that are jointly organised by ACT and the Ministry of Agriculture Food Security and Cooperatives.

Inadequate or lack of institutional capacity in Tanzania for wide scale adoption and application of profitable and sustainable conservation agricultural practice is one of the weaknesses. URT (2012) highlighted the urgent need to strengthen human and institutional capacity for change and innovation in agriculture. New approaches and innovative initiatives need to be sought in order to address these critical capacity deficiencies. Adoption of Conservation Agriculture (CA) especially by smallholder farmers involves risk of reduced yield among others at an early stage of CA introduction. The government of Tanzania is using macro-economic policy, trade regulations, input subsidies, or education and extension to alter the decision-making environment in which farmers choose one practice over another, for this case conservation agriculture technology (Shetto *et al.,* 2007). It is however very important to note that not all policy instruments have worked in the same way or have given positive findings everywhere. Different situations need different policy instruments to make the desired end. Therefore policy research is necessary in the differing socio ecological environment to enable identification of right policy incentives to target beneficiaries and address differentiated needs.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of Study Area

This study was conducted in Matombo Division in Morogoro District in Morogoro Region. The study area will comprise villages in which CA practices have been promoted over time (more than one year). Matombo Division has been selected for the study because it is one among the divisions in Morogoro Region whereby CAs have been introduced and promoted for addressing soil degradation problems resulting from agricultural practices. Uluguru Mountains has been selected also because are among the mountain forests in Tanzania faced with increasing deforestation and problems of agricultural practices.

3.2 Research Design

A cross-sectional research design was adopted whereby data were collected at a single point in time (Malter *et al.,* 2007; Creswell, 1994). The design also is chosen because it allows to easily obtaining a representative sample for the whole population (Rubin and Babbie, 2010).

3.3 Study Population

The study population consisted of all smallholder farmers growing crops in villages where CA practices have been promoted in Matombo Division.

3.4 Sampling Procedure and Sample Size

Purposive sampling method was used in selecting the division, four wards and then four villages in which CA practices have been promoted over time were randomly selected including respondents (adopters and non adopters). The study was involving a sample size of 133 smallholder farmers. The sample was determined by using Yamane's formula (1967) that states:

$n = \frac{N}{1+N(e)2}$Where; n is a population sample, N is the number of smallholder farmers (200) and e is the precision level which was 0.05. A Unit of measure was a household. Therefore,

$$n = \frac{N}{1+N(e)^2}\frac{200}{1+200(0.05)^2} = \frac{200}{1+200(0.0025)} = \frac{200}{1+0.5} = \frac{200}{1.5} = 133,$$

However, a total of 100 smallholder famer's respondents were used on entire study following encountering non response. According to Roscoes (1975) rule of thumb the sample size more than 30 and less than 500 is sufficient.

3.5 Data Collection

3.5.1 Types of data

Both quantitative and qualitative data were collected including primary and secondary data.

3.5.2 Primary Data

Primary data on individual characteristics such as sex, age, and marital status, level of education, and household size, and conservation agriculture measures were collected using a structured questionnaire and interview also was used in which unstructured questions was used to collect qualitative information. Again, data on various attributes on adoption of conservation agriculture measures by individual farmers was collected by scoring adoption and non-adoption of the attribute and was summed to get a total score of adopted attributes out of the total package advanced to them to obtain an adoption index.

3.5.3 Secondary data

Secondary data on introduced conservation agriculture measures, implementation and constraints were obtained through district agricultural office and from ward extension agents.

3.6 Data Analysis

Data collected was summarized, coded and analysed using Statistical Package for Social Sciences (SPSS) to obtain frequencies. The knowledge level and attitude of farmers towards adopting CAs were determined by recording responses based on the established likert scale. Chi-square test was used to determine the association between adoptions levels of CAs based on different socio-economic attributes of the respondents. Multiple Linear Regression analysis was used to determine the extent of the influence of socio-economic on adoption of various CAs among different smallholder farmers in the study area.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Social-demographic Characteristics of the Respondents

The socio-demographic characteristics of the respondents are shown in Table 1. Out of 100 respondents who were interviewed (33%) had less than 35 years, (27%) had between 36 to 45 years and 40% had above 46 years. Again, of the 100 respondents who were interviewed most, (75%) of respondents were male while females were only (24%).

The findings show that out of 100 respondents who were interviewed most 85.0% were married while only a few (6%) were single, four percent each were separated and divorced, respectively and widows accounted for only one percent. Again, out of 100 respondents who were interviewed, slightly above half, (57%) said their family size had less than four family members while in (42%) of the households the family members ranged between five to 10 members.

The findings show that out of 100 respondents who were interviewed most (76%) had completed primary school education while (17%) had completed Ordinary level secondary school education and the remaining (4) and (3) had no formal education and had not completed primary school education, respectively. Out of 100 respondents who interviewed, slightly over half (52%) relied on informal business as another source of income. However, (29%) and (17%) of the respondents interviewed said casual labour and livestock keeping were the alternative sources of their household income, respectively, while two percent of the respondents relied on salaried employment as an alternative source of income.

Table 1: The socio-demographic characteristics of the respondents

Attributes	Frequency	Percentage
Age category		
≤ 35	33	33.0
36-45	27	27.0
≥46	40	40.0
Sex		
Male	76	76.0
Female	24	24.0
Marital status		
Married	85	85.0
Single	6	6.0
Widowed	4	4.0
Divorced	1	1.0
Separated	4	4.0
Family size		
< 4	57	57.0
5 to 10	42	42.0
≥11	1	1.0
Education level		
No formal education	4	4.0
Below standard seven	3	3.0
Finished standard seven	76	76.0
Finished “o” level secondary education	17	17.0
Years involved in farming activities		
< 4	18	18.0
5 to 10	32	32.0
11≥	50	50
Other sources of income apart from farming		
Salaried employment	2	2.0
Informal business	52	52.0
Livestock Keeping	17	17.0
Casual labour	29	29.0

4.2 Socio-economic and Farm Characteristics of the Respondents

The socio-economic and farm characteristics of the respondents are shown in Table 2. The findings show that out of 100 respondents who were interviewed most, (93%) said that they earned up to TZS 500 000.00 from crop farming, while five percent were earning between TZS 500 000.00 to 1 000 000.00 and only few, (2%) earned more than TZS 1 000 000.00. Approximately, above half (54.0%) of the respondents said they received extension services on CA including contour strip farming, terracing on slopes and avoided burning crop residues after harvesting while the remaining (46%) said that they had no access to extension services specifically for CA in the study area. Out of 54 respondents who received extension services on CA, majority (70.4%) said they received extension services on CA once per month for the whole cropping season while (25.9%) received advice on CA more frequently and the remaining (3.7%) received once in a cropping season.

Majority of respondents, (91%) owned land where they practiced CA while (nine percent) did not own land. However, 77(77%) of the respondents owned land which they inherited, while 14(14%) owned land which they purchased and only few, (nine percent) rented land where they practiced CA. The findings indicate that the main cropping systems used by respondents in the study area include monocropping and intercropping farming systems as indicated by (88%) of the respondents who practiced rain fed intercropping while the remaining seven and five percent of the respondents practiced irrigated intercropping and rain fed mono-cropping farming systems, respectively. Most, (85%) of the respondents indicated that their field or plots were situated on sloppy land as shown by (66%) who said their farm plots are on steep slopes while (16) said the farm plots were on gentle slopes a condition that necessitated application of CA practices to conserve soils. However, the remaining (15%) of the respondents said their farm plots were on flat land. Of the 100 respondents interviewed, (51%) of them said there were village conservation bylaws that helped to reinforce application of CA practices.

Table 2: Socio-economic and farm characteristics of the respondents

Variable	Responses	n	%
Estimated household income from crop farming (Tshs)	≤ 500000	93	93.0
	500000 to 1000000	5	5.0
	≥1000000	2	2.0
	Total	**100**	**100**
Availability of extension services on CA	Yes	54	54
	No	46	46
	Total	**100**	**100**
Frequency of receiving advice on CA	Once in a month	38	70.4.
	Once in cropping season	2	3.7
	Frequently	14	25.9
	Total	**54**	**100**
Land ownership	Yes	91	91
	No	9	9
	Total	**100**	**100**
Form of land ownership			
	Rented	9	9
	Purchased	14	14
	Inherited	77	77
	Total	**100**	**100**
Cropping system used	Intercropping irrigated	7	7.0
	Intercropping Rain fed	88	88.0
	Mono-cropping Rain fed	5	5.0
	Total	**100**	**100**
Place where a plot is situated	On flat land	15	15.0
	On gentle slope	66	66.0
	On steep slope	19	19.0
	Total	**100**	**100**

4.3 Presence of Land use Conservation Bylaws in the Study Area

The presence and type of village conservation bylaws are shown in Table 3. Out of the 100 respondents interviewed, 51% said the village conservation bylaws were put in place and of these, (55.1%) said cutting of trees near water sources is forbidden while (26.5%) and (20.4%) said uncontrolled bushfires and cultivating closer to water sources was not allowed, respectively. Again, other conservation bylaws that were in place include tree planting was considered a routine activity to be carried out by all community members as reported by (16.3%) while (14.3%) said burning of crop residues was not allowed and hence they were advised to plough them under. , Other bylaws mentioned were, contour farming was proposed to conserve soils as said by (10.2%) and (4.1%) each said community members were also required to practice zero grazing and undertake terracing on slopes, respectively.

Table 3: Presence and types of conservation bylaws in the study area

Variable	**Responses**	**n**	**%**
Presence of village land Conservation Bylaws	Yes	51	51
	No	49	49
Types of conservation bylaws	No burning of crop residues	7	14.3
	Cutting trees is forbidden	27	55.1
	Tree planting is a routine activity	8	16.3
	Practice contour farming to conserve soils	5	10.2
	Terracing on slopes	2	4.1
	No bush fires	13	26.5
	No cultivation near water sources	10	20.4
	Practice zero grazing	2	4.1

4.4 The Knowledge of Respondents on Importance of CA Practices in the Study Area

Respondents were asked to give their views and perceptions on how they viewed importance of CA practices relative to soils conservations and improvements. The perceptions of respondents on importance of CA practices in soil management practices are given in Table 4.

The findings show that out of the 100 respondents, (90%) accepted that conservation agriculture improves soil structure, protects the soil from the erosion and nutrients losses .These findings are supported by the fact that, land areas covered by plant biomass, living or dead, are more resistant to wind and water soil erosion and experience relatively little erosion because rain drop and wind energy are dissipated by the biomass layer and the topsoil is held together by the biomass (Pimentel and Burgess, 2013).

Again, findings show that about 47 (47%) of the respondents accepted that no till operations under conservation agriculture reduced number of labourers on farm while 43(43%) were not sure and only 10(10%) declined that no till operations under conservation agriculture reduced number of labourers on farm. Moreover, out of 100 respondents who were interviewed, most, (79%) of the respondents agreed that they were leaving crop residues on farm to help them protect the soil surface and enhance water holding capacity. This findings were in agreement with findings by Kassam *et al.* (2009) when studying the spread of conservation agriculture: justification, sustainability and uptake in Africa who found that combining the retention of crop residues with direct seeding of crops without soil disturbance lead to retention and increased organic matter and hence assisting to better provide water and nutrients to plant roots ‘on demand’ over sustained periods.

The findings show that out of 100 respondents who interviewed majority (81%) had accepted that mulching on their farm protected soil from extreme temperatures and reduced surface evaporation hence retaining soil humidity. The findings are supported by (Kassam *et al*., 2009) who said good mulch cover provides 'buffering' of temperatures at the soil surface which otherwise are capable of harming plant tissue at the soil/atmosphere interface, thus minimizing a potential cause of limitation of yields. The findings also show that out of 100 respondents who were interviewed, most (86%) accepted that conservation agriculture increased crop yield. According to Kahimba *et al.* (2014) when studying adoption and scaling-up of conservation agriculture in Tanzania: case of Arusha and Dodoma regions who found that from Arusha and Dodoma regions the adoption of CA technologies has helped farmers increase yield. Farmers felt that the yields would be affected without CA technologies therefore indicated that terraces, minimum tillage, large pits and cover cropping have had impacts on crop yields.

The findings from this study show that no till agriculture resulted in fewer greenhouse gases into atmosphere and cleaner air as supported by over half (54%) of the respondents interviewed, but 36(36%) of the respondents said that they were not sure that no till agriculture resulted in fewer greenhouse gases and cleaner air and a few (10%) denied that no till agriculture could result in fewer greenhouse gases and cleaner air. The findings are similar to the study conducted in Lesotho by FAO (2010) which found that conservation agriculture also contributes to wider environmental benefits such as No-till/zero till and mulching reduce the release of carbon into the atmosphere.

The findings show that majority 93 (93%) of the respondents accepted that agro forestry practice protect soil from erosion while minority (four percent) said they were not sure if agro forestry practices could protect soil from erosion. However three (three percent) of the respondents did not accept that agro forestry practices protect soil from erosion. However, according to Kassam (2009) reported that growing of woody perennials and annual crops together in a sustainable manner helped improve soil protection and efficient use of water and soil nutrients and such practices were increasingly being practiced in degraded areas with perennial legumes. Therefore, CA works well for agro forestry and related systems in which crops are combined with woody perennials in the production system. Moreover, the findings show that, out of 100 respondents interviewed (68%) accepted that direct planting of crop seeds increase yields of crops and helped reduce soil disturbance.

Moreover, it was revealed that crop rotations helped to break disease cycles on the farmers crop fields as agreed by (80%) of the respondents. However (19%) of the respondents were not sure of the functionality of crop rotations in relation to breaking disease cycles on crop fields. This findings are similar to those of Blank (2008) in Bangkok who found that crop fields under CA systems were less vulnerable to insect pests, diseases and drought effects because of better soil and plant conditions that include greater biotic diversity of potential predators on pests and diseases.

Table 4: The knowledge level of respondents on existing CA practices in the study area

Attribute	Accept		Neutral		Not accept	
	n	%	n	%	n	%
Conservation agriculture improves soil structure, protects the soil the from erosion and nutrients losses	90	90.0	9	9.0	1	1.0
No till operations under Conservation agriculture reduces number of labourers	47	47.0	43	43.0	10	10.0
Crop residues on the soil surface enhance water holding capacity	79	79.0	17	17.0	4	4.0
Mulches protect soil from extreme temperatures and reduce surface evaporation	81	81.0	9	9.0	10	10.0
Conservation agriculture increases crop yield	86	86.0	14	14.0	0	0.0
No till agriculture findings in fewer greenhouse gases into atmosphere and cleaner air	54	54.0	36	36	10	10.0
Agro forestry protects soil from erosion	93	93.0	4	4.0	3	3.0
Direct planting of crop seeds on the rip line increases yield crop and maintain soil disturbance	68	68.0	16	16.0	16	16.0
Crop rotations breaks disease cycles on my field	80	80.0	19	19.0	1	1.0
Manure application during appropriate time improve soil fertility	73	73.0	6	6.0	21	21.0
No burning of crop residues protect soil from sun, rain, wind and to feed soil organisms	83	83.0	8	8.0	9	9.0
Conservation tillage/reduced tillage protects soil surface	67	67.0	28	28.0	5	5.0
Cover crops protects soil from moisture and limited weed growth	84	84.0	13	13.0	3	3.0

Moreover, the findings show that out of 100 respondents, majority (73%) accepted that applying manure during appropriate times helped improve soil fertility and (21%) did not agree that applying manure could help improve soil fertility conditions while a few (6%)

were not sure that applying manure was of importance to soil fertility. This finding is in agreement with Roy and Kashem (2014) in Bangladesh who found that application of manures have been proven to enhance efficiency and reduce the need for chemical fertilizers, to improve the soil fertility and soil health.

The findings in Table 4 show that out of 100 respondents, majority (83%) accepted that they practiced no burning of crop residues for protecting soil from sun, rain, wind and feed soil organisms. These findings are supported by FAO (2005) in Africa who found that Soil moisture was one of the most important factors that determine the presence of earthworms in the soil. Through cover crops and crop residues, evaporation is reduced and organic matter in the soil is increased, which in turn can hold more water. Residues on the soil surface induce earthworms to come to the surface in order to incorporate the residues in the soil. The burrowing activity of earthworms creates channels for air and water and is of importance in effecting oxygen diffusion to the root zone in the soil.

The findings show that (67%) of the respondents accepted that conservation tillage protected soil surface while (28%) were not sure that conservation tillage protected soil surface, and a few, (5%) disagreed that conservation tillage could protect soil surface(See Table 4). Moreover, the findings show that out of 100 respondents, majority (84%) of the respondents agreed that cover crops prevented soil from moisture loss and suppressed weed growth. The findings are in agreement with Fakhari *et al*. (2013) in Iran, who found that a cover crop contribute significantly to weed management. This findings were supported by key informants including the ward agricultural officer (WAO) and ward extension agent who reported that smallholder farmers were aware of CA that were introduced. They also reported that smallholder farmers were practicing CA technologies that include contour strip cropping, mulching, agro-forestry, intercropping, crop rotations, direct planting of crop seeds on the rip line and leaving crop residues on fields.

4.5 Attitude of the Respondents towards Applying CA Practices

Respondents were asked to give their views on application of various CA practices on their farms relative to soils conservations. The views of respondents on application of various CA practices in soil management practices are given in Table 5. The finding show that out of 100 respondents, 60 % were trained on conservation agriculture practices while 40 % were not trained about CA although some of them were adopting the technologies by copying from their fellow farmers who had already been trained. The findings also indicate that majority, 78% said they were applying conservation agriculture practices. This finding is in agreement with Kahimba (2014) in Arusha and Dodoma who found that farmers adopting different CA techniques varied from place to place depending on biophysical characteristics and that farmers in Arusha adopted terraces and less land disturbing technologies like zero tillage, ripping and cover crops and ridges.

The findings show that majority, (59.0%) indicated were applying contour strip farming as a practice on conservation agriculture while (41%) were not applying contour strip farming. Similarly, majority, (73%) were applying mulching on their farms which helped to protect soil from extreme temperatures and reduced surface evaporation. These findings are similar to (Ajani *at el*., 2013) in sub-Saharan Africa who reported that Local farmers have been known to conserve carbon (C) in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques. Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests and conserve soil moisture.

Moreover, It was revealed that cover crops as CA technology helped to protect soil from moisture loss and limited weed growth as indicated by majority 76(76%) of the respondents who used cover crops. Out of the 100 respondents majority, (77%) were applying agro-forestry practices and therefore protecting soil from erosion. Approximately, majority, 70.0% of the respondents were applying crop rotations on their farms which helped break disease cycles. These findings are in agreement with ICARDA (2012) in dry areas of Iraq, Syria, Morocco and Tunisia who reported leaving the previous crop's stubble and other residues raised the risk of plant pests and diseases surviving into the following crop.

Majority, 73(73%) of respondents were not applying manure although they were trained on the importance of applying manure while a few, 27(27%) were applying manure on their farms. Reasons advanced for not applying manure include having difficulties in obtaining manure as livestock keepers were very few. These findings are in agreement with FAO (2006) in Southern and Eastern Africa who found 70% of the participating farmers who had access to organic fertilizers like manure decided to use manure. Access to kraal manure, was mainly linked to ownership of livestock and varied widely across the study areas. The findings show that out of 100 respondents 54% were directly planting crop seeds therefore reducing soil disturbance. Majority, 82% of the respondents were applying crop residues which helped improve soil surface and enhancing water holding capacity. These findings are contrary to Sukartono *et al*. (2011) in Lombok, Indonesia who reported that application of organic matters (i.e. manure, mulches, and composts) on farm have frequently been shown to increase soil fertility.

Out of the 100 respondents, 83% were avoiding burning of crop residues on their farms which helped protect soil from rain and facilitated feeding soil organisms. The finding also show that all respondents were not applying no till/zero till technology on their farms as they were not trained on the technology. Moreover, majority 51% were applying reduced tillage on their farms and leaving at least 30% soil surface covered by plant residues hence increasing water infiltration and reducing soil erosion and runoff while 49% were not applying reduced tillage technology. This finding is in agreement Baudron *et al*. (2007) in Zambia who found that reduced tillage can improve soil as regular hoeing to the same depth may result in a hard pan or compacted layer of soil.

Table 5: Attitude of the respondents towards applying CA practices

Attribute	**Responses**	**n**	**%**
Trained about Conservation agricultural Practices	Yes	60	60.0
	No	40	40.0
	Total	**100**	**100.0**
Use Conservation agricultural Practices on your farm	Yes	78	78.0
	No	22	22.0
	Total	**100**	**100.0**
Use Contour farming for Conservation agriculture	Yes	59	59.0
	No	41	41.0
	Total	**100**	**100.0**
Use Mulch on your farm	Yes	73	73.0
	No	27	27.0
	Total	**100**	**100.0**
Use Cover crops on your farm	Yes	76	76.0
	No	24	24.0
	Total	**100**	**100.0**
Use Agro-Forestry on your farm	Yes	77	77.0
	No	23	23.0
	Total	**100**	**100.0**
Use Crop rotations on your farm	Yes	70	70.0
	No	30	30.0
	Total	**100**	**100.0**
Use manure on your field	No	73	73.0
	Yes	27	27.0
	Total	**100**	**100.0**
Use direct planting of crop seeds on the rip line on your field	No	54	54.0
	Yes	46	46.0
	Total	**100**	**100.0**
Leaving crop residues on your farm	Yes	82	82.0
	No	18	18.0
	Total	**100**	**100.0**
Apply manure during the appropriate time on your farm	No	73	73.0
	Yes	27	27.0
	Total	**100**	**100.0**
Do not burn crop residue/Plough under crop residue on your farm	Yes	89	89.0
	No	11	11.0
	Total	**100**	**100.0**
Ever used no-till/zero till on your farm	Yes	100	100.0
Use Conservation tillage/reduced tillage no your farm	No	51	51.0
	Yes	49	49.0
	Total	**100**	**100.0**

4.6 Reasons of Smallholder Farmers Not Adopting Some of Conservation Agriculture Practices in the Study Area

The respondents were asked to give their views on the reasons that made them not to apply some of the conservation agriculture practices. Views of the respondents on the reasons that made them not to apply some CAs are shown in Table 6. Out of the 100 respondents 24% said that high costs of some of CA technologies as application of manure involved buying and transporting that made them not to adopt the technology while 17% were not trained. Similarly, 16% of the respondents said CAs were not well understood while 11% said it was difficult to obtain manure due to the fact that apart from farming they were engaged in informal business, whereas nine percent said it was difficult to use some of CAs such as contour farming because they consumed time and sometime needed payable labourers and eight percent of the respondents each said by applying manure soil could become infertile in some years to come and that they were influenced by their neighbours/fellow farmers not to apply some of CAs, respectively. Two percent each of respondent said absence of market for their produces and difficulties in obtaining grasses for mulching to cover all owned acres was discouraging them to apply CAs. The findings are similar Kahimba *et al*. (2014) in Arusha and Dodoma regions who found that failure of adoption of the CA technologies was also contributed by some technical, biophysical, and economic constrains. Lack of immediate returns, lack of training to farmers and extension agents, taking more than two years for farmers to start realizing results of applying CAs and most CAs being labour intensive and expensive compared to conventional tillage were also cited among the reasons for not adopting most CAs technologies.

Table 6: Reasons for not applying some of conservation agriculture practices in the study area

Variable	Reasons made you not to practices Conservation agriculture	n	%
Reasons for not practicing CAPs	Difficult to use	9	9.0
	Influenced by others	8	8.0
	Expensive	24	24.0
	Difficult to obtain manure	11	11.0
	Not well understood	16	16.0
	I have never been trained	17	17.0
	Consumes time	3	3.0
	Difficult to obtain grasses for mulching to cover all owned acres	2	2.0
	soil will become infertile by applying manure	8	8.0
	No market for produces	2	2.0
	Total	**100**	**100.0**

4.7 The Adoption Levels of CA Practices in the Study Area

4.7.1 The relationship between socio-economic factors and adoption of CAs

Socio-economic characteristics are very important in influencing adoption of CA practices and thus describing the changes in using CA by a population over time. In this study age, sex, marital status, family size, education level, years of farming, income, extension services, land tenure, where is farm/plot situated, farm size under conservation agriculture, sources of income and conservation bylaws where analyzed to determine their influence on adoption levels of CA.

Adoption levels of CA were categorized in three, that is, low, medium and high, whereas low adoption level implied that a respondent used plus two standard deviation (50 percent) of CA practices while medium adoption level meant a respondent applied plus three standard deviation (50 to 75 percent) CA practices and high adoption level implied that a respondent used plus three to four standard deviation (76-100 percent) CA practices. The influences of socio-economic characteristics on adoption of CA practices are shown in Table 7.

The study findings show that out of 100 respondents 44%, 36% and 20% had high, medium and low adoption levels, respectively. Out of the 20 respondents who had low adoption level, nine (45%); six (30%) and five (25%) were of age categories of less than 35 years, between 36 to 45 years and 46 above years of age, respectively. Of the 36 respondent who had medium adoption level of CA practices,11(30.6%);12(33.3%) and 13(36.1%) were of age categories of less than 35 years, between 36 to 45 years and 46 above years of age, respectively. The remaining 44 respondents who had high adoption levels of CA practices, 13(29.5%); nine (20.5%) and 22(50%) were of age categories of less than 35 years, between 36 to 45 years and 46 above years of age. However, the differences in adoption levels of CA practices based on age of the respondents was found to be statistically significant at p= 0.006. These findings are similar to (Wanagwa and Charles, 2013) in Nkhotakota in Malaawi who found age of the farmer that reflected experience could wear down confidence hence, they become more or less risk averse to new technologies.

Out of 100 respondents 44%, 36% and 20% had high, medium and low adoption levels, respectively. Out of the 20 respondents who had low adoption level, 14(70%) and six (30%) were male and female respondents, respectively. Out of the 36 respondent who had medium adoption level of CA practices, 63.9% and 36.1% were male and female respondents, respectively. The remaining 44 respondents who had high adoption levels of

CA practices, 88.6% and 11.4% were male and female respondents, respectively. However, the differences in adoption levels of CA practices based on sex of the respondents was found to be statistically significant at p= 0.000. This finding is similar to Lugandu (2013) in Karatu and Kongwa districts of Tanzania who found that more males had adopted CA compared to females.

Out of the 20 respondents who had low adoption level, 65% and 35% had family size of less than four people, between five to ten people and above 11 people, respectively. Of the 36 respondent who had medium adoption level 58%; 38.9% and one percent had family size of less than four people, between five to ten people and above 11 people, respectively. Again of the respondents who had high adoption levels 52.3% and 47.7% had family size of less than four people and between five to ten people, respectively and the differences in adoption levels of CA practices based on family size was found not to be statistically significant (p= 0.074). These findings are similar to Wanagwa and Charles (2013) in Nkhotakota in Malawi who found families with high reliance on agricultural production were more willing to adopt CA.

Findings show that of the 20 respondents who had low adoption level, five percent, 85%; and 10% had no formal schooling, below standard seven, finished standard seven education and finished “O” level secondary education, respectively. Of the 36 respondent who had medium adoption level of CA practices, 5.6%, 72.2% and 22.2% had no formal schooling, below standard seven, finished standard seven education and finished “O” level secondary education, respectively. The remaining 44 respondents who had high adoption levels of CA practices, 2.3%; 6.8%, 75.0% and 15.9% had no formal schooling, below standard seven, finished standard seven education and finished “O” level secondary education, respectively and the differences in adoption levels of CA practices based on education level of the respondents was found to be statistically significant a p= 0.000. These findings are in agreement to Wanagwa and Charles (2013) in Nkhotakota, Malawi, who found an increase in education level by one year increased chances of adopting CAs by 15%. Education helps farmers to analyze alternatives critically and forecast the expected benefits to their activities (Nakhumwa, 2004).

Out of the 20 respondents who had low adoption level, 25%; 20% and 55% had farming experience of less than four years, between five to ten years and 11 years and above, respectively. Of the 36 respondent who had medium adoption level of CA practices, 16.7%; 44.4% and 38.9% had farming experience of less than four years, between five to ten years and 11 years and above, respectively. The remaining 44 respondents who had high adoption levels of CA practices, 15.9%; 27.3% and 56.8% had farming experience of less than four years, between five to ten years and 11 years and above, respectively. However, the differences in adoption levels of CA practices based on years involved in farming activities was found to be statistically significant at p= 0.004. This finding is in agreement Ngwira (2014) who found that as the length of time of practicing CA increases (and therefore more knowledge and experiences on CA are gained), the likelihood of allocating more land to CA also increases.

Findings show that out of the 100 respondents 44%, 36% and 20% had high, medium and low adoption levels, respectively. Out of the 20 respondents who had low adoption level, all earned annual income of less than TZS 500 000.00 from crop faming. Of the 36 respondent who had medium adoption level of CA practices, 94.4% and 5.6% earned income of less than TZS 500 000.00 and between TZS 500 000.00 to TZS 1 000 000.00, respectively. The remaining 44 respondents who had high adoption levels of CA practices, 93%; 6.8% and 5.0% earned income of less than TZS 500 000.00 and between TZS 500 000.00 to 1 000 000.00 and more than TZS 1 000 000.00, respectively. However, the differences in adoption levels of CA practices based on income of the respondents was found to be statistically significant at p= 0.006. The findings are in contrary to Kahimba *et al.* (2014) in Arusha and Dodoma regions who reported that wealth status influenced the decision to adopt conservation technologies and that wealthier farmers in Arusha invested more on CA technologies while in Dodoma farmers adopted CA technologies regardless of their wealth status.

Out of the 20 respondents who had low adoption level, 30%; 50% and 20% had farm size of less than one acre, between one to two acres and above two acres, respectively. Of the 36 respondents who had medium adoption level of CA practices, 19.4%; 50% and 30.6% had farm size of less than one acre, between one to two acres and above two acres. The remaining 44 respondents who had high adoption levels of CA practices, 36.4%; 36.4 % and 27.3% had farm size of less than one acre, between one to two acres and above two acres, respectively. However, the differences in adoption levels of CA practices based on total farm size owned by the respondents was found to be statistically significant at p= 0.031. These findings are consistent Adeola (2010) in Ibadan/Ibarapa who found that farmers with small land sizes were likely to adopt new technologies probably for maximum utilization of their small farmlands. Farmers with smaller landholdings are likely to engage in sustainable land husbandry management practices that could increase land productivity. Farmers with larger sizes of land on the other side entertain practicing shifting cultivation when fertility of the piece of land is depleted (Lugandu, 2013).

Table 7: The influence of socio-economic characteristics on adoption of CA practices/ adoption levels of CA practices among smallholder farmers

Attribute	Low		Medium		High		P value
	n	**%**	**n**	**%**	**n**	**%**	
Age of respondents							
≤35	9	45.0	11	30.6	13	29.5	
36 to 45	6	30.0	12	33.3	9	20.5	0.006**
≥46	5	25.0	13	36.1	22	50.0	
	20	**100**	**36**	**100**	**44**	**100**	
Sex of the respondents							
Male	14	70.0	23	63.9	39	88.6	
Female	6	30.0	13	36.1	5	11.4	0.000**
	20	**100**	**36**	**100**	**44**	**100**	
Family size							
≤4 people	13	65.0	21	58.0	23	52.3	
5 to 10 people	7	35.0	14	38.9	21	47.7	0.074ns
≥11 and more people	-	-	1	1.0	-	-	
	20	**100**	**36**	**100**	**44**	**100**	
Education level							
No formal schooling	1	5.0	2	5.6	1	2.3	
Below standard Seven	-	-	-	-	3	6.8	
Completed STD VII	17	85.0	26	72.2	33	75.0	0.007**
Completed Form IV	2	10.0	8	22.2	7	15.9	
	20	**100**	**36**	**100**	**44**	**100**	
Years in farming activities							
≤4 years	5	25.0	6	16.7	7	15.9	
5 to 10 years	4	20.0	16	44.4	12	27.3	0.004**
≥11 and more years	11	55.0	14	38.9	25	56.8	
	20	**100**	**36**	**100**	**44**	**100**	
Income from crop farming 2013/2014							
< 500 000 (Tshs)	20	100	34	94.4	39	93	
500 000 to 1 000 000 (Tshs)	-	-	2	5.6	3	6.8	0.016**
≥1 000 000 (Tshs)	-	-	-	5.6	2	4.5	
	20	**100**	**36**	**100**	**44**	**100**	
Total farm size 2013/2014							
≤ One acre	6	30.0	7	19.4	16	36.4	
One to two acres	10	50.0	18	50.0	16	36.4	0.031**
>Two acres	4	20.0	11	30.6	12	27.3	
	20	**100**	**36**	**100**	**44**	**100**	

4.7.2 The relationship between institutional factors and adoption of CAs

The relationship between institutional factors and adoption level of CAs are shown in Table 8. Out of the 20 respondents who had low adoption level, 70% had no extension agents for advising them on CAs. Of the 36 respondent who had medium adoption level of CA practices, 61.1% had access to agricultural extension service on CAs while among respondents with high adoption level of CAs only 59.1% had extension agents for advising them on recommended practices in CAs. However, the differences in adoption levels of CA practices based on access to agricultural extension services was found to be statistically significant at p= 0.000. The findings are in agreement to Ahmad (2009) in Varamin County, who found that extension services were major source of technical information for farmers and hence increasing adoption. Wanangwa (2013) also found that that households that have access to agricultural extension services have higher probability of adopting CA.

Out of the 20 respondents who had low adoption level, 35% owned land while 65% did not own land where they practiced conservation agriculture. Of the 36 respondent who had medium adoption level of CA practices, 80.6% owned land where they practiced conservation agriculture. The remaining 44 respondents who had high adoption levels of CA practices, 88.6% owned land where they practiced conservation agriculture and the differences in adoption levels of CA practices based on land ownership of the respondents was found to be statistically significant at p= 0.000. The findings are in agreement with Abdulla (2009) who found private land owners were more likely to conserve their land compared to the public managed land. Again, of the 20 respondents who had low adoption level, 55% and 45% indicated that their farm/plots were situated on flat land and on gentle slopes, respectively. Of the 36 respondent who had medium adoption level of CA practices, 11.1%; 77.8% and 11.1% had their farm/plots situated on flat land, on gentle slope and on steep slopes, respectively. Out of the 44 respondents who had high adoption levels of CA practices, 9.1%, 65.9% and 25% had their farm/plots situated on flat land, on gentle slope and on steep slopes, respectively and the differences in adoption levels of CA practices based on where farm/plots are situated was found to be statistically significant at p= 0.000. The findings are similar to Zulu *et al.* (2001) in the agricultural highlands of Uganda who found that based on the location of the plot, farmers perceived use of different practices on their plots differently.

Out of the 20 respondents who had low adoption level, 45% had land conservation bylaws set in their area while 55% did not have bylaws governing land conservation. Of the 36 respondents who had medium adoption level of CA practices, 61.1% said that they had land conservation bylaws in their area and of the respondents who had high adoption level 59.1% said they had bylaws in their area and the differences in adoption levels of CA practices based on presence of land conservation bylaws on the respondent area was found to be statistically significant at p= 0.006. These findings are similar to Kahimba *et al.* (2014) and Shetto *et al.* (2007) in Arusha and Dodoma regions who found that policies and bylaws played a vital role in the adoption and spread of CA technologies.

Table 8: The influence of institutional factors on adoption of CA practices

Attribute	responses	Low		Medium		High		P value
		n	%	n	%	n	%	
Extension services	Yes	6	30.0	22	61.1	26	59.1	
	No	14	70.0	14	38.9	18	40.9	0.000**
	Total	**20**	**100**	**36**	**100**	**44**	**100**	
Own land	Yes	7	35.0	29	80.6	39	88.6	
	No	13	65.0	7	19.4	5	11.4	0.000**
	Total	**20**	**100**	**36**	**100**	44	**100**	
Farm/Plot site	On flat land	11	55.0	4	11.1	4	9.1	
	On gentle slope	9	45.0	28	77.8	29	65.9	0.000**
	On steep slope	--	-	4	11.1	11	25.0	
		20	**100**	**36**	**100**	**44**	**100**	
Presence of	Yes	9	45.0	22	61.1	26	59.1	
Conservation	No	11	55.0	14	38.9	18	40.9	0.006**
bylaws	**Total**	**20**	**100**	**36**	**100**	**44**	**100**	

4.8 The Regression Analysis on Factors Influencing Adoption of CA Practices

The regression analysis on the relationship between socio-economic factors and other institutional factors selected as predictors to the adoption levels of CAs are shown in Table 9. The findings show that there is positive and significant relationship (p=0.002) between age of the respondent and adoption of CAs. The positive relationship implies that farmers who are relatively older and hopefully linked to their experience had a tendency of adopting and practicing CAs. This finding is similar to Wanagwa (2013) in Nkhotakota, Malawi, who reported that the age of the farmer usually reflect experience in farming held by the farmer and thus increasing or decreasing the probability of adopting the CA technology.

The findings show that there is positive relationship between sex of the respondent and adoption of CAs implying that female respondents tended to adopt more the CAs compared to male farmers as most of the farming activities in rural areas of Tanzania are conducted by females, however the relationship between sex of the respondent and adoption of the CAs was not statistically significant (p=0.122). The findings are in supported by Lugandu (2013) in Karatu and Kongwa districts of Tanzania who found no significant statistical difference between male or female respondents in adopting CAs.

The findings also show that there is negative relationship between family size and adoption of CAs implying failure of households with smaller family size to adopt CAs probably due to the fact that most CA practices are labour intensive and hence such smaller family size were unable to provide enough labour and hence reducing chances of them adopting CAs and the relationship between family size and adoption of CAs was found to be statistically significant at p= 0.010. This finding is similar to Lugandu (2013) in Karatu and Kongwa districts of Tanzania who found that the family size influenced adoption of CAs with non-adopters having relatively smaller family size implying that the source of labour for the smaller household sizes is limited hence impacting on adoption of CAs.

The findings show that there is negative relationship between adoption of CAs and respondents' level of education implying that respondents who had less formal education and who were the main occupants in rural areas were more likely adopting CAs but the relationship between adoption level and education levels of the respondents was not statistically significant (p=0.269). The findings are in agreement with Dass (2013) in Bangladesh who found that farmers who had a standard level of education were likely to decide to adopt CA. The findings show that there is positive relationship between farming experience and adoption of CAs implying that experienced farmers who had also experienced some negative effects of wrong agricultural practices were more likely willing to adopt the recommended CAs to revive their productivity levels and the relationship between farming experience and adoption of CAs was not statistically significant (p=0.098). The positive relationship implies that households who had been involved in farming activities for many years gain high experience in farming practices a result it is also being reflected in adoption of CAs on their farms. The findings are in agreement Ahmad (2009) in Varamin County, who reported that years of farming was reflected in levels of adoption among farmers who applied conservation practices effectively.

The findings show that there is positive and significant relationship (p=0.018) between income earned from crop farming by the respondents and adoption of CAs. The positive relationship implies that income earned from crop farming by adopters/ famers were motivating them to apply or adopt more CAs on their fields. The findings are in agreement with Corbeelsa *et al.* (2013) in Africa who found that earnings from cropping were a reflection of applying CA compared to non-CA fields. The findings show that there is negative relationship between farm size and adoption of conservation agriculture practices implying that smaller farm/plots under crop farming increased the possibility of smallholder farmers to adopt CAs and the relationship between farm size and adoption of CAs was statistically significant at p= 0.005. The findings are in similar to Ngwira (2014) who argued that the total cultivated land influenced adoption and extent of CA applications.

The findings show that there is positive and significant relationship (p=0.030) between access to extension services and adoption of CAs. The positive relationship implies that farmers who had access to agricultural extension service on recommended practices in CA may get courage to adopt and continuously apply CAs. The findings are in agreement with Ahmad (2009) in Varamin County who found that there was a positive correlation between availability of extension agents and level of adoption as the change agents attempt to create and maintain positive viewpoint among farmers and influencing the adoption level of conservation practices. Extension service is a major source of technical information for farmers therefore contact or proximity to extension agents increases adoption.

The findings show that there is positive relationship between ownership of land and adoption of CAs as a privately owned land could influence one to adopt the technologies as some CAs are long term and impacts are realized after sometimes making those who rent land to get discouraged to adopt such CA practices that could take long to realize impact on productivity and the relationship between land ownership and adoption of CAs was not statistically significant (p=0.116). The findings are in agreement with Ahmad (2009) in Varamin County who found that ownership is significantly related to use of profitable practices. The findings show that there is a positive and significant relationship (p=0.000) between farm/plots locations and adoption of CAs. The positive relationship implies farm/plots located on steep slopes influenced farmers to adopt CAs to protect the soils and improve crop productivity.

The findings are also in agreement with Tumbo *et al*. (2012) in Tanzania who found that the number of farmers adopting different CA techniques varied from place to place depending on biophysical and physiographic characteristics of the farm areas. The findings also show that there is positive and significant relationship (p=0.000) between presence of land conservation bylaws and adoption of CAs. The positive relationship implies that land conservation bylaws made majority of respondents to abide to the set bylaws and hence influencing adoption of CAs. The findings are in agreement with Owenya *et al*. (2012) in Karatu District, Tanzania who found that CA adoption has been successful because of the efforts of the government, NGOs and international institutions to create an enabling environment for smallholder farmers, including overcoming conflict on crop residue use by training smallholders on livestock management and enforcement of bylaws protecting land from grazing.

Table 9: The relationship of socio-economic characteristics and adoption levels of CA practices

Attribute	Unstandardized Coefficients		Standardized Coefficients		p-value
	β	Std. Error	Beta	t	
Constant	0.426	0.356	0.023	4.211	2.11
Age of the respondent	0.632	0.329	1.002	3.202	0.002**
Sex of the respondent	0.086	0.056	0.096	1.551	0.122ns
Family size	-0.253	0.097	-.142	-2.601	0.010**
Education level	-0.086	0.077	-.058	-1.108	0.269^{ns}
Farming experience(years)	0.115	0.069	.090	1.662	0.098^{ns}
Income level	0.149	0.063	-.148	-2.380	0.018**
Farm size	-0.314	0.110	.144	2.858	0.005**
Access extension service	0.111	0.051	-.109	-2.179	0.030**
Land ownership	0.136	0.086	0.089	1.579	0.116^{ns}
Plot site	0.405	0.101	0.230	4.001	0.000**
Presence of bylaws	0.515	0.079	0.393	6.498	0.000**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the study it can be concluded that;

i. Smallholder farmers were knowledgeable on the different CAs that are promoted in the Uluguru mountains

ii. A number of CAPs introduced are adopted by respondents of different socio-economic categories and they include contour strip cropping, mulching, leaving crop residues on fields, intercropping, crop rotations, direct planting of crop seeds on the rip line, cover crops, minimum tillage, No burning of crop residues/No bush fire and agro-forestry.

iii. Some CAs were not adopted by smallholder farmers due to the fact that were expensive to apply, never been trained, not well understood, difficult to use, consumes time in application.

iv. Majority of smallholder farmers applied contour strips on farm, planting trees, terracing on slopes, leaving crop residues on farm, no bush fires/ burn crop residues, and practice zero grazing.

v. Generally age, family size, income, farm size, availability of extension services, location of plot and presence of bylaws highly influenced adoption of CAPs among smallholder farmers.

5.2 Recommendations

Based on the above conclusions, the following recommendations are made;

i. Extension agents in the study area should intensify promoting more adoption of the CAPs that are generally accepted and practiced by the smallholder farmers.

ii. Study need to be carried out to ascertain reasons behind unacceptability by smallholder farmers on some of the CAPs among smallholder farmers in the study area.

iii. Extension agents should encourage proper use of CAPS that are cost effective and train farmers on reducing costs of using some of the practices.

iv. The local government authorities and NGOs working in areas that are prone to soil fertility losses should introduce programmes that will train and promote CAs to adopted by farmers and improve productivity.

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APPENDICES

Appendix 1: Smallholder Respondent's Questionnaire

Smallholder Respondent's Questionnaire

Title: Adoption of Conservation Agricultural Practices among smallholder farmers: A case study of Uluguru Mountains; Morogoro District

Ward…………………….............................Village…...……………………..……..………

Name of the interviewer…………..…………..Date of interview…….......……………......…

SECTION A: Respondent's general information

1. Age of the respondent….……… (Years)

2. Sex of the household head/ farmer [Tick] 1.Male ( ) 2.Female ( )

3. What is your marital status1 (tick one) (a). Married ( ) (b). Never married ( )
   (c). Widowed ( ) (d).Divorced ( ) (e). Separated ( )

4(a).What is your family size……… (Number)
   (b).How many are working on farm…………………(number)

5. What is your highest level of education? (Tick one)(a) No formal schooling ( )
   (b) Below standard seven ( ) (c) Finished standard seven education ( ) (d) Finished "O" Level Secondary education ( )(e) Finished "A" Level secondary education ( ) (f) Vocational training ( ) (g) Graduate ( ) (h) College

6. For how long have you been involved in farming activities? …………...... (Years)

7. What is your other source of income apart from farming? (Tick that apply)
   (a) Salaried employment ( ) (b) Informal business ( )(c) Livestock Keeping
   (d) Casual labour (e) other specify…………………………………………..

8. How much income do you get from crop farming in 2013/14...............................? (Tshs)

11. What was your total farm size under crop farming in 2013/14...................................? (Acres)

12. Do you have an extension agent advising you on recommended practices in Conservation agriculture? 1. Yes ( ) 0. No ( )

13. If answered yes, in Qn.12, how often do you receive advice from this extension agent? (Tick one),(a) Once in a month ( ) (b) Once in a production season ( ) (c) Frequently ( )

(d) Others, specify ……………………...............................………………………..

15. Do you own land where you practice Conservation Agriculture?

1. Yes ( ) 0.No ( )

16.If answered Yes in Qn15, what is the ownership of the land where you practice Conservation agriculture? (Tick one) (a) Family land ( ) (b) Rented ( ) (c) Purchased ( ) (d) Inherited ( ) (d) others, specify………………………....................……

16. What is your farm/plot situated? (a) On flat land ( ) (b) on gentle slope ( ) (c) On steep slope ( ) (d) Other specify ....

17. Do you have land Conservation Bylaws in your village?

18. If answered yes, in Qn.20, what type of Conservation Bylaws are imposed in your village?

(a)...

(b)...

(c)...

SECTION B: Attitude towards CA practices among smallholder farmer

19. Indicate by putting a tick on appropriate answers on the corresponding box on the following

Attitude towards Conservation agricultural practices	**I accept**	**Neutral**	**Not accept**
Conservation agriculture improves soil structure, protects the soil from erosion and nutrients losses			
No till operations under CA reduces no. of labourers			
Crop residues on the soil surface enhance water holding capacity			
Mulches protect soil from extreme temperatures and reduce surface evaporation			
Conservation agriculture increases crop yield			
No till agriculture findings in fewer greenhouse gases into atmosphere and cleaner air			
Agro forestry protects soil from erosion			
Direct planting of crop seeds on the rip line increases yield crop and maintain soil disturbance			
Crop rotations breaks disease cycles on my field			
Manure during the appropriate time fertile the soil			
No burning of crop residues protect soil from sun, rain, wind and to feed soil organisms			
Conservation tillage/reduced tillage protects soil surface			
Cover crops protects soil from moisture and limited weed growth			

SECTION C: smallholder farmers' knowledge levels and use/adoption of Conservation Agricultural Practices in Uluguru Mountains

20. Indicate by putting a (tick/x) on appropriate answers on each the corresponding box on the following

Conservation Agricultural Practices	**Trained**	**Understand**	**Use**
Conservation Agricultural Practices			
Contour farming for conservation agriculture			
Mulch			
Cover crops			
Agro-forestry			
Crop rotations			
Manure on my field			
Direct planting of crop seeds on the rip line			
Leave crop residues			
Applying manure during the appropriate time			
Do not burn crop residue/plough under crop residues			
No-till/ zero till on my farm			
Conservation tillage/reduced tillage			

22. If you do not practice Conservation agriculture on your farm, what made you not to practice? (Put a tick)

1. Difficult to use ( ) 2. Influenced by others ( ) 3.Expensive ( ) 4. Other specify...

23. What kind of a cropping system do you use on your farm?

1. Intercropping irrigated farming system ( ) 2. Rain fed intercropping farming system ( )

3. Mono cropping irrigated farming system ( ) 4. Rain fed monocropping system

THANK YOU

Appendix 2: Checklist for key informants (extension officers/ward agricultural officers and NGOs)

Title: Adoption of conservation agriculture practices among smallholder farmers: A case study of Uluguru Mountains; Morogoro District.

Division…………………………………………………………………………........

Sex: males………………..females……………………..……

Ward…………………………………Village name……………………......................

1. Are CA practices introduced in your area?
2. Were the farmers trained on CA practices introduced/promoted in your area?
3. Which year CA practices introduced in your area?
4. How many smallholder farmers trained on CA practices?
5. Which CA practices have been introduced in your area?
6. How many smallholder farmers are practicing CA on their farms?
7. What is the problem hindering implementation of CA technologies in your area?
8. Do you think CAs help to reduce soil loss in your area?
9. Do you think agriculture conservation practices help to control soil erosion?
10. Which CA practices are commonly used by farmers in the study area?
11. What are the benefits of CA on your area?

THANK YOU