FACTORS INFLUENCING ADOPTION OF CONSERVATION AGRICULTURE IN SOUTH ULUGURU MOUNTAINS IN MOROGORO REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ARTS IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE.

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ABSTRACT

The study was conducted in two wards Kolero and Kasanga of South Uluguru Mountains in Morogoro Region to assess factors influencing adoption of conservation agriculture. In this study the level of adoption was assessed, contribution of conservation agriculture in agricultural productivity was identified; and the influence of socio-economic factors and institution factors in adopting conservation agriculture were identified. The methodology involved a cross-sectional research design with sample size of 120 farmers from both adopters and non adopters. Purposive sampling technique was employed to select key informants in the two wards of Kolero and Kasanga. Random sampling was used to select four villages of Kasanga, Kolero, Kitonga and Lubasazi. The main methods of data collection used were structured questionnaires, personal observation, focus group discussion and interview. Descriptive and inferential statistical analyses were undertaken for quantitative data analysis using Statistical Package for Social Sciences. Binary logistic regression analysis was used to analyze the factors affecting adoption of conservation agriculture. The findings show that farmers who adopted conservation agriculture were 67% while 33% did not. The results obtained from T test showed that there was significance influence ($p<0.05$) of maize yield before and after the adoption of conservation agriculture. The factors that significantly ($p<0.05$) affected the adoption of conservation agriculture were sex, level of income of farmers and land ownership. It is concluded that the rate of farmers who adopted conservation agriculture is still low. Hence it is recommended that policy makers should work on the factors that significantly influence adoption of conservation agriculture in order to encourage farmers to adopt it

DECLARATION

I **MAMKWE LILACK GILBERT,** 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

_____ _____

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The above declaration is confirmed

_____ _____

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(Supervisor)

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LIST OF ABBREVIATIONS AND ACRONYMS

ACT	African Conservation Tillage
AGRA	Alliance for a Green Revolution in Africa
CA	Conservation Agriculture
CARE	Cooperative for America Relief Everywhere
CARMATEC	Centre for Agricultural Mechanization and Rural
CASARD	Conservation Agriculture and Sustainable Agriculture and Rural Development
FAO	Food And Agriculture Organisation
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HICAP	Hillside Conservation Agriculture Project
RECODA	Research Community and Organizational Development Associates
RELMA	Regional Land Management Agency
SARI	Sellian Agricultural research institute
SCAPA	Soil Conservation and Agroforestry Programme in Arusha Technology
TEMDO	Tanzania Engineering and Manufacturing Design Organization
TFSC	Tanzania Farmers Service Centre Ltd
UM	Uluguru Mountains

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Conservation agriculture (CA) emerged as an alternative to conventional agriculture as a result of losses in soil productivity due to soil degradation (FAO, 2001). Techniques involved include zero-tillage, mulching, mixed cropping, crop rotation, and Integrated Pest Management (IPM) using botanicals rather than chemical pesticides. Studies which were conducted in relation to CA practices indicated that, it is cost effective in terms of labour and time and requires minimum inputs unlike other types of agricultural production activities that are labour intensive and demand more inputs (FAO, 2008). In many parts of the world, CA practices have been widely adopted by farmers (ICRAF and ACT, 2006). The most extensive adoption is found in the southern cone of Latin America, especially in Argentina, Brazil and Paraguay, and in North America and Australia and later on spread to other countries such as Eastern Europe and East Asia (Rockstrom *et al.*, 2009). Presently, 95 million hectares in the world are under CA (ICRAF and ACT 2006). For the last decade many African countries, have been exposed to no-tillage systems and CA, for example South Africa, Kenya, Tanzania, Zambia, Zimbabwe, Lesotho, Swaziland, Mozambique and Malawi (FAO, 2008).

In Tanzania agriculture is the leading sector of the economy, accounting for about half of both the gross domestic product (GDP) and merchandise exports (URT, 2001). About 80% of the total populations who live in rural and peri-urban areas depend on agriculture for their livelihoods (URT, 2003, 2001). Low and generally declining soil fertility, soil and water loss through erosion, and erratic and unreliable rainfall are key factors constraining crop production (Shetto and Owenya, 2007). Conventional farming practices such as

burning or removing crop residue and intensive tillage often make these problems worse (Shetto and Owenya, 2007). Therefore CA was introduced in some districts such as Karatu, Babati, Morogoro, Arumeru, Kilimanjaro, Mbulu, Njombe and Mbeya to improve agricultural productivity.

In Uluguru Mountains there are several initiatives which have been under taken by the government, NGOs and donor partners to conserve and protect the land. Such initiatives were Uluguru Land Usage Scheme (ULUSU) which was initiated in 1947 (Maack, 1996). Also Uluguru Slopes Planning project (USPP), Uluguru Mountains Agricultural Development Project (UMADEP), and Catchment Forest Project (CFP) (World Bank 1992). In February 2009 CA was introduced in South Uluguru Mountains under Hillside Conservation Agriculture for Improved Livelihoods in the South Uluguru, Tanzania (HICAP). The prime objective is sustaining and enhancing the livelihoods of smallholder farmers through improving family food security, better resource conservation, and development of gender-sensitive essential support services CARE (2009). This study therefore aimed to investigate factors influencing adoption of CA in South Uluguru Mountains.

1.2 Problem Statement and Justification

Low and generally declining soil fertility, soil and water loss through erosion, and erratic unreliable rainfall and the use of conventional farming practices, in which crop residues are burned or removed, shifting cultivation and intensive tillage are key factors constraining crop production (Shetto and Owenya, 2007). CA practice has a potential to improve productivity through its three principles of zero tillage, crop rotation and soil cover. CA has been found to be profitable in terms of resource use, labour saving, environmental conservation, cost effectiveness, sustainable soil fertility and increasing

profit margin of farmers, unlike other types of agricultural production activities that are labour intensive and demand more inputs (Baron *et al.*, 2003; Rostorm *et al*., 2009; Shetto and Owenya, 2007). Despite all visible effects of CA its adoption in many parts of Tanzania like Karatu, Mbeya, Babati, Arumeru is generally low (Shetto and Owenya, 2007; CARE, 2008). Besides there is little empirical studies on factors that influence farmers to adopt CA. Therefore this study intended to investigate factors influencing adoption of CA in South Uluguru Mountains. The study will be important for policy makers, extension officers, individual farmers and for will provide supplement information to those who may wish to conduct similar studies. In addition it bears a direct relevance to the Millennium Development Goals 1 (MDG1) and 1996 World Food Summits, to reduce half of the proportion and number of people suffering from hunger and malnutrition by 2015 (URT, 2011). The study is in line with (NSGRP) cluster II aiming at poverty alleviation and improving the quality of life and social wellbeing of the people (URT, 2011).

1.3 Objectives

1.3.1 The overall objective

The overall objective of this study was to investigate factors that influence farmers to adopt CA in South Uluguru Mountain.

1.3.2 The specific objectives

The specific objectives were:

i. To examine the level of adoption of CA among farmers in south Uluguru Mountains,

ii. To determine the contribution of CA on agricultural productivity among farmers in South Uluguru Mountains, and

iii. To evaluate socio-economic factors and institution factors that affect adoption CA in South Uluguru Mountains.

1.4 Research Questions

The research questions were:

i. What is the extent of use of CA in the study area?

ii. What are the most important socio-economic and institutional factors that affect farmers' decision to adopt CA?

iii. If CA techniques have been adopted by farmers did they increase their agricultural productivity?

1.5 Hypotheses

Ho**:** Adoption of CA is not significantly influenced by socio-economic and institutional factors in South Uluguru Mountains.

1.6 Significance of the Study

This study will raise awareness among stakeholders especially policy makers and implementers on the factors that influence adoption conservation agriculture and be able to design policies or strategies that enhance adoption of CA. Also the study will raise awareness among farmers on contribution of CA in agricultural productivity that it may encourage them to practice CA.

1.7 Organization of the Dissertation

This study is structured into five chapters. Chapter one presents background information, problem statement and justification, objective of the study the overall objective and specific objectives, hypothesis, research questions, significance of the study and the

organization of the dissertation. Chapter two presents literature review which reviewed the following origin of CA, the situational analysis of CA, research and initiatives conducted in promoting CA, factors influencing adoption of CA and lastly conceptualization and theorization of CA. Chapter presents methodology part which contains conceptual framework, description of the study area, land tenure practiced in South Uluguru Mountains, justification of the study area, research design, sampling procedure, data collection and processing and lastly limitation of the study. Chapter four presents results and discussion and the final chapter which is chapter five presents conclusion and recommendation

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Origin of Conservation Agriculture (CA)

At the beginning CA was developed as natural resource saving practice (Berger *at al.,* 2008). The development of conservation tillage began in the USA in 1935 as a result of the dust bowl which devastated large areas of the USA in 1930s, the principle objective of was to retain a cover by crop residue on at least 30% of the soil surface, and protect soil from wind erosion (Berger *et al.,* 2008). Zero tillage was introduced in Brazil in the early 1970s, mainly as an answer to severe water erosion problems (Derpsch, 2001). In the hilly part of southern Brazil, water erosion was leading to disastrous loss of soil and severe degradation of farmland, in response to these problems a new kind of agriculture has been developed without any mechanical soil movement (zero tillage and direct seeding) and the use of cover crops and crop rotation (Derpsch, 2001). The initial zero tillage came from USA, it was converted to more complete approach called CA in Brazil (Berger *et al.,* 2008).

CA is practiced worldwide on more than 100 million ha with exponential growth rates. The area cultivated under CA more than doubled between 1999 (45.5 million ha) and 2005 (95 million ha) (Derpsch, 2005). The countries under biggest area under no-tillage are USA, followed by Brazil, Argentina, Australia and Paraguay (Derpsch, 2005), however, the highest rates of adoption and best quality of CA are concentrated in Latin America. Despite good and long lasting research in these continents showing positive results for no-tillage systems, CA has experienced only small rates of adoption in Africa (Kassama *et al.,* 2010).

Table 1: Extent of CA adoption worldwide

Country area	Under no-tillage ha 2004/2005
USA	25 304 000
Brazil	23 600 000
Argentina	18 269 000
Canada	12 269 000
Australia	9 000 000
Indo-gangetic plns	1 900 000
Paraguay	1 700 000
Bolivia	550 000
South Africa	300 000
Spain	300 000
Venezuela	300 000
Uruguay	263 000
France	150 000
Chile	120 000
Columbia	102 000
China	100 000
Other	1 000 000
Total	98 480 000

Source: Derpsch, 2005

2.2 The Situational Analysis of CA in Tanzania

In Tanzania, the practice of conservation agriculture is not a new practice, as some of the principles such as accumulation of crop residues on soil surface; minimum soil disturbance, crop rotation and mulching were practiced although not on a large scale (Mutunga, *et al.,* 2001). However, according to Shetto and Owenya (2007), increased livestock and human activities has led to collapse of the conventional soil, conservation system and increased land degradation. The same source argued that in the late 1980s the government initiated programmes to address the situation, most aimed at combating land degradation through mechanical and biological measures which included; reforestation

activities, agro forestry, protection of water catchments, improved land husbandry and environmental conservation in general. Other measures including fallowing that involves planting of selected fast growing trees and shrubs, usually leguminous species to improve soil fertility through Biological Nitrogen Fixation it has long been practiced by Chagga people (Fernandes *et al.,* 1981). Fallowing 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 (Fernandes *et al.,* 1981). 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 (Jonsson *et al.,* 2000; Elwell *et al.,* 2000).

2.3 Initiatives and Research Conducted in Promoting Conservation Agriculture

2.3.1 Selian agricultural research institute

The Selian Agricultural Research Institute (SARI) is one of the biggest Agricultural Research Institute (ARI) in Tanzania pioneering CA. Its objective is to attain sustainable household and community food security. It focuses on crops, soils and livestock. SARI has several on-farm trials in Arumeru District, including integrated soil fertility management, zero-grazing and agro forestry. It conducts on station trials, which many farmers visit during field days. Some of the demonstration plots include sub soiling, cover crops, and crop rotation. The institute is also a resource centre for agricultural information. SARI has been involved with CA since 1999, developing no tilling, intercropping, and soil cover. Similarly, SARI has been able to distribute cover crop seeds to farmers and conservation agriculture projects and is accelerating the use of cover crops in Babati (Shetto and Owenya, 2007).

2.3.2 Soil Conservation and Agro forestry programme in Arusha

The Soil Conservation and Agro forestry Programme in Arusha (SCAPA) is a community land-management programme, operating since 1989. In 1989, it was observed that in various agro ecological zones, crops and fodder had stunted growth, low productivity and sensitivity to even short dry spells. The roots of pigeon pea, shrubs and fodder crops revealed serious restriction from hardpan 10–12 cm below the surface. The hardpan was caused by mechanized hoe and ploughing. SCAPA entered into partnership with Regional Land Management Agency (RELMA) and started introducing, testing and designing conservation tillage with farmers in 1998. Contour construction was undertaken by the new partnership. Later, it was apparent that poor infiltration of rainwater into the soil led to high runoff between the *fanya chini* terraces. Reduced tillage techniques, rippers and sub soil, were introduced with complementary soil conservation measures and agro forestry. The aim was to have a long-term improvement in crop yields and land productivity. The programme had on-farm trial plots to test and develop, with farmers, conservation tillage under varying rainfall, soils, slope and use of farm machinery.

2.3.3 Research, community and organizational development associates

In 2003, Research, Community and Organizational Development Associates (RECODA) introduced diversified crops, reduced tilling, and cover crops. At the same time conservation agriculture was introduced to reduce soil erosion, conserve soil moisture and restore soil organic matter (RECODA, 2005). The organization introduced fodder crops and are planted them along the contours lablab, mucuna and improved pigeon pea and breaking compacted soil with rippers. Banana leaf mulch, made from leaves a are used for livestock feed, balancing the needs of both livestock and the soil.

2.3.4 Conservation agriculture for sustainable agriculture and rural development in Southern and Eastern Africa

Conservation Agriculture and Sustainable Agriculture and Rural Development (CASARD) are regional projects in East Africa, with technical support by FAO, to facilitate and accelerate profitable conservation agriculture by small-scale farmers in Arumeru, Bukoba and Karatu Districts in Tanzania. It mainly uses Farmer Field Schools (FFS), which emphasize farmer-created techniques. The farmer group receives supplies and equipment from the project maize, pigeon pea, and lablab seeds, disease control chemicals, jab planters, and no-till direct planter. The goal is to increase water infiltration, soil moisture, soil organic matter, and to reduce pests, diseases and soil inversion (Shetto and Owenya, 2007).

2.3.5 International maize and wheat improvement centre

The CA maize project of CIMMYT, the International Maize and Wheat Improvement Centre, started in Mareu village in Arumeru. The project started in Mareu as a pilot; five farmers were selected after a village meeting in October 2004. The farmers did ripping and maize intercropped with lablab, beans and sunflower or either of the two. At farmers' request a research trial on controlling insect pests in lablab was started in 2006 at SARI and Mareu. The initial data and field observations from SARI in July 2006 showed pod production was higher where lablab was treated with neem oil or Karate insecticide. Lablab recovers its canopy quickly and insect pests do not affect the biomass required for soil cover (Shetto and Owenya, 2007).

2.3.6 Nandra engineering: manufacture of ca equipments in Tanzania

Nandra Engineering Ltd is a private agricultural implement designer and manufacturer. Nandra manufactures CA equipments such as animal-drawn rippers and spare parts for

rippers and tractors on request. Nandra was selected to produce and distribute implements through the Tanganyika Farmers Association (TFA). The company makes animal-drawn rippers, ripper planters, chisel ploughs, weeders and cultivators and ox carts (Shetto and Owenya, 2007).

2.3.7 Tanzania engineering and manufacturing design organization and centre for agricultural mechanization and rural technology

The Tanzania Engineering and Manufacturing Design Organization (TEMDO) and the Centre for Agricultural Mechanization and Rural Technology (CARMATEC) are public agricultural implement designers and manufacturers. Providing the agricultural sector with skilled engineers and machines, they can design and manufacture many agricultural implements. TEMDO is an applied engineering research and development institute that designs and manufactures manual and engine-driven postharvest equipment. It produced 10 rippers and sub soilers for SCAPA while CARMATEC in Arusha deals in animal-drawn rippers and mould board ploughs. It made more than 150 jab planters (Bishop-Sambrook, 2004).

2.3.8 Tanzania farmers service centre

Incorporated in the 1990s, Tanzania Farmers Service Centre Ltd (TFSC) is a private company that provides small and medium scale farmers with agricultural services. It sells agricultural machinery, provides workshops on equipment repair and hires out machinery. The organization also holds workshops and courses on sustainable agriculture, using agricultural machinery and efficient crop production. It provides machinery for demonstration trials, seeds and expert support for CA. In 1999, TFSC started on-farm trials with CA, mainly in cover crops combined with direct planting, using hand and animal-drawn seeders. It was also contracted with SARI to conduct the on-farm field days

and training workshops, which were technically and financially supported by the German Development Bank and GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). In Arusha in 2003, the centre organized the first national workshop on CA (interview with TFSC manager) (Shetto and Owenya, 2007).

2.4 Factors Influencing Adoption of CA

Factors that Influence the adoption of CA included both farm and farmer characteristics. These factors in other literature have been identified as institutional, physical, personal and socio-economic factors. These include:

2.4.1 Socio-economic factors

2.4.1.1 Farmer's age

Age is an important factor that influences the probability of adoption of new technologies because it is said to be a primary latent characteristic in adoption decisions (Akudugu *et al*., 2012). Farmer's age has the expected negative and significant influence on the chances of farmers participating in adopting innovation like Conservation farming (Amir, 2006). The negative sign for the age variable could be understood from the commonly observed negative correlation between the age and adoption decision for most technologies in dynamic economic environments, in other words, younger farmers tend to be more willing to adopt than their older counterparts (Amir, 2006). On top of that, older farmers tend to be risk adverse and may avoid innovations in an attempt to avoid risk associated with the initiative, furthermore being older creates a conservative feeling among farmers and hence resistance to change. On the other hand older farmers with farm experience are more likely to practice all CA technologies; they are expected to use their farming experience to decide to adopt new technology (Mazvimavi *et al.,* 2009). In Karatu District many youths (18–30 years) and some people 40–50 years were ready to

adopt conservation agriculture technologies, youths were eager because they are more business minded, However, lack of capital has prevented many from adopting them, some youths don't have their own land or they have only a small area obtained from the parents; hence they are not motivated to invest in agriculture (Shetto and Owenya, 2007).

2.4.1.2 Farm size

Farm size influence farmer's participation in conservation farming thus inadequate farm size can affect farmer's decision of adopting CA (Feder *et al.,* 1985). Farmers with large arable land have the opportunity to spare some sections to try out new practices at less risk. Large land size also implies that farmers can diversify into other crops and reduce the inherent risk in agricultural production (Perseverance *et al*., 2012). A study by Gabre-Madhin and Haggblade (2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than smallholders in Kenya. Large farm size also gives a farmer the capacity to use land intensive conservation practices (elements) such as improved fallow and crop rotation (Thangata *et al*., 2002). Large-scale farmers e.g. Msituni Catholic Church Farm in Karatu District were ready to take up such innovations as sub soiling, and in fact, they were not waiting for external encouragement (Shetto and Owenya, 2007).

2.4.1.3 Household size

Household size has been linked to the availability of own/family farm labor in adoption studies (Amsalu and De Jan, 2007). The argument is that larger households have an importance in the determinant of the availability labour required during the introduction of new technologies (Woziniak, 1984). It is expected that a larger household size will influence the decision of acceptance because of the availability of labour required during the adoption process; hence household size increases the chance of farmers to adopt CA

(Woziniak, 1984). Labour constrains can affect the decision of farmers to adopt conservation farming (Feder *et al.,* 1985).

2.4.1.4 Education

Education is a major factor that can influence the adoption of any innovation. Through education Norman (2005) claims that farmers may know the rationale for managing land through better farming practices and other social economic factors. The farmer's education background is an important factor that determining the readiness to accept and properly apply technologies (Swamson *et al.,* 1984). In Tanzania most farmers have low formal education and they mostly use traditional farming practices, the more complex the technology to be utilized the more likely it is the education will play the major role (CIMMYT, 1993).

2.4.1.5 Perception of the farmer

Perception of the farmer plays an important role in the decision of adopting conservation agriculture. It is expected that farmers who would view such initiatives as important would accept the project at a larger extent. The possible explanation here is that farmers who perceive this innovation as beneficial to them would adopt the CA more than those whose their perception is negative or indifferent (Ayuya *et al.,* 2011).

2.4.1.6 Household income

Household income plays a role of financing the uptake of new innovation. Serman and Filson (1999) argued that high farm income improves the capacity to adopt agricultural innovations as they have the necessary capital to start the innovation. The influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new innovation (Amsalu and De Jan, 2007).

High income has a positive influence on the initial stages of trial of innovations as the wealth allows the farmer to invest a relative small proportion if their income into an uncertain enterprise (FAO, 2003). Wealthier farmers may be the first to try new technology especially if it involves purchased inputs because they are more able to take risk that is farmers who do not utilize new technology may complain the lack of cash as the principle factor limiting their utilization (CIMMTY, 1993).

2.4.1.7 Gender

Gender is also hypothesized to influence adoption. It is often that women are forgotten a lot in the case of technology adoption and transfer (CIMMYT, 1993). This is reinforced by the cultural system which requires women to remain at home while husbands attend seminars, and yet do not always teach the women what they have learnt in the extension meetings (Morris, 1991). Women also do not have accessibility to the key productive resources of land, labor and capital, as well as being under privileged in education and knowledge (Morris, 1991; Mazvimavi *et al.,* 2009).

2.4.1.8 Land tenure system

According to Adjei *et al. (*2003) the settlement of farmers at one place has an important implication on access or control of resources and long term investment on the farm, a migrant with short stay on the land will be unwilling to invest capital and labour in practices of which the effects can only be realized after the period of time that is farmers are not likely to invest to a land of which long term access is not secured. The hired land especially when it is rented for 2-3 years is the constraining factor for adoption of CA because the landlords might need the land back when the soil fertility has distinctly improved and crop production has increased (Adjei *et al.,* 2003).

2.4.2 Institutional factors

2.4.2.1 Access to credit and inputs

Access to credit is an important factor in acquiring basic inputs required for adoption of conservation farming (Feder *et al*., 1985). Credit was identified as a major factor affecting adoption for new hybrid rice technologies in Thailand (Ruttan and Thirtle, 1987). The CA techniques involve purchase of new equipments necessary for direct planting such as fertilizer and other agrochemicals, the high cost of farming inputs has a significant impact on cash demand of farmers during the farming season (Adjei *et al.*, 2003).

2.4.2.2 Extension Services

Extension is regarded as a process of integrating indigenous and derived knowledge, attitudes and skills determined assistance available to overcome particular obstacle (FAO, 2004). An extension agent's role is to provide smallholder farmer with the necessary agricultural and livestock production knowledge and skill that enable them to make rational production decision, for increasing production that ultimately improves their socio-economic status (Mlonzi, 2005). The same source also claimed that the level of adoption of improved agricultural technologies and practices is clearly related to the quality of extension workers. Baidu-forson (1999) found that adoption rate of farmers who having contact with extension agents working on agro forestry technologies was higher compared to farmers who have never contact any extension agent. An effective extension system should be able to identify farmer needs and problems to determine the best possible solution (Mattee, 1994).

2.4.2.3 Availability of market and transportation

Market and means of transport are also important factors that encouraging adoption. Millar and Tolley (1989), cited by Howel *et al*. (2012) found that market interventions such as price supports can speed up the adoption of new technologies. Market access plays an increasingly important role in the determination of adoption. Available market for agriculture produce means of farmers to sell their products thus will increase adoption (Heisey *at al*., 1998) cited by (Chum, 2009). It is agreed that agriculture development needs good infrastructure.

2.5 Conceptualization and Theorization of CA

2.5.1 Conservation agriculture

CA is any soil management system that leaves the soil surface less exposed to erosion and conserve soil moisture, based on three agronomic principles; minimal soil disturbance, permanent soil cover and crop rotations (FAO, 2001). The first and second principles of improving soil fertility, organic matter content and rain water infiltration especially in the 0 to 20 cm top layer help in increasing crop production while crop rotation reduces the necessity of pesticides and herbicides in the long run (Derpsch, 2005). According to Hobbs (2006), Hobbs *et al*. (2006) and FAO (2001) CA is a technology that conserves, improves and efficiently utilizes resources through integrated management of available resources combined with external inputs. The technology is variously known as conservation tillage, no tillage, and zero-tillage; direct seeding/planting and crop residue mulching (Nkala *et al.*, 2011). The impacts of CA have been markedly positive both in agricultural, environmental, economic and social terms it is also often stated to be labour-saving and presented as a potential solution to farm power shortages (FAO, 2006).

2.5.2 Principles of conservation agriculture

According to CARE (2008), CA encompasses a set of complementary agricultural practices based on three principles of minimal soil disturbance, permanent soil cover and diversified crop rotation.

2.5.2.1 Minimal soil disturbance

Minimum soil disturbance refers to low disturbance no-tillage and direct seeding, the disturbed area must be less than 15 cm wide or less than 25% of the cropped area (whichever is lower), therefore there should be no periodic tillage that disturbs a greater area than the aforementioned limits (FAO, 2001; Berger *et al.*, 2008). Strip tillage is allowed if the disturbed area is less than the set limits, land preparation for seeding or planting under no-tillage involves slashing or rolling the weeds, previous crop residues or cover crops, or spraying herbicides for weed control, and seeding directly through the mulch (FAO, 2011).

2.5.2.2 Permanent soil cover

Permanent soil covers protects the soil from rain, sun, and wind, it reduces soil erosion and protects the fertile topsoil, so preventing the silting of rivers and lakes and stops the soil surface from sealing, reduces the amount of precious rainwater that runs off (FAO, 2001). It suppresses weeds by smothering their growth and reducing the number of weed seeds, this reduces the amount of work needed for weeding, also it increases the soil fertility and the organic matter content of the soil, and on top of that it increases soil moisture by allowing more water to sink into the ground and by reducing evaporation (FAO, 2001). Decomposing vegetation and the roots of cover crops improve the soil structure and make the clumps and lumps in the soil more stable making it harder for rain to break them up and wash them away, earthworms and other forms of life can

prosper in the cover as well as in the soil, it also stimulates the development of roots, which in turn improve the soil structure, allow more water to soak into the soil, and reduce the amount that runs off (FAO, 2001; FAO, 2011; Derpsch, 2005).

There are two main types of soil cover:

i. Living plant material: crops and cover crops.

ii. Mulch or dead plant material: crop residues and prunings from trees and shrubs, to keep soil covered the use of combination of both mulch and living plants can be applied, also to obtain a good soil cover, leave crop residues such as maize and sorghum stalks in the field (FAO, 2001).

2.5.2.3 Diversified crop rotations

The rotation of crops is not only necessary to offer a diverse "diet" to the soil micro organisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients (FAO, 2001). Nutrients that have been leached to deeper layers and that are no longer available for the commercial crop can be "recycled" by the crops in rotation, this way the rotation crops function as biological pumps. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients (FAO, 2001; ACT, 2008).

2.6 Theoretical Perspective of the Study

2.6.1 Diffusion of innovation theory

This study is guided by the theory of diffusion of an innovation, which was found by Rogers (1962) who defined an innovation as an idea, practice or object that is perceived

as new by individual. He also defined diffusion as a process through which an innovation is communicated through a certain channel over time among the member of social system. The theory helps to understand the factors that influence the choices an individual on adopting CA. It is the basis of understanding adoption. Grepperud (2003) defined adoption as a degree of use new technology in long run equilibrium when the farmer has full information about new technology. Van de Ban and Hawkins (1996) argued that adoption is a mental process an individual passes from first hearing about an innovation to the final utilization. In this theory, adoption process is inseparable from the diffusion process. The adoption decision process describes five stages that individuals go through during their evaluation of an innovation, stage one is when an individual becomes aware of an innovation. The awareness of an innovation is influenced by personal characteristics (Wood and Swait, 2002), socioeconomic factors, and access to change agents like mass media (Bandura, 2001). Stage two, persuasion, this is when an individual gains enough knowledge about the innovation's salient characteristics to make a personal judgment, the outcome of which is a favorable or unfavorable view of the innovation. Stage three, decision, this has an outcome of an individual's choosing to adopt or reject an innovation. Stage four, implementation, this is when an individual acts on his or her decision. Finally, stage five, confirmation, this is when an individual reflects on his or her decision and implementation process and re-evaluates whether to continue or discontinue with the innovation adoption (Rogers, 1995).

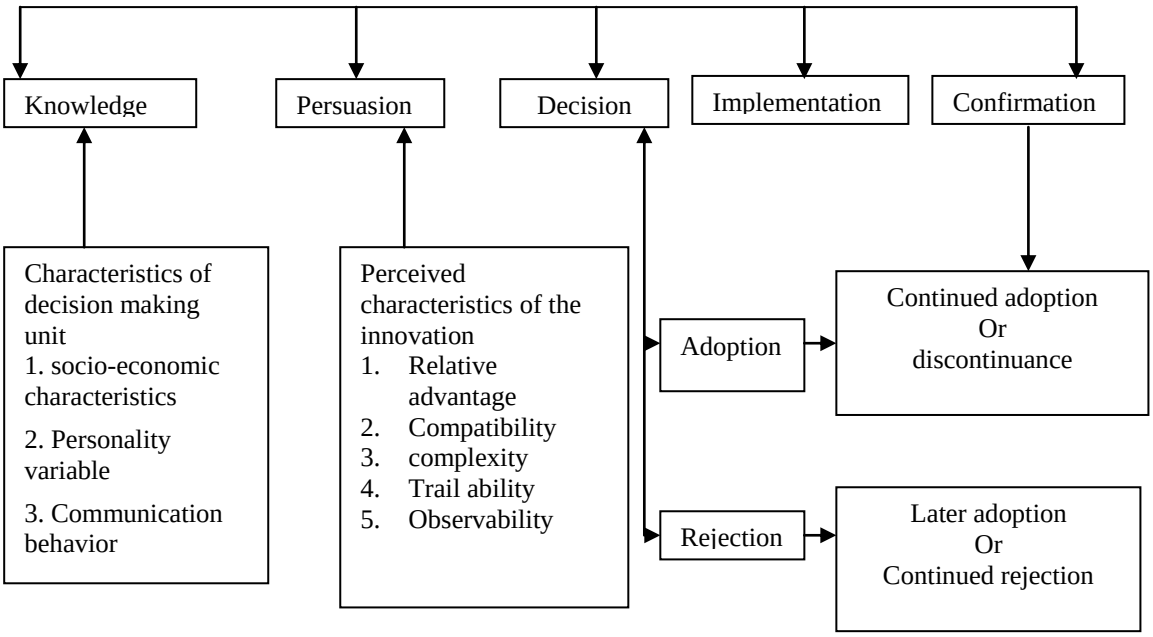

Figure 1: Rogers innovation decision process model

Source: Rogers, 1995

In additional to that Rogers (1995) who is the founder of this theory has classified the adopters into five categories of innovators; early adopters, early majority, late majority and laggards on the basis of the time taken to adopt the innovation and practically implement into their life style (Kaur and Kaur, 2010). Some key features of each adopter category have been summarized in Fig. 2.

Adopter Category	Key Features	Percentage of total population that are likely to adopt %
Innovators	**Venturesome:** who are very eager to try new ideas, acceptable if risk is daring, more social relationship, communicate with other innovators	2.5
Early Adopters	**Respect:** who are more integrated into the local social system, the person to check with before adopting a new idea, generally are role models	13.5
Early Majority	**Deliberate:** who adopt new ideas just prior to the average time, seldom hold leadership positions, deliberate sometime before adopting	34
Late Majority	**Skeptical:** who adopt new ideas just after the average time; adopting may be both an economic necessity and a reaction to peer pressures; innovations approached cautiously	34
Laggards	**Traditional:** who adopt an innovation at last stage; oriented to the past, suspicious of the new	16
Total		100

Figure 2: Adopter categories and their key characteristics

Source: Kaur and Kaur, 2010

Kaur and Kaur (2010) and Rogers (1962, 1995) has explained the s- shaped adoption curve, which reveals that at the initial stage, the innovation diffused at slow pace. As more as more people adopt the innovation, it spreads quickly and ultimately the saturation point comes which indicates that everyone who need to adopt the innovation has adopted it. It has also been discussed that some innovations which diffuse rapidly create steep s-curve; others having a slower rate of adoption, create a more gradual slope of the s-curve. Rogers (1962, 1995) depicted that the innovation process from knowledge to

final adoption averaged about nine years, indicating that considerable time is required for adoption to occur.

2.7 Studies on Factors Influencing Adoption of CA

Adoption of CA is affected by several factors socio-economic, institutional and environmental factors. Nyanga (2012) used binary logistic regression model to identify factors influencing adoption of CA in Zambia found that extent of knowledge on CA, farm size and quality extension service were factors influencing adoption of CA. Malamba (2010) found that gender of the household head, farmer training and income to be the factors that have impact in adopting CA. However Lugandu (2013) in assessing factors influencing adoption of CA by smallholder farmers in Karatu and Kongwa District of Tanzania found size of land owned by the farmer and farmers scale category to be the factors that affect adoption of CA. Persevearance *et al*. (2013) reported that age of the farmer, land size, and level of education are significantly affect the decision of farmer to adopt CA in Zimbabwe.

2.8 Studies on Factors Influencing Adoption of other Technologies

A study by Mwanga (2002) found that number of years in formal school, number of livestock units market opportunities, family size, location relative to urban centres, and seed source as the main factors influencing adoption of sorghum. Senkondo *et al*. (1998) found family size, number of family members working on the farm, experience in farming and extent of knowledge in rain water Harvesting (RWH) technologies were significant in explaining adoption of RHW technologies. Mvena and Mattee (1988) found that lack of credits, limited access to information, knowledge and inadequate incentives to be the main factors that limited adoption of improved grain storage in Tanzania. Nicholson *et al.* (1999) reported factors influencing adoption of livestock technologies are age, education,

family size, income, price and gender. However, Chi (2008) identify farmers' perception, low level of education, knowledge level of extension staff, low capital, small land, poor infrastructure, limited capacity of extension staff and ways of organization and management of extension programs to be the factors that affecting technology adoption among rice farmers in the Mekong delta. A study by Ayuya *et al*. (2011) used double hurdle model to explain factors that influence the willingness to accept and the extent the farmers are willing to adopt the carborn tree, the findings of the model indicate gender, household size, farm debt, attitudes towards risk, farm size, land tenure, age, perception of the technology were found to influence the willingness to accept and adopt the project. On the other hand Akudugu *et al.* (2012) in explaining factors that influence adoption of modern agricultural production technologies by farm household in Ghana found that farm size, expected benefits from technology, access to credit and extension services were influencing the decision of farmers to adopt the technology.

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Conceptual Framework

The conceptual framework is the narrative outline of the study which shows the relationship between variables. The conceptual framework of this study is grounded by the assumption that the decision of farmers to adopt CA is influenced by socio-economic factors, institutional factors, and environmental factors. The socio-economic factors are age, education, farm size, household size, household income, and farmer's perception. The institutional factors are extension services, credit, and infrastructure and environmental factors are soil type and slope .Therefore if a farmer adopt CA it is expected that the result will be an increase of agricultural productivity, increase of food security, increase household income and increase standard living of people (Fig. 3).

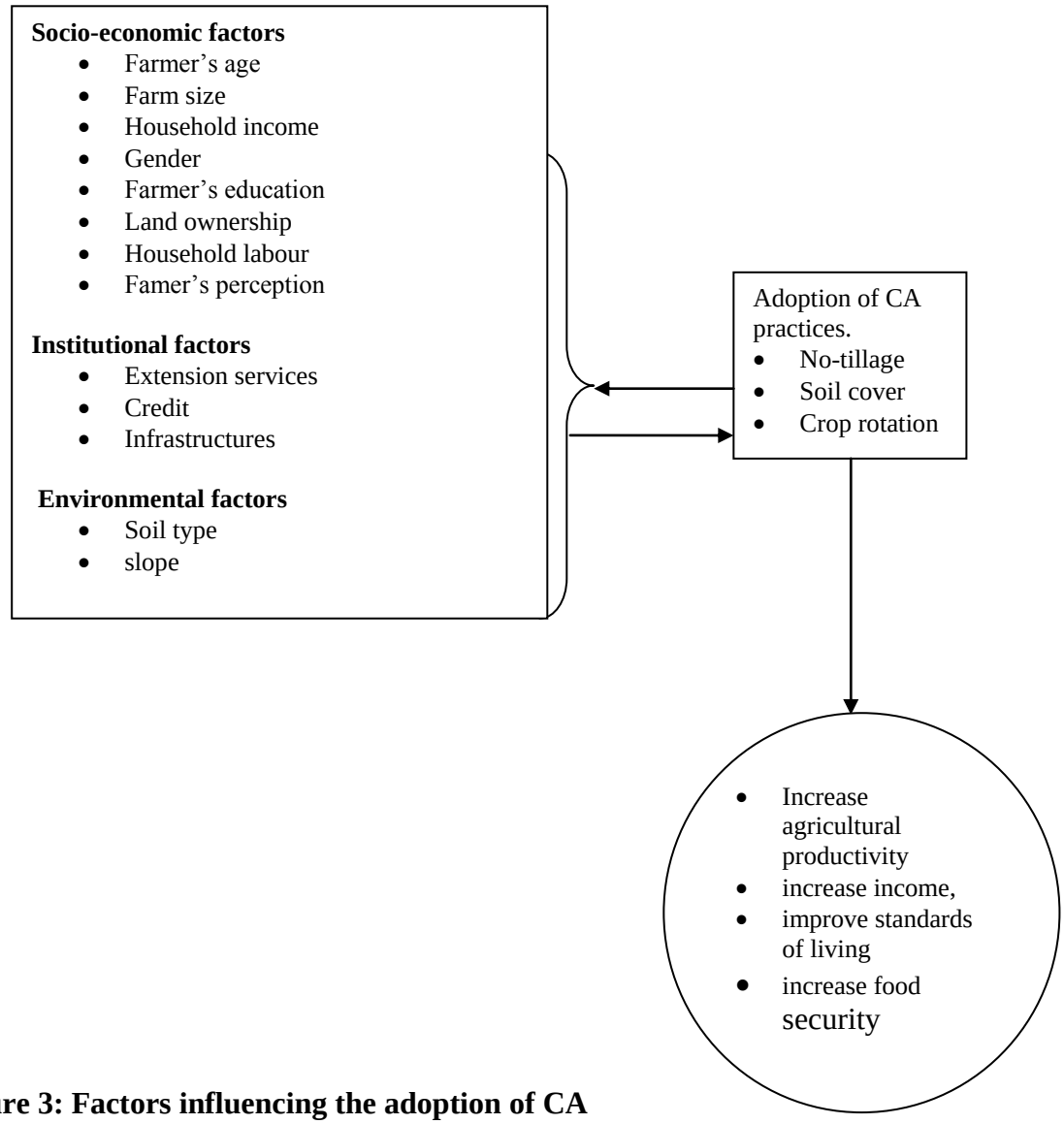

Figure 3: Factors influencing the adoption of CA

3.2 Description of the Study Area

3.2.1 Climate and topography

The study was conducted in South Uluguru Mountains in Morogoro rural District. According to URT, (2005) Uluguru Mountains (UM) lie 200 km inland from Indian Ocean Coast and South of Morogoro town in Tanzania. They are one of thirteen mountain ranges that form the Eastern Arc Mountains (EAM), and are also recognized as part of a Global Biodiversity Hotspot. The main soil types are acidic lithosol, ferralitic red and yellow, and brown lithosol it receives an average rainfall of over 2000 mm/year (CARE, 2008).

3.2.2 Population

UM are inhabited by approximately 151 000 people in 50 villages and are also of exceptional interest for being an important water catchment area in the country (URT, 2005).

3.2.3 Economic activities in uluguru mountains

The economy of UM area is dominated by agriculture and livestock as a major income earner. Others are craftsmen and merchants who operate shops, butchers and local bars. Farm management practices are mainly traditional, farm implements are mainly limited to hand hoes, sickle and axe that is due to some extent that topographical condition is not friendly to mechanized implements (Senkondo, 1992).

3.2.4 Farming system

CARE (2008) the farming systems practiced in the South Uluguru Mountains is determined by the landscape. Typically farmer plant mixed crops and practice some agro-forestry. On a positive note, a local form of terracing called *fanya chini/ fanya juu* is adopted sporadically in an attempt to control soil erosion and improve soil fertility. Another more common and beneficial practice is tree planting around homesteads, which allows for the inclusion and further promotion of multi-story, perennial, home gardens where citrus fruit trees, bananas or papayas are mixed with maize, sweet potato, beans, pumpkin and other annual crops.

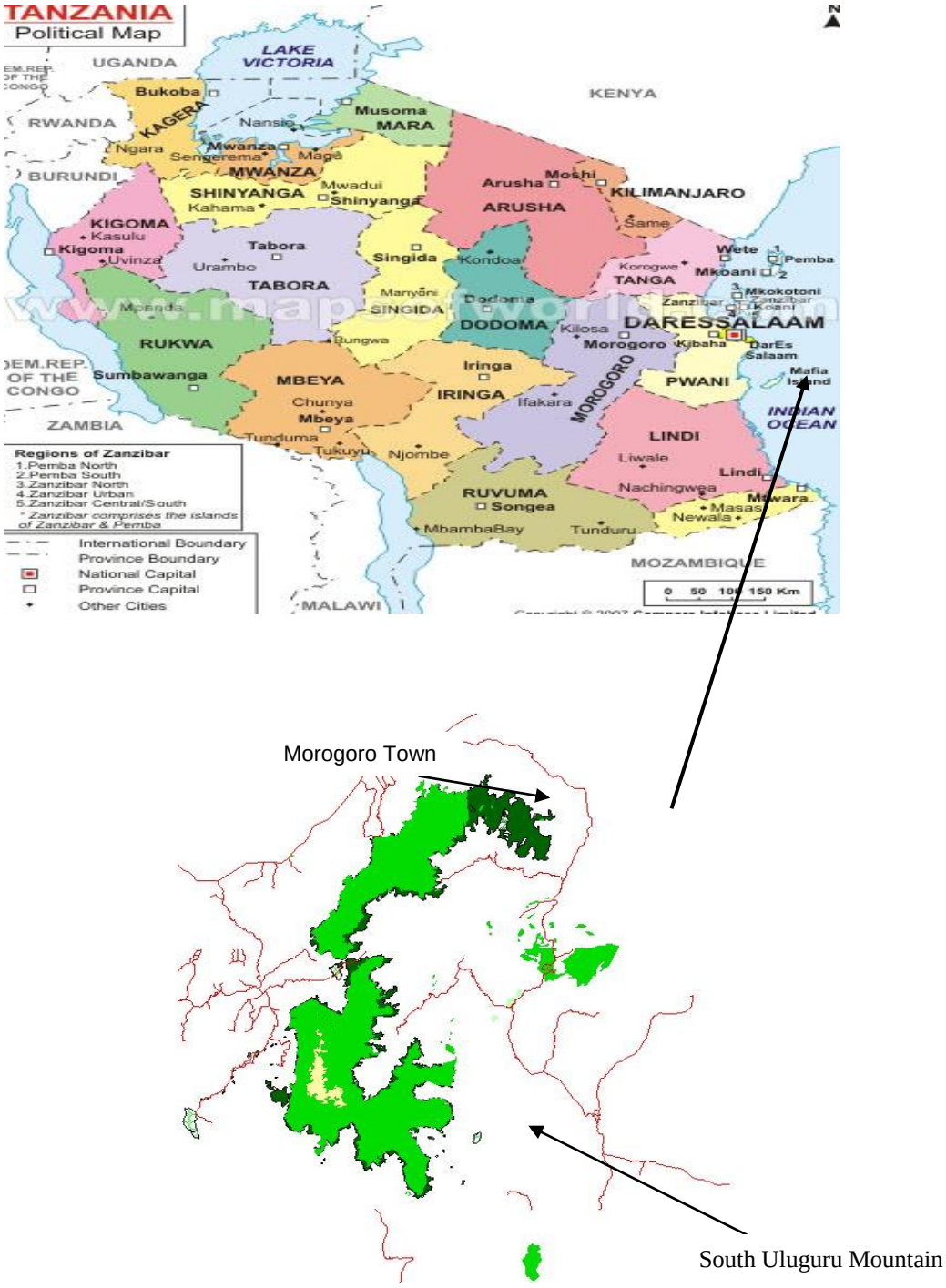

Figure 4: Map of Tanzania showing South Uluguru Mountains

3.3 Land Tenure Practices in the South Uluguru Mountains

Land tenure has an important influence on people's attitude towards land use, the vast majority of the world's slash and burn farmers do not have formal land title, most of them have customary rights or no right at all (Senkondo,1992). Across the African continent, agricultural land degradation has long been exacerbated by a lack of secure land ownership which limits the land user's interest in managing the land for the long term CARE (2008). The same source urged that in Tanzania, land tenure and land reform have been hot issues for many years, in the majority of community settings, land is owned and redistributed in accordance with customary or religious/statutory laws. Customary land ownership is determined by clan elders, the Traditional Authority versus the Government Village Council, although the balance of power between clan elders and village councils varies from one village to the next, the former continue to have substantial authority when it comes to the new or reallocation of land. Land tenure system in Uluguru Mountains have changed from purely traditional land tenure to mixtures of inheritance, purchase and rent or borrowed (Senkondo, 1992).

Traditionally land ownership follows the lineage, inheritance is possible from mother to her children it is furthered argued that children can work on his or her father's land as long as the father is alive but when the father dies the land goes back to the lineage (Senkondo, 1992). Nevertheless, the owner is free to improve the family plot without fear of loss of his or her investment, even though in most cases there is no legal documentation provided to support ownership. A key point here is that land allocation is accompanied by the traditional authority's expectation that the land holder will serve as an able steward of that land and its immediate environs (CARE, 2008).

3.4 Justification of the Study Area

Uluguru Mountains is highly vulnerable to land degradation in particular soil compaction, land degradation and deforestation. This is caused by felling of trees for timber, firewood and building pole collection; uncontrolled fires; clearance subsistence; and cash-crop cultivation. Much of the catchment areas have been destroyed (CARE Tanzania, 2008). Hence this makes the study to be conducted in that particular area.

3.5 Research Design

A cross-sectional research design was used in this study. A cross-sectional design involves a collection of data at a single point in time; it can be used in descriptive study for the determination of relationships of variables (Barley, 1998). This design was used because of the limited time in the process of data collection.

3.6 Sampling Procedure

Purposive sampling was used in this study to select ten key informants. These were the project coordinator of HICAP project, three experienced HICAP representatives, two councilors and four village executive officers. The two wards were purposively selected due to the fact that CA was introduced in two wards that are Kasanga and Kolero. Four villages were selected using simple random sampling. Sampling units were both male and females. The sample size composed a total of 120 respondents who are farmers chosen from four villages.

3.7 Data Collection

3.7.1 Primary data

Primary data were obtained using structured questionnaires with both open and closed ended questions, Checklist, interview, physical observation and focus group discussion.

Focus group discussion is a complementary data collection method which facilitates the presence of interaction between respondents and researchers' questions (Wolf *et al.*, 1993).

3.7.1.1 Physical observations

Systematic physical observation was carried out to gather general information such as system of land size, type of CA method applied by the farmers, types of crop grown under CA and tools used in practicing CA.

3.7.1.2 Focus group discussion

It was carried out after individual interview. Aimed at validating information gathered through other research tools as well as clarifying controversial issues that rose during the interview session (Koda, 2000). This technique is valuable in gaining insight into the dynamic relationships, concern and problems related to adoption of CA. In focus group discussion issues like right to own land, income and extension services were obtained and clarified.

3.7.1.3 Key informants

Discussion and consultations with key informants were carried out to obtain information about the study problem as well as clarifying information from observation, questionnaires, interview and focus group discussion. The key informants used were project coordinator of HICAP project, three experienced HICAP representatives, two ward councilors and four village executive officers.

3.7.1.4 Questionnaires

A structured questionnaire containing both closed and open ended questions was also used to collect data from both farmers adopters and non adopters of CA so as to obtain information from the background variables such as age, sex, education level income, as well as dependent and independent variables. The questionnaire was pre- tested using 20 farmers selected randomly from 4 villages. The main reason for pre-testing was to carry out the necessary adjustment and corrections of the research instrument to the target respondents.

3.7.2 Secondary data

Secondary data were obtained from CARE and various records from the village government office to obtain information about the adoption rate of CA in all villages and additional information about the amount of maize yield after and before CA.

3.8 Data Processing and Analysis

Data collected was coded, edited and entered in computer software using a programme of Statistics Package for Social Science (SPSS). The SPSS employed both descriptive and inferential statistics, where by descriptive statistics was used to find the percentage, mean and frequency to describe variability and central tendency of the variable. The inferential statistics was used for objective number two and three.

3.8.1 Analytical model

The analytical model for objective three was binary logistic regression model which explained factors that influence adoption of CA. Dependent variable was adoption or non-adoption of CA. The independent variables considered to influence adoption of CA represented as follows:

$Y=\alpha+\beta 1X1+\beta 2X2+\beta 3X3+\beta 4X4+\beta 5X5+\beta 6X6+\beta 7X7+\beta 8X8+\varepsilon_i$ .....(1)

Where y= if a farmer has adopted CA or otherwise.

α Constant

β Coefficient of independent variable X1……Xn are independent variable

x1 Education(measured by years of schooling)

x2 Farm size per household (measured per hector)

x3 Income (tsh)

x4 Extension service (yes\no)

x5 Household labour (number of members who are able to work)

x436 Land ownership (nominal level) = 1 if a farmer owns the land or otherwise.

X7 Age of the farmer measured in years

x8 Sex of farmer (1 if is a male 0 otherwise measured as dummy variable)

ε_i Random error term

3.8.2 Definition of variables

Education: There is a positive relation between level of education and adoption. It was given by years spent in school and the adoption of CA. It was hypothesized that the educated farmers are more likely to adopt CA because they can use information relevant for adoption.

Farm size: This was referred to the total size of farm owned by the farmer. It was hypothesized that a farmer with larger farm size he/she is more likely to adopt CA than the farmer with small size.

Income: Income of the farmer was hypothesized to be positively related to the adoption of CA. A farmer with higher income can adopt CA more easily than the farmer with

lower income.

Household labour: Referred to the number of people who are able to work in a family. It was expected that the household chooses to adopt a technology if there is household labors to work in the farms.

Land ownership: It was expected that farmers who own land can adopt CA easily compared to farmers who rent or borrow land.

Age of the respondents: It was measured in years of respondents from birth to the time of interview. It was hypothesized that age of the farmer can influence or affect farmers to adopt CA. Farmers' age has a positive relation with adoption CA.

Sex: If a respondent is a male or female. It was hypothesized that sex of the farmer can affect adoption of CA. Male tend to adopt new innovation fast than female.

Extension service: If extension officer visits the farmer. It was expected that Visits from extension staff are positively related to adoption by exposing farmers to new information.

3.9 Limitation of the Study

In conducting this study there were some critical limitations which include:

i. Getting information from non-adopters farmers of CA because they thought that I was among the CARE employees since they do believe that CARE were there to kill them
ii. The roads of some villages were very poor for a researcher to pass hence it made the process of collecting data to be hard and took long period.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter discusses the results of the study. It includes socio-economic and demographic characteristics of farmers. The chapter also presents factors that influence farmers to adopt CA both socio-economic and institution factors. The study result involved in this chapter were based on two sources of data which are secondary and primary data.

4.1 Socio-economic and Demographic Characteristics of Respondents

4.1.1 Age of the respondents

The age of farmers was categorized into three categories for both adopters and non - adopters (Table 2). The findings show that about 50% of the respondents aged 31-50 adopted CA while 52.5% in the same age category did not adopt CA. It was also found that 40% of respondents both adopters and non adopters were in the age category of 51-70. Furthermore 9 % of the respondents were aged between 19-30 adopted CA while 7 percent in the same age category did not adopt CA. This implies that farmers who adopted CA were adult found in age category of 31-65, this group is responsible in decision- making on adoption of CA and thus age of the farmer can positively influence the decision of farmers to adopt CA. These results are similar to the study of Harford (2009) who argued that with an increase in age farmers tend to reject new farming practices for less demanding cropping systems with low transactional cost associated with them. Furthermore, older farmers tend to be risk adverse and may avoid innovations in an attempt to avoid risk associated with the initiative. Rukuni *et al.* (2006) argued that being older creates a conservative feeling among farmers and hence resistance to change. Also Baudron (2001), found that chances of participation in conservation farming

increased with age because youths have little appreciation on the importance of agricultural activities in most rural set ups and will take marginal effort to expand these activities. Therefore there is a relationship between age of the farmer and adoption of CA. Same results found by Mazimavi and Twomlow (2009), that there is a positive correlation of age and adoption of conservation practices in Zimbabwe. Also age was found to be positively influence adoption of sorghum in Burkina Faso (Adesina and Baidu-Forson, 1995). In contrast, age has been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions, In the study of adoption of Hybrid Cocoa in Ghana (Boahene *et al*., 1999).

Table 2: Age of the respondents in south Uluguru Mountains

Variable	**Adopter category**			
	Adopter (N=80)		**Non adopters (N=40)**	
	N	%	n	%
19-30	7	8.8	3	7.5
31-50	41	51.2	21	52.5
51-70	32	40.0	6	40.0
Total	80	100.0	40	100.0

4.1.2 Level of education of the respondents

The findings show that respondents (100%) non adopters had attained primary level of education while (94%) of adopters had primary level of education and 1% of the respondents had secondary level of education. Neither adopters nor non-adopters of CA had attained to college or university. It implies that farmers' education may significantly influence participation in CA but with more years in schooling probability of participating decreases. Same results found by Perservance *et al.* (2012) in the study of adoption and efficiency of selected conservation farming technologies found that educated people tend to reject agriculture activities for white color jobs in Madziva in Zimbabwe.

Table 3: The level of education of respondents in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Non	4	5.0	0	0
Primary level	75	93.8	40	100
Secondary level	1	12.0	0	0
Total	80	100.0	40	100

4.1.3 Sex of the respondents

The findings show that (50%) of adopters were male while female were (49%) while non adopters female were (55%) and male were (45%) it shows male were more willing to adopt CA than female thus there is gender imbalance between male and female in adopting of CA. Also it was found that female farmers who did not adopt CA were many compared to male farmers. These results are similar with those of (Matlon, 1994; Adesina, 1996) who argued that men are more willing to participate in conservation agriculture than women as a result of gender based wealth differences. This result however proves positive since women in the African countries forms big portion of the population undertaking farming activities, though they face socially conditioned inequities in the access, use and the control of household resources (Adesina *et al*., 2000).

Table 4: Sex of respondents

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Female	41	48.8	22	55.0
Male	39	51.2	18	45.0
Total	80	100.0	40	100.0

4.1.4 Marital status of the respondents

It was found that the majority (87.5%) of non-adopters farmers were married, 7.5% were single and 2.5% were either divorced or widowed. For adopters 82.5% were married,

7.5% widowed, 6% divorced and about 4% were single (Table 5). Mtama (1997) found that marriage has an effect in production process as it increases labour availability in the household.

Table 5: Marital status of the respondents in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Married	66	82.5	35	87.5
Single	3	3.8	3	7.5
Divorced	5	6.2	1	2.5
Widowed	6	7.5	1	2.5
Total	80	100.0	40	100.0

4.1.5 Household size of the respondents

The results of household size were categorized into three groups, where by the majority 67.5% of farmers who were non-adopters were in a group of 1-4 members, and about 30% were in a group of 5-8 members, and only 2.5 % were in a group of 9-12 members, while among adopters 64% were found in a group of 1-4 members, and 35% were ranging in 5-8 members and the last group of 9-12 were about 1 %. The findings show that among non adopter farmers majority were found in group of 1-4 members. It implicates that the number of family members of the household might influence farmers' decision of adopting CA. Ayuya *et al.* (2011) made an argument that the larger households have the capacity to relax the labour constraints required during the introduction of new technologies. Also Amsalu and Jan de (2007) found that household size had a significant and positive effect on determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. It is expected that a larger household size will influence the decision of acceptance because of the availability of labour required during the adoption process. Therefore it is important to know the household size of the respondents in studying adoption.

Table 6: Household size of the respondents

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
1-4	51	63.8	27	67.5
5-8	28	35.0	12	30.0
9-12	1	1.2	1	2.5
Total	80	100.0	40	100.0

4.1.6 Source of income of the respondents

It was found that the majority 90% of non adopter farmers were depending on agriculture as their source of income, 7.5 % depend on business and 1 % depend on other activities apart from agriculture and business but for adopters 82.5% depend on agriculture, about 14% respondents on business, and 4 percent said that their source of income is obtain from different activities apart from agriculture and business such as carpenters this implies that source of income of the farmer does not necessarily helped farmer to adopt CA, therefore there is no correlation between source of income of the farmer and the adoption of CA since the majority of farmers both adopters and non adopters depend mostly in agriculture. (Table 7)

Table 7: Source of income of respondents

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Agriculture	66	82.5	36	90.0
Business	11	13.8	3	7.5
Others	3	3.8	1	2.5
Total	80	100.0	40	100.0

4.1.7 Respondents' income per year

During the survey respondents were asked about their estimated income per year. Income was grouped into three categories, less than 50 000, from 50 000 to 99 000 and lastly from 100 000 to150 000 Tsh. majority of farmers (80%) who adopted CA had an income

of 100 000 to 150 000 Tsh per year, 16% were in category of 50 000 to 99 000 Tshs and 2% had an income of less than 50 000. The majority (80%) of non adopter farmers were having an income of 50 000 to 99 000 per year followed by 17.5% who had an income of less than 50 000 thousands and 2.5% who were in a category of 100 000 to 150 000 estimated income per year. It is hypothesized that farmers with high income can adopt CA measures easily than farmers with low income level. From the findings it is found that farmers who had high income were more likely to adopt CA compare with farmers with low income.

Table 8: Income of respondents in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Less than 50000	2	2.4	27	80.0
50000-99000	13	16.2	11	17.5
100000-150000	65	81.2	2	2.5
Total	80	100.0	40	100.0

4.1.8 Land holdings and land tenure

The findings of this study showed that (57.5%) of non adopter farmers get land for cultivation through renting or buying and very few from communal land (Table 9) for non adopters of CA 57.5% they do purchase land, 22.5% rent land and 20% get land for cultivation from the community while the adopters of CA 37.5% purchase or buy land, 47.5% rent land and 15% got land from the community. These results indicate that majority of farmers South Uluguru Mountains do not possess their own land. Thus land ownership can influences farmers to adopt CA or not to do so. Ayuya *et al.* (2011) argued that Land tenure provides farmers with full rights of land ownership and usage thus influencing the decision to participate in tree carbon trade project. Same source claims that Land ownership with title deeds ensures farmers the right to usage (security of

tenure) thus creating an incentive to the farmers to adopt new, long term and even riskier technologies. Similar results found by Arellanes and Lee (2001) who argued that farmers with security of tenure were four times likely to employ more of the new techniques due to security of land access and usage.

Table 9: Different types of land ownership in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Purchase	30	37.5	23	57.5
Rented	38	47.5	9	22.5
Communal	12	15.0	8	20.0
Total	80	100.0	40	100.0

The findings show that majority of farmers both adopters and non adopters in south Uluguru mountains own land which is not more than three acres (Table 10) for adopters about 5% own land less than one acre while non-adopters 20% own land less than 1 acre, 10% of adopters and 30% of non adopters own 1 acre, also those who own 3 acres are 29% for adopters and 15% for non adopters, while 6% adopters and 7% non-adopters own 4 acres of land and only 2.5 % adopters and 5 % non adopters own 6 acres of land and lastly 46% adopters and 22.5% non adopters do not have land at all. This shows there is a different in amount of land possessed by adopters and non adopters of CA. Adopters of CA tend to have large amount of land compared to non adopters. These results are similar with those Just *et al.* (1980) who claimed that adoption of an innovation will tend to take place earlier on larger farms than smaller farmers. Large scale farmers are more likely to adopt a technology than small holders CIMMYT (1993).

Table 10: Household land size in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Less than 1 acre	4	5.0	8	20.0
1 acre	13	10.2	12	30.0
3 acres	19	23.8	6	15.0
4 acres	5	6.2	3	7.5
6 acres	2	2.5	2	5.0
0 acre	37	46.2	9	22.5
Total	80	100.0	40	100.0

4.1.9 Source of farm labour

The findings show that 85% of both adopters and non adopters hired labour, while (14%) adopters and (15%) non adopters use family labour and from neighbors it was 1 % for adopters only. This indicates both adopters and non adopters hired laboures for cultivation. Labour is a key factor known that hinder adoption of new technologies more especially those which are labour intensive. Hicks and Johnson (1974) argued that higher rural labour requirement explained non-adoption of intensive rice varieties in Taiwan and shortage of family labuor explains non-adoption of high yielding rice varieties in India. Similar results were found by Ntege-Nanyeeya *et al*. (1997), who argued that adoption of improved maize varieties in Iganga District was significantly found to be positively affected by use of hired labor.

Table 11: Source of labour of both adopters and non-adopters of CA in South Uluguru Mountains

Variable	Adopter category			
	Adopter (n=80)		Non adopters (n=40)	
	n	%	n	%
Family members	11	13.8	6	15.0
Neighbors	1	1.2	0	0.0
Hired	68	85.0	34	85.0
Total	80	100.0	40	100.0

4.2 Level of Adoption of CA

The findings show that among the 120 respondents 33 % were non adopters of the CA and 67 % were adopters of CA (Table 13). The adoption rate of CA in South Uluguru Mountains is increasing in every year. CARE (2008) reported that the number of farmers adopting CA in south Uluguru Mountains was 882 from thirteen villages in three years this is from 2009-2012. The same source reported that during the first year only 162 farmers adopted CA, second year there were 243 farmers who adopted CA and the third year 477 farmers adopted CA. This trend is a proof that there is an increase of adopters of CA in every year.

Table 12: Adoption rate of CA in four villages

Variable	**Sex of the farmer**		
	Female	Male	Total
Kassanga	7	19	26
Kolero	59	82	141
Kitonga	22	34	56
Lubasazi	96	106	202
Total	184	241	425

It was found that the selected villages that is Kolero, Kasanga, Lubasazi and Kitonga farmers who adopt CA were 425, whereby male were 241 and females were 184 (Table12). The trend of adopting CA is increasing in every year although not in a high rate

Table 13: Farmers who adopt CA in South Uluguru Mountains

Adoption status of CA	**Farmers (n=120)**	
	Frequency	Percentage
Yes	80	66.7
No	40	33.3
Total	120	100

4.2.1 Information about CA

4.2.1.1 Reason for farmers to adopt

The findings show that (49 %) of the respondents said that they decided to adopt CA because they wanted to increase crop production. CA through its major three techniques helps to increase crop production. Shetto and Owenya (2007) claimed that CA helped to increase crops yield in Mbeya region, where by maize yield increased from 26%-100% and sunflower for 360%, while in Arumeru and Karatu the increase of maize yield was 60-70%.

The other reason which made farmers to adopt CA is to increase income. (24%) respondents agreed that they adopted CA because they wanted to increase their income. When CA was introduced in South Uluguru Mountains also Village Saving Loans (VSL) was introduced aiming at increasing community level of income through money and material, increasing community income through their social funds and to give out loans to members for their development (CARE 2008). Therefore for a farmer to get loan he or she must be a member of CA. Since CA increases production the increase in crop yield will increase farmers' income.

It was found that 10 percent of farmers adopted CA because they wanted to improve food security. ICRAF and ACT (2006) emphasized that there is a reason to believe that CA will help to improve food security in sub-Saharan Africa.

Furthermore 6 % of farmers adopt CA after getting motivation from the early adopters. Early adopters in any technology are acting as role models therefore many farmers might adopt new technology after seen the benefits that early adopters get. If there are visible benefits most of farmers will adopt the technology in early stage.

The findings show that 5 percent decided to adopt CA in order to reduce soil erosion because exposing soil to the sun and rain leads to crusting, runoff, soil erosion and degradation therefore CA can be used to reduce soil erosion.

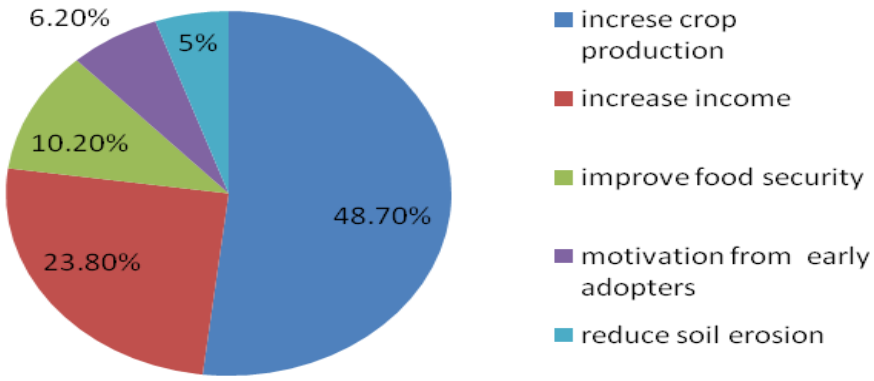

Figure 5: Reasons for farmers to adopt CA

4.2.1.2 Reasons for other farmers not adopting

Farmers who were non adopters of CA were asked to mention reasons as to why they did not adopt CA despite many visible benefits. The majority (45%) said that low income was the reason for them not to adopt CA. CA needs farmers to purchase improved hand hoes different from those they were using in conventional farming. Also high income will help farmer to hire labour, and buying seeds. This supported by Anim (2003) who reported that wealthier farmers have better access to extension information and can stand a better chance to use their own resources to practice new technology.

Apart from that the findings also show that (22%) of the respondents said that they did not adopt CA because of shortage of labour. The size of the family determines the number of people who are able to work (Table 6). These farmers also argued that during the early stage of CA needs enough labour, sub-soiling and double digging want a farmer to have enough laboures, but this is only done once after three years. These results are similar with the study conducted by Haggblade and Tembo (2003), who argued that the labour

requirements during the establishment stage of pot holing could be double the labour requirements during the later stage on the same piece of land. This shows that the relationship between CA practices and labour is expected to be positive or negative depending on the stage of establishment

It was found that (20%) of the respondents said that land ownership and shortage of land were the reasons for them not to adopt CA. This finding is consistent with (feder *et al.*, 1983; Akudugu *et al.*, 2012) that large scale farmers are more likely to adopt new technology than small scale farmers. This is also supported by Thangat *et al*. (2002), large farm size gives a farmer the capacity to use land intensive conservation practices such as crop rotation. Therefore the farm size may be one of the reasons that made farmers adopting CA.

Furthermore the findings show that 7.5 percent of the respondents said that market accessibility was the reason for them to refuse adopting CA. Market access in the study area plays a great role in determine adoption of CA. Howley (2012) argued that the market interventions such as price supports speed up the adoption of the new technology.

It was found that 5 percent of the respondents claimed that changes in weather made them not to adopt CA, the climatic factor have the major influence in adopting CA, the amount of rain and its distribution were the most factor that made them not to engage themselves in CA.

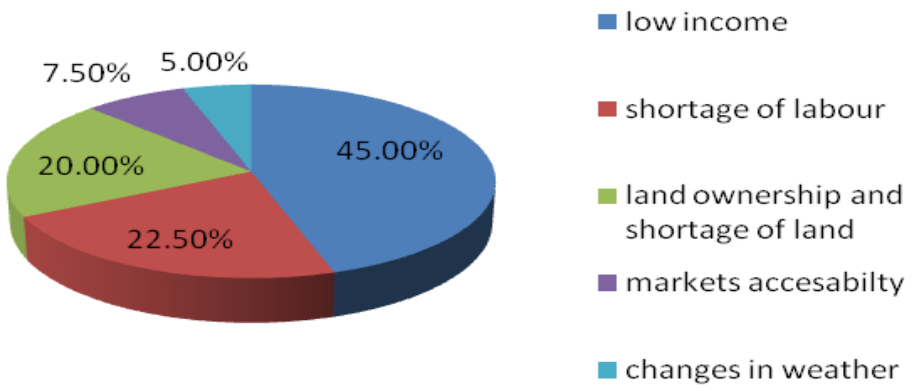

Figure 6: Reasons for farmers not adopting CA

4.3 Inferential Statistical Analysis

4.3.1 The contribution of CA in agriculture productivity

A comparison was made between the mean yield of maize after and before adoption of CA (Table 14). There is significant difference of maize yield before and after adoption of CA whereby the result showed that the mean yield before were 88.1250 kg and mean yield after adoption of CA was 627.5 kg.

Table 14: Comparison of mean yield of maize before and after CA

Variable Mean	Mean	N	Std	Std. error
Maize yield after CA	627.50	80	187.43610	22.07403
Maize yield before CA	88.1250	80	21.41180	2.39391

To reaffirm this result T. test was carried out to compare maize yield by farmers who adopted CA against maize yield of farmers who did not adopt CA. The mean yield of farmers who adopted CA was 627.5 and for non adopters 83.75. The difference between non adopters yield and adopters yield is significant whereby t=34.531 and p=0.000. These results may not necessarily be varied due to the fact that there are other factors

which may affect crop yield of adopters of CA such as age, education, labour, income, land size and land ownership.

4.3.2 Socio-economic factors and institution factors that affecting adoption of CA in South Uluguru Mountains

In this study binary logistic regression model was developed to analyze factors affecting adoption of CA. The dependent variables were factors affecting adoption weather a farmer had adopted or not and the independent variables were age, sex, level of education, household income, household size, extension services, land ownership and household labour.

Table 15: Factors affecting adoption of CA

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Sex	2.643	1.537	2.955	1	0. 086**	14.054
Age	-.040	.053	.563	1	0.453	.961
Education	-10.425	3.294E3	.000	1	0.997	.000
Ownland	5.989	1.573	14.503	1	0.000***	399.111
Income	0.000	.000	3.939	1	0.047**	1.000
Market	8.812	5.714E4	000	1	1.000	6.713E3
Infrastructure	-15.666	1.746E4	000	1	.0999	000
Credit	-25.915	5.897E3	.000	1	0.996	.000
Shortageoflabour	17.020	4.019E4	.000	1	1.000	2.463E7
Constant	73.714	9.205E4	.000	1	0.999	1.031E32

= significant ($p<0.05$); * = ($p<0.01$)

The results shows that, factors which significantly affect the adoption of CA were sex of the farmer ($p<0.05$), land ownership ($p<0.01$) and income of the farmer ($p<0.05$) but others factors were not significant (Table 15). Although from the survey results it was indicated that some socio-economic factors and institutional factors had some influence in decision of farmer to adopt CA.

4.3.2.1 Gender

Gender of farmer was found to significant affect the adoption of CA ($p<0.05$). In the study area showed that men are the ones who adopted CA more than women with the percentage of 51 % and for non adopters farmers who did not adopt most of them were female compared to male (55%). From these results it implicates that between male and female farmers, make are the ones who adopted CA than female farmers. One of the reasons for that is land. Land in Kolero and Kasanga Wards is allocated to the male head of the household based on the clan's decision, and it is passed on to subsequent generations on the male side (CARE, 2008). Semgalawe (1998) argued that gender of the household head determines access to technical information provided by extension agents. Due to social barriers, male extension agents tend to address male-headed households. Also, female-headed households, who are mainly widows, divorcees and unmarried women, have limited access to production resources such as land. However these findings contradict with those of Doss and Morris (2001) who found insignificant influence of gender on adoption in their study on factors influencing improved maize technology adoption in Ghana.

4.3.2.2 Land ownership

Land ownership was highly statistically significant ($p<0.01$) it is positively related to the adoption of CA. Farmers who own land have a great chance to adopt CA compared to those who rent or using a communal land. This is due to the reason that most of farmers both adopters and non adopters they either own 1 acre of land, less than one acre or own nothing (Table 14). Makundi (2010) observed that land ownership and land size are the factors that influence a farmer to plant trees in Tanga District.

4.3.2.3 Low level of income

Low level of income was statistically significant ($p<0.05$) it is found that farmers with high income are likely to adopt CA compared to farmers with low income. Farmers with low income may not be able to hire labour during the initial stage of CA, also most of farmers in the study (Table 14) are either rent land or purchase land for cultivation hence it may be difficult for them to adopt CA if they don't have enough capital to buy or rent land. The same results was found by Makundi (2010) who argued that low level of income constrains farmers to adopt methods of land management technology like constructing terraces and tree planting technology. Also a study by Serman and Filson (1999) claimed that high farm income improves the capacity to adopt agricultural innovations as they have the necessary capital to start the innovation.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The level of adoption of CA among farmers in south Uluguru Mountains is increasing in every year. For three years since the introduction of CA farmers who adopted CA were 882 in the two wards. The four villages selected farmers adopted CA in three years were 427. Even though the trend of adopting CA is increasing in every year the adoption is still low. On top of that CA has helped farmers to increase their agricultural productivity especially on maize. Maize yield after adoption has increased compared to maize yield before CA.

Lastly the study results showed that income of farmers influence farmers to adopt or not to adopt CA because when a farmer have high income he\she can be able to hire labour at the early stage and buying agricultural equipments, it has been indicated that most of farmers who were non adopters had low income that's why they didn't adopt CA. Also shortage of land and land ownership can affect adoption of CA; most of farmers said that shortage of land made them not to adopt CA since they are not sure if CA will give them good results. Farmers who own land found to adopt CA than farmers who hire land for cultivation

Furthermore gender affect farmers to adopt CA, the study results showed that female farmers who adopted CA were few compared to male although there was a slightly different between male and female who adopted CA. The results from the secondary data showed that female who were using CA were few compared to male. Other factors such as education, household size, extension services, and age did not significantly influence adoption of CA.

5.2 Recommendations

In the view of the major findings of the study and the above conclusion the following were recommended:

5.2.1 Recommendations to farmers

i. Income was found to be an important factor affecting adoption of CA. This suggests that farmers are likely to adopt CA only if they have income. Therefore it is important for farmers to engage themselves in different actives such as small business apart from agriculture so as to improve their income. Also the government should establish rural financial institutions to address farmers' credit needs on loan terms with low interest rate.

5.2.2 Recommendation to policy markers

i. There is a need to have a clear policy framework to support CA in South Uluguru Mountains so as to conserve environment around the mountains. Research and development programmes should be linked to farmers who practicing CA.

ii. Land ownership was found to be the factor that may affect farmer's decision to adopt CA. Therefore it is important for a government to distribute land well in these two wards and so that all people may have an access of land for agricultural practices.

iii. Market accessibility and poor infrastructure were also mentioned as factors that affect farmer' decision of adopting CA. Hence Government should make sure transportation and infrastructures are improved to make them passable in all seasons also improving the demands of market.

5.2.3 Recommendation for further research

This study was conducted on factors influencing adoption of CA did not go for its impacts on conserving environment and challenges for adoption therefore it is recommended that further studies should conduct a research on impacts of CA on conserving environment and on challenges for the adoption of CA

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APPENDICES

Appendix 1: The Description of variables, indicators, and level of measurement

Variable	Operational definition	Indicators	Level of Measurement
Age	Number of years since one was born	Years	Ratio
Sex	Biological state of being a male or a female	1. Female 2. Male	Nominal
Marital status	Marital relationship of the respondent	Married -1 Single -2 Widow-3 Divorced-4	Nominal
Education	Level of education of household respondent	No formal education-1 Primary education-2 Secondary education-3 College education-4	Ratio
Household size	Number of members in a household	Number of members	Ratio
Land ownership	Status of land possession by household	1. owned=1 2. hired=2 3. others	Nominal
Farm size	The size of land possessed by the household	Per acre	Ratio
household Income	Amount of money possessed by household	Tshs	Ratio
Household labour	Number of household members who are able to work from 18-50 years	Number of members	Ratio
Extension service	Agriculture extension officers provide to farmers	Yes or no	Nominal
Adoption	Decision to apply an innovation	1.number of farmers practicing CA 2.number of farmers not practicing CA	Ratio
Agricultural productivity	Crop yield acre	Kg/acre per year	Ratio

Appendix 2: Questionnaire on factors influencing adoption of CA in South Uluguru Mountains

A: FOR FARMERS

Respondent Number…….

District……...

Village……..

General Information

1 Gender: male ( ) female ( )

2 How old are you?

(a) Less than 18 years…….

(b) 18-55……..

(c) Greater than 55…….

3) How many people living in the household?

(a) 1-4……..

(b) 5-9……

(c) 10-12…….

(d) Above 12…….

(4) What is your highest level of formal education?

(a) No education……

(b) Adult education…….

(c) Secondary education……

(d) College education…..

(e) Other (specify)……..

5) Marital status

(a) Single….

(b) Married….

(c) Divorced…..

(d) Widowed……..

6) Source of income

a) Estimated income per month

b) Estimated annual income

II. Information about Agriculture and Land Tenure

1. How do you acquire land?

a) Purchase……..

b) Clearing forest…….

c) Communal……..

d) Rented……..

2. Do you own land?

a) Yes……

b) No……

3. If yes how big is your farm?

a) Less than one acre…..

b) 1-4 acres…….

c) 5-9 acres….

d) More than 9 acres……

4. What is the source of farm labour?
    a) Family members……
    b) Neighbors…..
    c) Work group…..
    d) Hired labour……
    e) Other source (specify)……
5. How many acres of maize did you grow under CA?
    a) Less than 1 acre……..
    b) 1-4 acres……
    c) 5-9 acres…..
    d) Above 9 acres……

6. How much money do you get after selling crop yield under CA per 1 bag?

7. How much money did you get after selling crops yield before adopting CA per 1 bag?

8. What is your household income per year?

III. RATE OF ADOPTION

1. Have you heard about CA?

    Yes…..

    No….

2. If you have heard about it have u practiced?

a) Yes…

b) No….

3. If yes when did you start practicing it?

    a) Soon after getting information……

    b) 1 month after getting information……

    c) 6 month after getting information……

d) 1 year after getting information…….

e) 2 years after getting information……..

4. for how long have you practice CA?

a) 1 year…

b) 2 years….

c) 3 years…….

5. If you practiced CA how much yield do you get per acre?

6. Before practicing CA how much yield did you get?

7 if no in question number 1 how much yield of maize do you get per acre?

III. EXTENSION SERVICES AND RELATED INFORMATION

1. Have you ever received advice related to CA practices from extension officers?

Yes……. No…….

2. If yes how many times you were visited by agent per month……

3. When you compare the last 2 years how do you evaluate the trend of current extension contact?

a) Decrease……

b) Increase…….

c) Remain the same …….

4. Have you ever attended extension training since the introduction of CA?

Yes…. No…..

4. If yes how many times…..

5. If yes how was the contribution of training in assisting you to adopt CA?

a) Good…….

b) Satisfactory

c) Poor…….

6. Are you satisfied with CA practices in reducing soil erosion and improving agricultural productivity?

Yes……. No…….

IV. FACTORS THAT INFLUENCE ADOPTION OF CA

Please indicate your agreement or disagreement with the following statements by circling the response that most nearly coincides with your own.

1. SA- strongly agree
2. A-agree
3. U-uncertain
4. D-disagree
5. SD-strongly disagree

Socio-economic factors influence adoption

Statement	Opinion
Farmers have low level of education that hinder the adoption of CA	1,2,3 4
Income level of most farmers is low for them to adopt CA	1,2,3,4
Women farmers are not involved in decision making of adopting CA	1, 2,3,4
Most of farmers around south Uluguru mountains have negative attitude towards CA	1,2,3,4
Farmers are not aware about the existence of CA	1,2,3,4
Farmers do not practice CA because of shortage of labour	1,2,3,4
Farmers do not adopt CA because they don't own land	1,2,3,4
Most of farmers are old enough and conservatives to adopt CA	1,2,3,4
Young farmers are not adopt CA because they don't have land	1,2,3.4
Farmers do not adopt CA because of the shortage land	1,2,3,4

Institutional Factors

STAMENT	OPINION
There are no credit facilities to motivate farmers to adopt CA	1,2,3,4
There are no village extension workers to advise farmers on CA	1,2,3,4
Village extension officers do not advice farmers in adopting CA	1,2,3.4
There are few extension officers to advice farmers in adopting CA	1,2,3,4
Farmers do not attend meetings	1,2,3,4

Environmental Factors

STATMENT	OPINION
This village do not get enough rains to support adoption of CA	1,2,3,4

V. Information about CA

1. Why did you adopt CA?

i……

ii…….

iii……

2. Are there any problems of using CA practices? Mention them

i……

ii……..

iii……....

3. If you're not using CA what are the causes of not adopting CA?

i……..……

ii……

iii……..…….

Appendix 3: Checklist for focus group discussion (farmers)

1. Do you at all own piece of land
2. what is the total size
3. How did you acquire land for farming?
4. Do you have right of land ownership
5. Is there any difficult or problems of land ownership in your area?
6. If at all you don't have the right of land ownership are you willing to adopt CA?
7. Do you think CA is suitable for you?
8. Have you ever attend any training providing by extension officer?
9. How often does extension officer pay a visit to your farm?
10. Does the extension services adequate for you?
11. When did you practice CA?
12. what are the problems hindering the implementation of CA

Checklist for Key Informants

1. Does the village know about CA?
2. What are the main economic activities in this village?
3. What is the trend of adoption of CA since it has been introduced?
4. What is the level of understanding of the community on CA?
5. Do you know any problem facing village, government, ward, district, during implementation of CA?
6. What are the possible problems do farmers facing during the implementation of CA?
7. What is the trend of adoption of CA in two years?
8. Does the famers aware about CA?