EFFECTIVENESS AND SUSTAINABILITY OF CONSERVATION AGRICULTURE TECHNOLOGIES IN MVOMERO DISTRICT, MOROGORO, TANZANIA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ART IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The main purpose of this study was to determine the conditions under which sustainable agriculture functions as an effective conservation tool whereby, increasing crop production while maintaining sustainability is a priority for agricultural development projects particularly in Tanzania. Factors contributing to the effectiveness of Conservation Agriculture (CA) technologies after project closure in improving the sustainability of cropping systems to participating and non-participating farmers of six villages in Mvomero District were investigated. It has been cited that non-project and project participants recognize CA as a technology with saving properties and a potential solution to farm power shortages suitable in household's labour stress. High yield grains and less cost of production per hectare were noted on CA as compared with conventional farms. Soils were improving which means that, the rate of degradation and erosion is lower than the rate of soil building-up. CA group at Msufini village experienced production of 4 000 kgs in CA compared to 1 900 kgs in conventional agriculture per 0.5 acre of season maize crop harvest. Data were collected from 120 randomly selected households in purposively selected villages using a structured questionnaire. Descriptive statistics, regression analysis and chi square analyses using SPSS were employed as major tools of analysis to determine factors influencing effective and sustainable CA practices. Of the 120 respondents, a total of 113 (93.3%) non-project and project participating respondents indicated that they were willingly to continue with CA which included 56 (91.8%) non-project and 57 (94.9%) project participating respondents, respectively. The main reasons given for being able to continue using CA technology included increase in production, income, cultivation of different types of crops and increase of soil fertility. However, significant change in farming practices, availability and use of specialist equipment, awareness as well as a fundamental change in mindset towards CA practices is necessary.

DECLARATION

I, Lameck Isack Hazali, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

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The above declaration confirmed

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DEDICATION

I dedicate this dissertation to the Holy Spirit -The Spirit of the Living God, who single-handedly instructed, supervised, guided and provided me with strength to accomplish this work. Then he answered and spoke to me, saying, “This is the word of Yahweh to Lameck, saying, ‘Not by might, nor by power, but by my Spirit,’ says Yahweh of Armies (Zachariah 4:6) and to my late parents, my father Ev./Mwl. Isaack Thomas Hazali, and my mother Mwivano Ng’wanyemi Ngoma.

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LIST OF ABBREVIATIONS

ACT	African Conservation Tillage Network
AGRA	Alliance for a Green Revolution in Africa
ARC	Agricultural Research Council
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
ASLM	Agricultural Sector Lead Ministry.
CA	Conservation agriculture
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology Development
CA SARD	Conservation Agriculture for Sustainable Agriculture and Rural Development
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
DAP	Draught Animal Power
DSMS	District Subject Matter Specialists
FAO	Food and Agriculture Organization (of the United Nations)
FFSA	Farmer Field School Approach.
GEF	Global Environmental Facility
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HH	Household
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
ICRAF	International Centre for Research in Agroforestry

ICRISAT	International Crops Research Institute for the Semi-Arid-Tropics
IFAD	International Fund for Agricultural Development
IITA	**International Institute of Tropical Agriculture**
IPCC	The Intergovernmental Panel on Climate Change
MAFCS	Ministry of Agriculture Food Security and Cooperatives (Tanzania)
NEPAD	New Partnership for Africa's Development
NSGRP	National Strategy for Growth and Reduction of Poverty
PROTA	Plant Resources of Tropical Africa
SACCOS	Savings and Credit Cooperative Societies
SARD	Sustainable Agriculture and Rural Development
SARI	Selian Agricultural Research Institute
SG2000	Sasakawa Global 2000
SLM	Sustainable Land Management
SMART	Specific, Measurable, Achievable, Realistic and Time bound.
SOM	Soil organic matter
SUA	Sokoine University of Agriculture
SUSTAINET	Sustainable Agricultural Information Initiative
TAMS	Tanzania Agricultural Mechanization Strategy
TFSC	Tanzania Farmers Service Centre
T&V	Training and Visits
URT	United Republic of Tanzania
VEOs	Village Extension Officers
ZFU	Zimbabwe Farmers Union

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

The concept of husbandry is widely understood when applied to crops and animals. As a concept signifying active understanding, management, and improvement, it is equally applicable to land (Shaxson *et al.,* 1989, Shaxson 1997, Shaxson *et al.,* 1999). Good land husbandry can be defined as the process of implementing and managing preferred systems of land use in such ways that there will be an increase or at the worst no loss of productivity, stability, and usefulness for the chosen purpose (Shaxson, 1993). The basic challenge for sustainable agriculture is to make better use of available biophysical and human resources, by minimizing the use of external inputs, by optimizing the use of internal resources, or by combinations of both (Pretty, 1998). The integrated process of land degradation and increased poverty has been referred to as the "downhill spiral of unsustainability" leading to the "poverty trap" (Greenland *et al.,* 1994). The aim of soil conservation is to facilitate optimum level of production from a given area of land while keeping soil loss below a critical value.

The soil loss tolerance value is defined as the rate of erosion at which soil fertility can be maintained over at least 25 years (de Graaff, 1993). Decreasing hunger requires increased food production which in turn requires farmer’s access to productivity-enhancing inputs, knowledge and skills. However, the majority of the chronically hungry are smallholder farmers in developing countries who practice subsistence agriculture on marginal soils, lack access to inputs and product markets, as well as financial resources to procure costly chemical fertilizer and other agrochemicals that might enhance the productivity of their land. Principles of sustainable technologies in agriculture agreed that, in order to be sustainable, a farm must be economically profitable while environmentally, it is frequently described as ecologically sound practices that have little to zero adverse effect on natural ecosystems and in social it relates to the quality of life of those who and live on the farm, as well as those in the surrounding communities (Menale and Precious, 2009).

Farming practices tend to degrade the natural resource base and the challenge for modern agriculture is to minimize this degradation while increasing agricultural production. This challenge, in the milieu of the semi-arid tropics of developing countries, has a different dimension, as here one is dealing with low-input technology and resource-poor farmers, working in an unpredictable agro-climate and on a highly variable and low quality resource base (FAO, 2001). The major forms of land degradation are soil erosion, soil fertility mining, soil compaction, water logging, and surface crusting (Nkonya *et al.*, 2005; Zake, 1993). Tropical soils often have a stable structure e.g. Ferrasols and are well aggregated but management practices like plowing or avoiding the use of cover crops can lead to rapid deterioration (Madari *et al.*, 2005).

Agriculture and rural development are sustainable when they are environmentally sound, technically appropriate, economically viable, socially acceptable and able to adapt to changing circumstances and conditions (FAO, 2007). The Poverty and Human Development Report (URT 2005) contends that if the National Strategy for Growth and Reduction of Poverty (NSGRP) targets are to be met, agriculture must grow at a sustained rate of at least six per cent per annum. Nowadays, people have come to understand that agriculture should not only be high yielding, but also sustainable (Reynolds and Borlaug, 2006).

The idea of introducing Conservation agriculture (CA) in the sub-Sahara region was initiated by FAO in 1998 when an international workshop on Conservation Tillage for Sustainable Agriculture was held in Zimbabwe. In Tanzania, CA started in 1996 with the Selian Agricultural Research Institute (SARI). In 2000, FAO supported a visit by a team from Brazil to Karatu. In 2004, MAFCS in collaboration with FAO initiated a pilot project on Conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD) in six Districts of Kilosa, Mvomero, Mbeya, Arumeru, Karatu and Bukoba Rural (TAMS, 2006). In Mvomero District, Participatory Farmer Groups (PFG) were formed in ten villages to allow farmers to practice different CA technologies using the Farmer Field School Approach. (FFS) The aim was to ensure the uptake of those introduced new technologies through the Tanzania Agricultural Sector Development Strategy (ASDS) and the subsequent Agricultural Sector Development Programme (ASDP). The 2020 Vision Initiative has urgently pushed for sustainable food security by 2020. This study will, therefore, investigate on the CA technologies introduced in Mvomero District after the donor support ended by tracking changes in the effectiveness and sustainability.

1.2 Problem Statement

Effective and sustainable agricultural systems are viewed in terms of resilience, persistence or spontaneous. Agricultural activities are one of the main factors contributing to soil degradation (Boardman *et al.,* 2003). According to Helming *et al.* (2006), in the 1970s, farmers relied on natural regeneration to improve their soil fertility, and now they rely on inorganic fertilizers. Furthermore, the cost of land preparation is increasing by becoming expensive due to costs of machinery, fuel and tractor spares. Increasingly, farmers are pointing to soil degradation as key issue/factors constraining crop production (Taruvinga, 1995). In some communities, rural people have developed agriculture and rural development practices that are environmentally sound, economically viable and socially beneficial, in other words, sustainable. Yet because community driven progress towards sustainable agriculture and rural development has occurred at local level, it has often unrecognized**.** Tanzania recognizes that managing its natural resources sustainably needs to be an integral part of its agenda for agricultural productivity (URT 2001, 2003). In Mvomero district, there is no evidence expressing to what extent the executed CA project contributed to be effective, sustainable and responsive to farmers needs. However, pilot initiatives to introduce sustainable farming practices are many in Tanzania, but little documentation of successful results and lessons.

1.3 Problem Justification

To improve crop production in Mvomero District, cultural practices that conserve fragile soils and extend the period of water availability to the crop should be developed. Effort is needed 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. This study, upon its completion is meant to address solutions on how CA projects activities will continue without external support, so that policy makers will find it easy to enhance agricultural programmes and projects by ensuring its continuity. In addressing those findings, farmers, private dealers and NGOs will be motivated to increase their interest and hence production which in turn will raise their income. Tanzania’s agriculture development plans aims to stimulate and facilitate effective and sustainable production in the smallholder farming systems (URT, 2000).

1.4 Objectives

1.4.1 Main objective

The main objective was to investigate the effectiveness and sustainability of conservation agriculture technologies for increasing farmer production.

1.4.2 Specific objectives

i. To assess the extent to which the introduced CA technologies are still applied by the contact farmers after the project activities closure.
ii. To examine the extent to which the introduced CA technologies have spread from the contact farmers to other farmers.
iii. To assess the farmers awareness and knowledge levels of the introduced CA technologies.
iv. To evaluate the cost effectiveness of CA technology transferred mechanisms used by the project, in the interests of long term use.

1.4.3 Research hypothesis

1.4.3.1 The uses of CA technologies introduced

Ho: The introduced CA technologies are not in use by the contact farmers after the project activities closure.

Ha: The introduced CA technologies are still in use by the contact farmers after the project activities closure.

1.4.3.2 Spreading of CA technologies from contact to other farmers

Ho: The introduced CA technologies have not spread from the contact farmers to other farmers.

Ha: The introduced CA technologies have spread from contact farmers to other farmers.

1.4.3.3 Awareness and knowledge level towards introduced CA technologies

Ho: Farmers awareness and knowledge level is not essential for effective and sustainability of CA technologies

Ha: Farmers awareness and knowledge level is not essential for effective and sustainability of CA technologies

1.4.3.4 Cost effectiveness of CA technology transfer mechanisms

Ho: There is no cost effectiveness of CA technology transferred mechanisms used by the project in the interests of long term use.

Ha: There is cost effectiveness of CA technology transferred mechanisms used by the project, in the interests of long term use.

1.5 Theoretical Framework

Technological changes are believed to lead to poverty alleviation through positive effects on consumer's food prices, producer's income, and laborers' wage income (Winkelmnann, 1998). According to Clancy (2005) who said that, "despite abstract philosophical and more real political problems, a community food security agenda is being crafted, joining the interests of small farms, family farm, and sustainability advocates, and anti-hunger groups. A causal model focuses on describing cause effect relationships which is also known as a 'theory of change' model. This is a 'theory-based evaluation tool that maps out the logical sequence of means-ends linkages underlying a project and thereby makes explicit both the expected results of the project and the actions or strategies that will lead to the achievement of the results' (GEF, 2009).

After reviewing social and economic studies of conservation behavior, Lockeretz (1990) concluded that, researchers were “not even close” to predicting “farmers’ conservation behavior from their personal characteristics, the characteristics of their farms, or their linkages to institutions and information sources.” The main argument, drawing upon actor-network theory (ANT), is that the innovation of CA led to and was created and sustained by new networks and relationships involving farmland, farmers, farm advisors, farm supply gents, new techniques and agricultural scientists. ANT is an analytical perspective that focuses on actor(s) networks as the central problem in all social phenomena. The fundamental principle or ANT is that “entities take their form and acquire their attributes as results of their relations with other entities” (Law, 1999). The reconstruction of successful tillage and planting system in new agroecological setting is nearly always a multi-year project, and the adaptive modification of the system continues almost indefinitely (Nowak and Korsching, 1998) called this an evolutionary process. Failure to recognize that farmers, when surveyed, may be at different stages in this evolutionary are adaptive process can contribute to substantial errors.

1.6 Conceptual Framework

The proposed conceptual framework presents a number of independent variables which can influence dependent variables (effective and sustainable CA technologies). The independent variables that include, land preparation methods, participation of local partners, demographic factors, farm power technology, agricultural inputs and weed management, institutional factors, climatic factors and morbidity factors. Scarboneugh and Kyadd (1992) argue that a conceptual framework should help to indicate the most useful areas(s) in which to focus limited resources and ensure that data collected are relevant to specific objectives of the research. It was from such arguments that a conceptual framework of selecting variables was developed as shown in (Fig. 1).

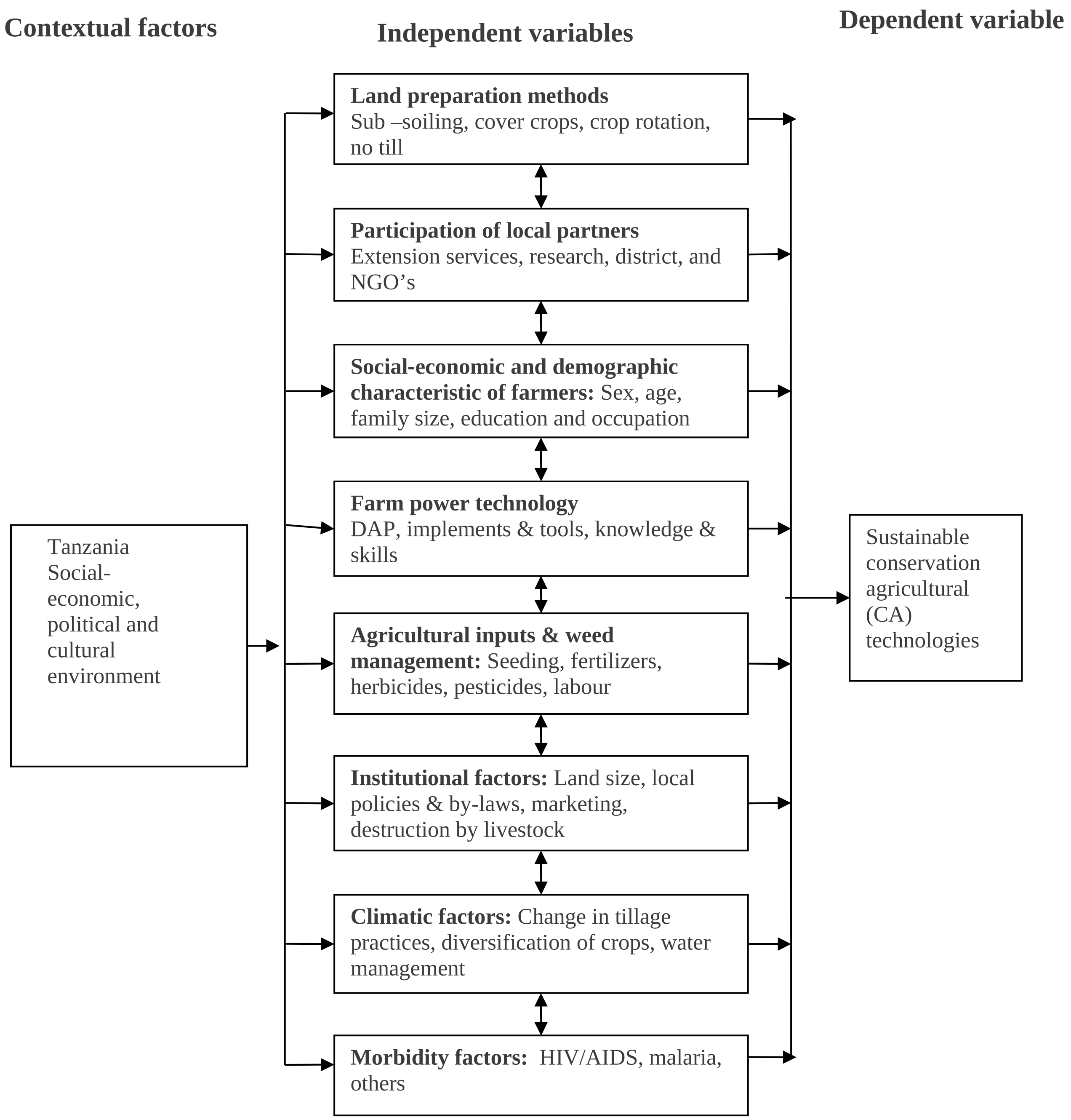
Contextual factors
Independent variables
Dependent variable
Land preparation methods Sub –soiling, cover crops, crop rotation, no till
Participation of local partners Extension services, research, district, and NGO's
Social-economic and demographic characteristic of farmers: Sex, age, family size, education and occupation
Farm power technology DAP, implements & tools, knowledge & skills
Agricultural inputs & weed management: Seeding, fertilizers, herbicides, pesticides, labour
Institutional factors: Land size, local policies & by-laws, marketing, destruction by livestock
Climatic factors: Change in tillage practices, diversification of crops, water management
Morbidity factors: HIV/AIDS, malaria, others
Tanzania Social-economic, political and cultural environment
Sustainable conservation agricultural (CA) technologies

Figure 1: Conceptual framework of sustainable CA technologies in Mvomero District

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of CA technologies

In nature there are laws that rule the diminishing productivity of soils, which have to be taken into account in agricultural and livestock production. Those who disrespect these laws are promoting the degradation of soils and the loss of soil productivity. To respect these laws is indispensable if we aim to obtain a sustainable agricultural production (Derpsch *et al.,* 2006). According to Kyomo (1992), ecologically sound, economically viable and socially just technologies are a key factor for sustainable agricultural development, where the needs of the present are met without compromising the ability of future generations.

The tragic dust storm in the mid-western United States in the 1930s was a wake-up call to how human interventions in soil management and ploughing led to unsustainable agricultural systems. In the 1930s, it was estimated that 91 M ha of land was degraded by severe soil erosion (Utz, 1938), this area has been dramatically reduced today. Because of the benefits that CA systems generate in terms of yield, sustainability of land use, incomes, timeliness of cropping practices, ease of farming and ecosystem services, the area under CA systems has been growing rapidly, largely as a result of the initiative of farmers and their organizations. Consequently, the total area under CA is still small about seven per cent relative to areas farmed using tillage. Nonetheless, the rate of increase globally since 1990 has been 5.3 million ha per annum, mainly in North and South America and in Australia and New Zealand. Currently, South America has the largest area under CA with 49 586 900 ha 46.6 per cent of total global area under CA followed by North America (39 981 000 ha, 37.5 per cent). Australia and New Zealand have 12 162 000 ha (11.4 per cent), Asia 2 630 000 ha (2.3 %), Europe 1 536 100 ha (1.4 %) and Africa 470 100 ha (0.4 %) (Kassam *et al.*, 2009). No-till agriculture in the modern sense originated in the USA in the 1950s, and from then until 2007 the USA had the largest area under no-till worldwide. In the USA, no-till currently accounts for some 25.5 % of all cropland (Derpsch, *et al.*, 2006). CA) has been practised for three decades and has spread widely. Sub-Saharan Africa, therefore, needs and has to get a clue from Asia and Latin America, where conservation agriculture has turned out to be a panacea for many ills in these regions (ACT, 2004). Wherever CA has been adopted it appears to have had both agricultural and environmental benefits. Indeed, CA now spearheads the alternative ‘biological and ecosystems’ paradigm that can make a significant contribution to sustainable production intensification including agricultural land restoration and meeting agricultural and food needs of the future human populations (Uphoff *et al.*, 2006; FAO, 2008; Pretty, 2008; Friedrich *et al.*, 2009; Kassam *et al.*, 2009, FAO, 2010).

2.2 Conservation Agriculture (CA) Definition

Conservation agriculture involves some land management practices that allow for the restoration of soil nutrients, increased infiltration of rain and surface water, enhanced retention of soil moisture, the regeneration and maintenance of a good surface vegetative cover and rooting depth (Shetto, 2006). CA has often been used interchangeably with conservation terms, such as conservation tillage, zero-tillage, or direct seeding and planting without disturbing soil surface (FAO, 2001; Giller *et al.*, 2009). However, Wall (2007) have argued that the emphasis of CA should shift from the tillage component alone to a broader concept of a sustainable agricultural system that embraces such ideas as tillage reduction, retention of adequate levels of crop residues, and use of crop rotation.

2.3 Conventional Agriculture

In sub- Saharan Africa, crop farming is characterized by frequent soil tillage, removal of waste crop materials from the fields by livestock grazing or burning, and, in many cases, mono-cropping (Chigonda, 2008). Previously, in the 1950s to the early 1970s, African farmers could respond to declining productivity by shifting to new areas. This is no longer feasible, let alone possible, due to increasing population. In consequence, fields are getting not only overused but also smaller. The net effect is declining productivity on account of declining soil quality, soil compaction, and infiltration. At a human level, there is increasing food insecurity and poverty in the region. As Chigonda (2008) contends, only a drastic change of farming systems, from the unsustainable towards more sustainable soil management, can improve the situation or even reverse the trend.

2.4 Project Effectiveness

Is the extent to which project objectives have been achieved or can be expected to be achieved. is defined by a handbook on productivity management as the degree to which goals are attained (Prokopenko, 1987). Agricultural extension has many goals such as social goals (e.g., farmer welfare) and economic goals (e.g., increased income). These operational goals are of special significance because their attainment makes realization of other goals possible.

2.5 Project Sustainability

Is an overall assessment of the extent to which positive changes achieved as result of the project can be expected to last after the project has been terminated. In many cases this is a question of the relationship between the necessary use of local resources and how recipients view the project. Sustainability is the final test of the project success. According to Howlett and Nagu (2001), sustainability of the project refers to the capability and capacity for the project’s benefits to be maintained beyond the life of the project, particularly after the specific project funds are exhausted. A key element in project planning and management is therefore geared to institutional development, training and generally creating the conditions for sustaining the project benefits beyond its actual life. The early and continuing participation of stakeholders may be an important element in this sustainability.

2.6 Features Supporting Sustainability of CA

According to its overall goal, CA makes better use of agricultural resources than does conventional agriculture through the integrated management of available soil, water and biological resources such that external inputs can be minimized (FAO, 2001; Garcı´a-Torres *et al.*, 2003). Its primary feature, and indeed central tenet, is the maintenance of a permanent or semi-permanent soil cover, be it a live crop or dead mulch, which serves to protect the soil from sun, rain and wind, and feed soil biota. This biotic community is essential as it provides a 'biological tillage' that serves to replace the functions of conventional tillage (FAO, 2001). Thus, 'conservation-effectiveness' encompasses not only conserving soil and water, but also the biotic bases of sustainability (Shaxson, 2006).

2.7 CA in Latin America

Latin America has the highest rate of adoption of CA practices in the world. The first recorded attempt at mechanized zero tillage was in sub-tropical Brazil, between 1969-1972 and in 1981/2 in tropical Brazil. The World Bank reiterated these observations in its review of a project in Brazil promoting sustainable agriculture, modern forms of land management, and soil and water conservation. It considered rural extension to be a pivotal element in the project. In addition, monetary incentives were highly successful in motivating group formation among farmers, leading to an increase in cooperation and social capital. It recognized rapid paybacks and government financial incentives and support as key influences on adoption (Sorrenson *et al.*, 1998 and World Bank, 2000).

2.7.1 CA in the sub Sahara region

CA is now beginning to spread to the sub-Saharan Africa region, particularly in eastern and southern Africa, where it is being promoted by FAO, CIRAD, the African Conservation Tillage Network, ICRAF, CIMMYT, ICRISAT, IITA (Haggblade and

Tembo, 2003; Baudron *et al.*, 2007; 2007; Kaumbutho and Kienzle, 2007; Nyende *et al.*, 2007; Ernstein *et al.*, 2008). Building on indigenous and scientific knowledge and equipment design from Latin America, farmers in at least 14 African countries are now using CA i.e. Burkina Faso, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mozambique, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. CA has also been incorporated into the regional agricultural policies by NEPAD and more recently by AGRA. In Africa CA is expected to increase food production while reducing negative effects on the environment and energy costs, and result in the development of locally adapted technologies consistent with CA principles (FAO, 2008).

2.7.2 Evolution of CA in Tanzania

CA has increasingly gained recognition in southern Africa as package of technology interventions that are meant to conserve of soil water, nutrients and farm power (Kizito *et al.*, 2007). An integrated extension approach has been developed in Tanzania based on on-farm minimum tillage trials, focusing on and analyzing linkages between livestock feeding strategies and their availability for traction, tillage and other aspects of crop husbandry. The results indicate that adopting these systems, which fit into the prevailing socio-economic and agro-ecological environments, can substantially increase fodder availability and staple food crop yields while reducing traction requirements (Rockstrom *et al.*, 2009).

The agricultural policy of Tanzania discussed alleviating poverty and reducing hunger by 2025, using available resources in farming communities. In 2006, the department of Agriculture Mechanization in the Ministry of Agriculture Food and Cooperatives gave a boost to disseminating conservation agriculture by supporting farmer field schools in 10 more districts and 10 oxen training centres. The ministry is supporting farm supplies such as cover crop seed, fertilizer and rippers. The government opened a credit line for farmer groups to buy conservation agriculture implements and trained village facilitators to promote CA in the rest of the country (Shetto and Owenya, 2007). Mvomero being one of the pilot district practicing CA, currently the government supports local laws prohibiting grazing on farms after harvest, which was limiting conservation agriculture adoption. Moreover, farmers adjusted their cropping strategy when switching from conventional agriculture to CA whereby yield trials comparing the same crop under either cultivation system expressed yield difference between CA and conventional agriculture as shown in Table 1.

Table 1: Comparative CA and Conventional Agriculture crop harvest in Mvomero District

Group Name	Maize Harvest (Kg)		Cover Crop Harvest (Kg)		
	Conservation Plot (CA)	**Conventional Plot**	**Lab lab**	**Cannavalia**	**Pigeon peas**
Mama Milama	2300	1,600	15	30	11
Amani	9350	5,330	40	509	23
Ukwajuni	9810	5,870	17	405	9
Igembe Sabo	4500	2,900	112	20	81
Mbugani	3030	2,240	144	113	103
Tushikamane	3985	3,250	120	190	20
Ukombozi	2850	1,975	0	12	6
Makuture	4000	1,900	23	6	0
Dibamba	10 400	7,333	82	400	22
Mbuyuni	8219	6,190	32	600	12
TOTAL	**58 444**	**38 588**	**585**	**2285**	**287**

Source: Mvomero District Council, (2006)

2.8 Land Preparation Methods

2.8.1 Sub-soiling

CA coupled with sub-soiling; reduce soil compaction, which was created after many years of no-till (He, 2006). In Njombe District, Tanzania, the grain yield in maize dropped from 5 tons/ha to 1.2 ton/ha in ten years. This was caused by the formation of plough pans. 2 - 10 cm below the surface due to continuous conventional tillage, using 34 discs trailed harrows year in year out (Shetto and Kwilingwa, 1989). Results from field trials conducted between 1999 and 2002 found subsoiled plots typically yielded 4 t/ha whereas plots that had not been subsoiled yielded only 0.75 – 1 t/ha (Mariki, 2003). According to Bishop-Sambrook *et al.* (2004), benefits led to about 250 farmers in Karatu, Tanzania, covering 150 ha, adopting CA by 2003 and had privately continued subsoiling with the help of TFSC.

2.8.2 Cover crops

Providing adequate soil cover is cornerstones of CA. Legumes represent a substantial input of N in tropical agricultural system through symbiotic N_2 fixation (Giller, 2001). Cover crops are crops planted primarily to manage soil fertility, soil quality, water, weeds, pests, diseases and biodiversity in agro ecosystems (Lu *et al.*, 2000), ecological systems managed and largely shaped by humans across a range of intensities to produce food, feed, or fibre. In addition, deep rooted legumes increase N availability in surface horizons by tapping nutrients in deep horizons and redistributing them at the soil surface in the litter (Bünemann *et al.*, 2004; Gathumbi *et al.*, 2003). This N accumulated in legume biomass can become available for the succeeding crops on the short term through mineralization of the residues, and on the long term through incorporation of the decomposing residues into soil organic matter fractions (Vanlauwe *et al.*, 1998a). This build up of soil organic N stocks is essential for the long-term sustainability of the system (Mulvaney *et al.*, 2009). In addition to N fertilization effect, yield increase of the crop following a legume cover crop may also be related to a decrease in weed pressure and an increased soil cover (Schmidt *et al.*, 2005) as well as a pest control effect (Cherr *et al.*, 2006). Cover crops contribute to the accumulation of organic matter in the surface soil horizon (Roldan *et al.*, 2003).

A fundamental scientific approach, in particular in crops, plant breeding, plant nutrition and crop protection, supported by technology development for mechanization, has made it possible to considerably increase the light, water and nutrient use efficiencies and cropping intensities in the major crops of the world (Tilman *et al.,* 2002). With regards to crop yield, preliminary results show that CA reduces significantly the soil erosion and soil degradation and leads to comparable increase in grain yield (Mganilwa, *et al.,* 2007). Legumes are grown as cover crops and serve as short term fallow species and have proven to be an effective means of sustaining soil fertility (Cheer *et al.,* 2006). Legume cover crops when incorporated into the soil, improve soil organic matter and moisture retention, soil workability, retard erosion and suppress weeds (Khisa *et al*., 2002).

2.8.3 Cover crops commonly used in Mvomero

Sufficient amounts of mineral fertilizers are not affordable and in small-scale farms, nitrogen (N) depletion is a major production constraint (Ayarza *et al*., 2007). Introduction of cover crop legumes can be beneficial to such a system due to their ability to add N via symbiotic N_2 fixation (Boddey *et al.,* 1997; Ojiem *et al.,* 2007) and to provide surface mulch during the dry season or to provide fodder to livestock (Said and Tolera 1993). In Mvomero district, CA was effective in the fight against hunger and poverty whereby lablab sell at 1500 - 2000 Tsh/kg. The yields under CA are generally higher and farmers noted that intercropping of maize with cover crops (pigeon pea and D. lablab) provided two harvests per season instead of one.

2.8.4 Crop rotation

Previous studies have indeed shown positive effects of canavalia on crop productivity when integrated in the crop rotation (Bordin *et al.,* 2003). Maize yield was higher after a rotation with canavalia than after other cover crops, because of its high biomass production and rapid litter decomposition rate (de Carvalho *et al*., 2008).

2.8.5 No or minimal mechanical soil disturbance

Direct seeding involves growing crops without mechanical seedbed preparation or soil disturbance since the harvest of the previous crop. The term direct seeding is used synonymously with no-till farming, zero tillage, no-tillage, direct drilling, etc. No-tillage involves slashing the weeds and previous crop residues or spraying herbicides for weed control, and seeding directly through the mulch using direct seeding implements. All crop residues are retained, and fertilizer and amendments are either broadcast on the soil surface or applied during seeding (FAO, 2006).

2.8.6 Jab-planters

The jab-planter used for CA is a manual implement with two points that are pushed into the moist soil through the mulch, and opened to release the seed and fertilizer. The jab planter is quicker than hoe or pointed stick methods once the technique is mastered, and seed and fertilizer can be placed with more precision. However, experience is needed to be able to seed well and accurately, and in wet clay soils, seeding can be difficult as soil sticks to the points. Jab planters are also more expensive than hoes or pointed sticks, and are still difficult to purchase (Wall, (2007).

2.8.7 Animal traction direct seeders

Direct seeders are designed to seed into surface mulch in untilled soil. The implement has separate seed and fertilizer bins and a cutting disk (coulter). The coulter cuts through the residues, a ripper tine opens a furrow, and the seed and fertilizer are placed in the furrow– all in a single operation. Seeder units are manufactured for both oxen and donkeys. First introduction of animal-drawn direct seeders in a Maasai village in northern Tanzania (FAO, 2007).

Plate 1: Hand-Jab planters ready for supply; local manufactured by NANDRA Engineering, Moshi. Tanzania (2006).

Plate 2: One of CA farmer planting in the trash using hand jab-planter – Babati Tanzania (2005)

Plate 3: DAP direct seeder in Babati District – Tanzania.

Plate 4 : Farmers using DAP- CA transplanter for direct seeding- Karatu District, Tanzania.

2.9 Cultural Aspects for Effective and Sustainability of CA

In most cases the integration of livestock and crops is not only a common practice but it is also a norm. Such cultural norms conflict with the CA practice of maintaining a soil cover with crop residues which are otherwise used as fodder for livestock. In most cultures, a good farm is synonymous with clean farm, which is the exact opposite of CA. Adoption of new technology by most African farmers is constrained by their difficult economic conditions and by their beliefs and culture. Because of this, all aspects of their production systems and economic behavior must be taken into account when technologies are developed (Eponou, 1996).

2.9.1 Agricultural extension agency

Extension has long been grounded in the diffusion model of agricultural development, in which technologies are passed from research scientists via extensionists to farmers (Rogers, 1983). AEAs approach is exemplified by the training and visit (T&V) system. It was first implemented in Turkey in 1967 and later widely adopted by governments (Benor, 1987; Roberts, 1989). Llewellyn *et al.* (2005) and D'Emden *et al.* (2008) studied well advanced diffusion processes for no-tillage cropping and integrated weed management practices. For some key variables they found that non-adopters were well-informed already and held perceptions similar to adopters. Our approach incorporates components of co-innovation described by Rossing *et al*. (2009) in which end users of technology become active participants in its development through frequent interaction, monitoring, and redesign.

2.9.2 Linkages between research, extension, farmers and NGOs

The experience of successful CA reveals that, the process has been achieved by close collaboration between farmers, researchers and extensionists; on farm trials, farmers-driven adaptations, strengthening of farmer's organizations, development of farm management skills, and private-public partnership (Evers and Agostini, 2001). Conscious efforts in establishing institutions that will spread the technology to new areas in the districts and coordinating various stake holders in participatory manner in implementing earmarked initiatives, will promote a sense of ownership and synergy among those involved thus the key to sustainability (Shetto and Lyimo, 2001). In the South Uluguru Mountains, CARE international as a private sector is attracted and has introduced a CA project aiming to sustain and support the livelihoods of 4000 households involving 20,000 underserved men, woman and children by the year 2012 starting by 2009.

2.9.3 Farm power technology

In order to increase food production, the availability of farm power is central to the success of these initiatives because the area under cultivation, the timeliness of field operations and effective use of farm inputs is ultimately determined (Bishop-Sambrook, *et al.*, 2004). In Tanzania, about 70% of the crop area is cultivated by hand hoe while 20% is cultivated by ox plough and 10% by tractors (URT, 2004). Majority of the producers are small holder farmers with typical farm sizes range from about 0.9 to 3.0 ha (URT, 2004).

2.9.4 Labour demand for sustainable CA

Labour is one of the factors limiting the uptake of agricultural technologies and it has to be taken into consideration that HIV/AIDS and other pandemics such as malaria has adversely affected the agricultural labour force (ACT, 2008). The perception of no-till farming offering labour saving benefits is one of the principal reasons cited by farmers in South America for adopting these practices (Pieri *et al.,* 2002). Studies of no-tillage systems in Brazil and Paraguay suggest savings range from 10 - 70% of the conventional labor input depending on farming system and conventional tillage practice.

2.9.5 Soil quality a need for effective and sustainable agriculture

Many studies show that manure is far more beneficial than other types of organic inputs for increasing soil carbon (C) stocks and yields (Farage, 2007; Gicheru *et al.,* 2005; Kapkiyaia *et al.,* 1999). But even though it is currently underutilized, there is not enough manure available even at low rates (Mapfumo *et al.,* 2007). Legumes are often considered to be the only option for poor smallholders on degraded soils (Kaizzi *et al.,* 2006), but are most effective at improving soil quality when nutrient contents are already adequate (Kone ´ *et al.,* 2007).

2.9.6 Effective and sustainable principles of CA

The link between rural livelihoods and natural resources management is of fundamental importance to effective poverty reduction strategies (Kalonga *et al.,* 2003). CA emphasizes that the soil is a living body, essential to sustain quality of life on the planet. In particular, it recognizes the importance of the upper 0-20 cm of soil as the most active zone, but also the zone most vulnerable to erosion and degradation. By protecting this critical zone, we ensure the health, vitality, and sustainability of life on this planet. Indeed, CA now spearheads the alternative biological and ecosystems paradigm that can make a significant contribution to sustainable production intensification including agricultural land restoration and meeting agricultural and food needs of the future human populations (Uphoff *et al.*, 2006; FAO, 2008; Friedrich *et al.*, 2009; Kassam *et al.*, 2009, FAO, 2010).

2.9.7 Soil health

Definition of soil health refers to the integration of biological with chemical and physical approaches to soil management for long-term sustainability of crop productivity with minimum negative impact on the environment. Healthy soils maintain a diverse community of soil organisms that help to control pests, form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, and improve soil structure (Wolf, 2000).

2.9.8 Mainstreaming gender and HIV/AIDS related issues in CA

Young people are moving out, and HIV/AIDS and malaria create a severe labour shortage. Many draught animals have died because of disease, or their owners have had to sell them to pay for medical treatment and burials. A lack of farm power forces farmers to look for other ways to farm (IIRR and ACT, 2005). The importance of addressing gender in agricultural production is widely appreciated. Similarly the impact of HIV/AIDS and other health pandemics on the agricultural labour force cannot be overemphasized. But the high mortality and morbidity due to HIV/AIDS make populations moribund which significantly reduces the labour force available for agriculture. This has led to increased vulnerability and dependence, especially in fragile communities with weak social structures. CA as a labour saving practice could be a plausible strategy to deal with labour constraints (ACT, 2008)

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

Mvomero district has four divisions, 17 wards 101 villagers and 577 hamlets. Mvomero district is among the six councils of Morogoro Region. Others are the Morogoro, Kilosa Kilombero, Ulanga, and Morogoro Municipal. The district boundaries are as follows: to the north is Handeni district, to the east Bagamoyo, to the south Morogoro Municipal and Morogoro District, and to the west there is Kilosa District. Mvomero District is located at North East of Morogoro Region between 8000' and 10 000' Latitudes south of equator also between Longitudes 37 000 and 28 022 East. The District has the total area of 7325 k.m.sq. Agriculture accounts for 80-90% of the region's economic activity, which consists of small and large scale farms as well as sugarcane and sisal plantations (URT, 1997).

3.3 Climate

Rainfall in the district is bimodal, with a long wet season from March to May and a short wet season from October to December. Average annual temperatures in Mvomero range from 20-30ºC (Mlozi *et al.,* 2006). The northern area has a humid to sub humid climate, and annual rainfall ranges from 1500 to 2000 mm (Lyimo *et al.,* 2004) while the southern part of the district is much drier, with annual rainfall between 600 and 1200 mm (Karimuribo *et al.,* 2005).

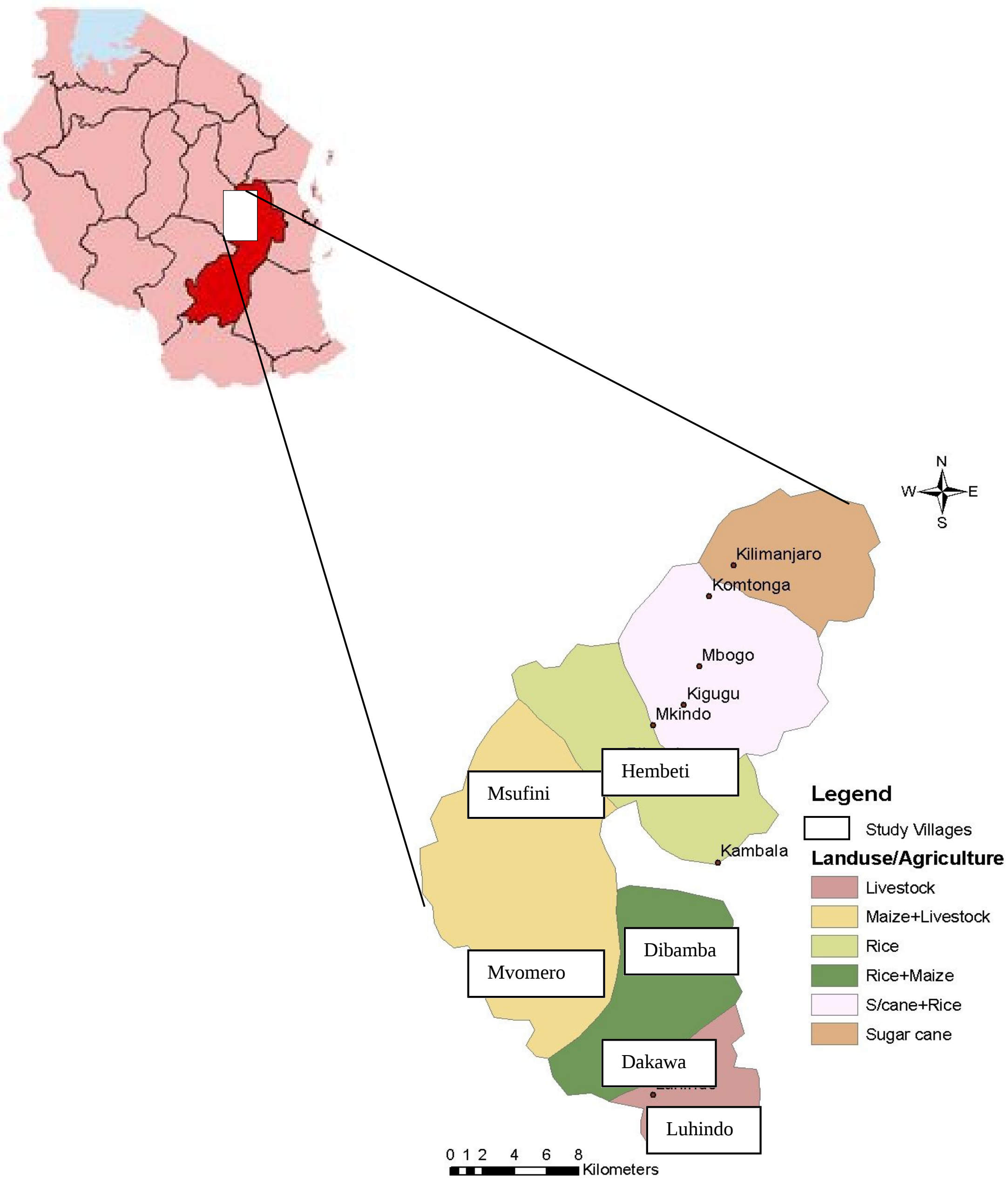

Figure 2: Six villages included in the study as well as primary agro-ecological practices in Mvomero District.

Source: Randell (2008).

3.4 Choice of the Study Area

The reason for carrying the study in Mvomero, it is one of the six pilot districts in the country where by *Conservation Agriculture for Sustainable Agriculture and Rural Development* (CA SARD) support project were initiated by FAO between 2004 to 2006. The research involves the assessing how this project have and continue to achieve the intended concept aimed to enhance agricultural production on sustainable and environmental friendly basis in Mvomero District.

3.5 Research Design

The study employed a cross sectional research design where by data were collected only once. Bailey (1994) noted that a researcher can identify the population relevant to his/her interest.

3.6 Sample Procedure

3.6.1 Sampling unit

The target population for the study was involving groups of people both male and female households who implemented CA project and non participants individuals. The sampling unit of the study was the household, which was defined as a group of people who eat from a common pot, share a dwelling house and may cultivate the same land and recognize the authority of one person, the household head.

3.6.2 Sampling and sample size

Purposive sampling method was employed in selecting the villages. Random sampling was used to select CA respondents participating and non-participating farmers. The target population for the study involved ten groups of people both male and female who implemented CA project under FAO and MAFC assistance, and non-participant’s farmers used for comparison in various issues. The study involves six villages out of 101 these were Hembeti, Msufini, Mvomero, Wami Luhindo, Wami Dakawa, and Dibamba from three wards of Wami Dakawa, Hembeti and Mvomero. Each village provided 10 participants and 10 non-participants respondents randomly selected to give a total sample of 120. (6 x10 x 2 total 120).

3.6.3 Data collection methods

Both primary and secondary data were collected in this study. A set of structured questionnaire with closed and open ended questions and interview were used to collect primary data. Questionnaire was tested to check the validity. Pretested survey was done with 10 respondents at Dumila village in Kilosa district, not included in the study and revised questions that respondents in the pre-test phase found unclear. Respondents were asked to indicate the source of information of the CA technology that they were using. Other tools used during data collection included discussion with key informants using checklists of issues of interest and participant observation. Participant observation consisted in directly observing practices in the village, trying to learn how and why things were done the way they were done (Martin, 1995). The research assistants and the researcher used the local vernacular language (Kiswahili) to facilitate understanding of the questions by respondents. Data management and analysis followed after completion of the data collection exercise, whereby data cleaning was done by scrutinizing the completed schedules to identify and minimize as far as possible errors, incompleteness, misclassification and gaps in the information obtained from the respondents.

3.6.4 Primary data

Data were gathered directly from respondent where by questionnaire instruments were used and unit of collection were households. Again, a checklist to key informant interview was conducted with District Subject Matter Specialists (DSMS), Village leaders, department officers and community leaders.

3.6.5 Secondary data

Data were obtained through MAFC, libraries, research works, and internet. Others were collected through review of available relevant documents at the district ward and village levels. Important data of the study area collected included demographic data, climatic data, soil data and crop production.

3.6.6 Data processing and analysis

Data collected through questionnaires was compiled, coded, entered and analysed by using SPSS computer programme version 12. Descriptive statistics including means, range, frequencies, and percentages were used in summarizing data. The household from CA groups was taken as a unit of analysis. Furthermore, association between grouped variables using the Chi square was employed to test association between qualitative and quantitative variables such as yield, income, cost of production, use of the technology and continue use in the future and labour supply and workload. Hypotheses were tested by using t-test to see if there is significant use of CA practices among project and non-project participants. Researcher applied a descriptive-regression modal analysis for this study. The regression analysis procedure was preferred to enable the researcher to determine the extent of relationship existing between variables. It also enabled the researcher to test the hypothesis about the relationship and variation between variables as well as to assess the magnitude and direction of the relationship.

Regression model:

$$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6\ldots\ldots b_nx_n+e\ldots\ldots \quad (1)$$

Where:

Y=Dependent variable (Crop yield under CA)

B_o = Constant

b_1 - b_n = coefficients

x_1- x_n = independent variables

e = error term

x_1=Age of respondents

x_2= Education level

x_3= Occupation

x_4= Household family size

x_5= Period involved in crop farming

CHAPTER FOUR

4.0 RESULTS AND DISCUSSON

4.1 Respondents' Characteristics

4.1.1 Sex

Table 2 indicates that, of the 120 respondent, two thirds, 82 (68 %) and 38 (32%) of the project non-participating respondents were males. Meanwhile, 43 (72%) and 39 (65%) of the project participants and non-project participants were males respectively. Of the 120 respondents, 17 (28%) were females non-project, while 21 (35%) project participating were females, respondents. The explanation for the large turn-up of males for the interviews was that the survey was in the month of February, which is a peak land preparation period that involves women. The overall mean differences for this variable were not statistically significant at p> 0.432.

4.1.2 Age

Table 2 indicate that, of the total 120 respondents, 29 (24%) were aged between 18 and 30 years, and 61 (51%) were aged between 31 and 45 years, and 29 (24%) were aged between 46 and 60 years. Yet, 15 (25%) of non-project participant respondents, and 14 (23%) project participants were aged between 18 and 30 years, whereby 31 (52%) and 30 (50%), were between age groups of 31 and 45. Also, 14 (23%) non-project respondents and 15 (25%), project participating respondents were aged between 40 and 60 years. Respondents in the age group of between 31-45 years old, who were project respondents, were more aggressive compared to other age groups to participate with CA technology practices. With regards to soil conservation technologies whose benefits are accrued after a long time, Robbestad (2004) observed that older farmers are less likely to invest in soil conservation activities which are beyond their reasonable life expectancy. However, John

(2003) observed that although older people are more experienced, their receptivity to new ideas and technologies, typically decreases with age, but in this study there was no statistical significant difference between them at p>0.781.

Table 2 Household characteristics (n=120)

Variables	Non-project participating respondents		Project participating respondents		Overall		χ^2 – value	p-value
	Freq.	%	Freq.	%	Freq.	%		
Sex								
Male	43	72	39	65	82	68	0.626^{ns}	0.432
Female	17	28	21	35	38	32		
Age group								
18 – 30	15	25	14	23	29	24	1.085^{ns}	0.781
31 – 45	31	52	30	50	61	51		
46 – 60	14	23	15	25	29	24		
Above 60			1	2	1	1		
Education								
No formal education	6	10	10	17	16	13	4.226^{ns}	1.512
Adult education	12	20	6	10	18	15		
Primary education	31	52	32	53	63	53		
Ordinary secondary education	7	12	9	15	16	13		
Advanced secondary education	3	5	3	5	6	5		
Post secondary	1	2			1	1		
Family size								
1 – 3	19	32	19	32	38	32	0.594^{ns}	0.898
4 – 6	16	27	13	22	29	24		
7 – 10	23	38	25	42	48	40		
Above 10	2	3	3	5	5	4		
Household status								
Male headed	37	62	38	63	75	63	1.741^{ns}	0.623
Female headed	13	22	9	15	22	18		
Grandparent headed	7	12	7	12	14	12		
Orphan headed	3	5	6	10	9	8		
Overall	60	100	60	100	120	100		

Note: ns = is not statistically significant at p< 0.05.

4.1.3 Education level

Of the 120 respondents, for project participating respondents, 16 (13%) mentioned that they had no formal education, 18 (15%) had attended adult education, 63 (53%) had attended primary, 16 (13%) had O-level education, and six (5%) had A-level education (Table 2). For the non- project participants, six (10%) indicated that they had no formal education, 12 (20%) had attained adult education, 31 (52%) had attained primary level education, while seven (12%) had attained ordinary level education. Education level of respondents was responsible for project effectiveness and sustainability and was vital in assessing respondent's ability in grasping CA new principles and concepts. However, this variable had no statistical significant difference at p>1.512 (Table 2).

4.1.4 Family size

Table 2 also shows that of the 120 respondents, 38 (32%) indicated to had 1 to 3, while 29 (24%) said they had 4 to 6 members in the household. Further, 48 (40%) of the respondents had between seven and ten members in the household. For the project participating respondents, 19 (32%) reported that they had between one to three members in the household, while 13 (22%) and 25 (42%) indicated having 4 - 6, 7-10 members in the household respondents, respectively. For both groups of respondents, less than half of the respondents indicated having between 7-10 members in their households (Table 2). The overall mean difference for this variable had no statistical significant at p>0.898.

4.1.5 Household status

Table 4, shows household status and of the 120 respondents, 75 (63%) reported that they were male-headed, 22 (18%) were female-headed. Yet, 14 (22%) respondents mentioned that they were grandparents headed, and nine (8%) were orphan-headed. For the project participating respondents, 38 (63%) mentioned that they were male-headed household and

13 (22%) were female-headed households. Similarly, of non-project participating respondents, 37 (62%) and nine (15%), reported that they were male-and female-headed, respectively. Few respondents were headed by other groups. Study results indicated that, adopting CA technology was not related to who headed a household as it was not statistically significant at p<0.62 (Table 2).

4.1.6 Respondents occupations

Respondents were asked about their occupations. Table 3 shows that of the 120 respondents, 69 (58%) reported that they did crop farming, while 37 (31%) did both crop farming and livestock keeping, and seven (6%), earned income from formal wage employment and livestock keeping.

Table 3: Household characteristics (n=120)

Variable	Non-project respondents		Project respondents		Overall			
	Freq.	%	Freq.	%	Freq.	%	χ^2 – value	p-value
Occupation								
Crop farming	28	47	41	68	69	58	8.816 *	0.032
Livestock keeping	3	5	4	7	7	6		
Both 1 and 2	26	43	11	18	37	31		
Wage employment	3	5	4	7	7	6		
Period did crop farming								
Years 0 – 1	1	2	2	3	3	3	9.539 ^{ns}	0.145
1 – 5	14	24	21	35	35	29		
5 – 10	16	27	20	33	36	30		
11 – 15	10	17	3	5	13	11		
16 – 20	9	15	6	10	15	13		
21 – 25	6	10	2	3	8	7		
Beyond 25	3	5	6	10	9	8		
HH members provide enough labour								
Yes	22	38	38	64	60	51	10.087 *	0.039
No	38	62	22	36	60	49		
Overall	**60**	**100**	**60**	**100**	**120**	**100**		

HH = Household; Note: ns = not statistically significant at p> 0.05).

For the project participating respondents, 41 (68%) mentioned that they did crop farming and 11 (18%) did both crop farming and livestock keeping. Few were employed (7%) and kept livestock (7%). Here, over two thirds (68%) of the respondents did crop farming. For the non- project participating respondent, 28 (47%) mentioned that they did crop farming and 26 (43%) did both crop farming and livestock keeping. Few were employed (5%) and kept livestock (5%). Here, over one thirds (47%) of the respondents did crop farming. The overall mean difference for this variable was statistically significant at $p<0.032$ (Table 3).

4.1.7 Period did crop farming

Table 3 indicates that, of the 120 respondents, 36 (30%), 35 (29%) and 15 (13%) mentioned that they had been doing crop farming between 5 to 10, 1 to 5 and 11 to 15 years, respectively. For the 60 non-project participating respondents, 16 (27%), 14 (24%), ten (17%), and nine (15%) reported that they had been doing crop farming between 5 to 10, 1-5, 11-15, and 16-20 years, respectively. The study results showed that over half, 30 (51%) of the non project participating respondents had done crop farming between 1-10 years. This period meant that they could have as well adopted the CA technology. Observation showed that project farmers trained other no-project farmers on CA. Also, some non-project farmers wanted to join the CA groups because their fellows got free inputs such as seeds, fertilizers, hand jab planters, direct seeders, knife rollers and ZAMWIPE herbicide applicators. For the 60 project participating respondents, 20 (33%), 21 (35%), three (5%), and six (10%) reported that they had done crop farming between 5 to 10, 1-5, 11-15, and 16-20 years, respectively. The study results shows that over half, 41 (68%) of the project participating respondents had done crop farming between 1-10 years. This period meant that they could as well adopt the CA technology.

4.1.8 HH provision of labour

Table 3 shows that, of the 120 respondents 60 (51%) indicted that HH members provided labour in crop farming. For the non-project participating respondents, 22 (38%) mentioned that HH member provided labour in crop farming, while this aspect was reported by two thirds 38 (64%) of the project participating respondents. The overall mean difference for this variable was statistically significant at p>0.039.

4.1.9 Age and acreage cultivated by a hand hoe

Table 4 shows area cultivated using a hand hoe by age groups of respondents for the two groups. For the 60 project participating respondents, over half, 31 (52.5%) mentioned that, they cultivated 2 acres using hand hoe. Further, of the 31 respondents, a quarter, 15 (25%) reported being in the age group of 31-45 years old.

Table 4: Area cultivated using hand hoe by age group (n=120)

Project participation			Age of respondent				Total
			18 - 30	31 – 45	46 - 60	Above 60	
Non-project respondents		Acreage					
X^2	p-value	1.00	2 (3.3)	1 (1.6)	4 (6.6)	0	7(11.5)
21.461	0.091 ns	1.50	0	5 (8.2)	2 (3.3)	0	7 (11.5)
		2.00	8 (14.8)	19 (31.1)	7 (11.5)	0	34 (57.4)
		3.00	0	2 (3.3)	0	0	2 (3.3)
		4.00	2 (3.3)	5 (8.2)	0	0	7 (11)
		5.00	1 (1.6)	0	1 (1.6)	0	2 (3.2)
		6.00	1 (1.6)	0	0	0	1 (1.6)
	Total		14 (24.6)	32 (52.5)	14 (23)	0	60 (1000
Project respondents		1.00	2 (3.4)	5 (8.5)	4 (6.8)	0	11 (18.6)
X^2	p-value	1.50	0	0	1 (1.7)	0	1 (1.7)
8.958	0.961 ns	2.00	8 (13.6)	15 (25.4)	7 (11.9)	1 (1.7)	31 (52.5)
		3.00	2 (3.3)	2 (3.4)	2 (3.4)	0	6 (10.2)
		4.00	1 (1.7)	3 (5.1)	0	0	4 (6.8)
		5.00	1 (1.7)	2 (3.4)	1 (1.7)	0	4 (6.8)
		6.00	0	2 (3.4)	0	0	2 (3.4)
	Total		15 (23.7)	29 (49.2)	15 (25.4)	1 (1.7)	60 (100)

Note : ns = not significant. Figures in parentheses are percentages and those out of parentheses are frequencies.

For the 60 non-project participating respondents, over half, 34 (57.4%) indicated that they cultivated two acres using hand hoe. Further, of the 34 respondents, more than a quarter, 19 (31.1%) reported being in the age group of 31-45 years old. In Tanzania, about 70 percent of the crop area is cultivated using hand hoes by majority of smallholder farmers with typical farm sizes ranging from 0.9 to 3.0 hectares (URT, 2004). The difference between both non- and project participants was not statistically significant at p>0.091 and p>0.961, respectively.

4.1.10 Education level and provision of labour

Observation showed that, shortages of labour in the study villages was due to old age, and most children going to school. Of the 60 non-project participating respondents, 24 (39.3%) agreed that there were no shortages of household labour. On the other hand, 36 (60.7%) of the non-project participating respondents said that there were shortages of household labour in crop farming. The responses were not statistically significant at $p \leq 0.542$ (Table 5).

Table 5: Education level and provision of labour (n=60)

Household provide enough labour?		Respondent education level: No formal education	Adult education	Primary education	O-level education	A-level education	Post secondary	Total
Non-project respondent	Yes	3 (4.9)	6 (9.8)	13 (21.3)	1 (1.6)	1 (1.6)	0	24 (39.3)
$X^2 = 4.053$, $p \leq 0.542$	No	3 (4.9)	6 (9.8)	17 (29.5)	7 (11.5)	2 (3.3)	1 (1.6)	36 (60.7)
Total		6 (9.8)	12 (19.7)	30 (50.8)	8 (13.1)	3 (4.9)	1 (1.6	60 (100)
Project respondent	Yes	8 (13.6)	2 (3.4)	18 (30.5)	7 (11.9)	1 (1.7)	0	36 (61)
$X^2 = 7.079$, $p < 0.132$	No	2 (3.4)	4 (6.8)	15 (23.7)	1 (1.7)	2 (3.4)	0	24 (39)
Total		10(16.9)	6 (10.2)	32 (54.2)	8 (13.6)	3 (5.1)	0	60 (100)

Of the 60 project participating respondents, 36 (61%) agreed that there were no shortages of household labour. On the other hand, 24 (39%) of the project participating respondents said that there were shortages of household labour in crop farming. The responses were not statistically significant at $p<0.132$ (Table 5).

4.2 Respondents Farm Size During and After Project Closure

Main crops under CA practices in Mvomero District were maize, *Dolichos lablab,* sorghum, Canavalia, cowpeas and pigeon peas. Lablab was a preferred cover crop because it was economical, reduce weed and improved soil quality, but Canavalia has few food uses and market opportunities. And the main crop preferred to be intercropped with lab lab by the respondents were maize. Table 6 indicates that of the 60 project participating respondents, less than half, 33 (28.6%) indicated to had planted maize on half an acre. Among them 19 (15.9%) was during the project, and 14 (12.7%) after the project closure. Again, of the 60 project participating respondents, 36 (29.1%) mentioned that they had cultivated one acre of maize, which included 17 (13.3%) during the project, and 19 (15.8%) after the project. One quarter, 30 (25%) respondents mentioned that cultivated 2 acres of maize, yet, 19 (15.8%) said it was during the project, and eleven (9.2%) said after project ended. Of the 60 respondents, a total of six (5%) project participating respondents, three (2.5%) indicated to had three acres during and after project closure. But a total of 15 (12.3%) project participants, extended CA plots size above 3 acres, of which, two (2.3%) was done during the project, and 13 (9.8%) after project had ended. This indicated that, land expansion was voluntarily accepted whereby 12 respondents were able to practice 3 acres of CA or more. In view of the above, it is predicted that the acreage and number of farmers adopting CA will triple by 2015 because they would have seen the benefits of CA from the early adopters. Normally, individual farmers start adopting CA in small fields of less than one acre, but they expand the acreage as they become more knowledgeable on management of CA fields (CA SARD, 2009). For example, Mwangaza B FFS farmers in the Marera sub-village in Karatu Tanzania, started with only 1 acre, but after two years they became experts on CA; they realized an increase in crop yields, reduced erosion and a reduced time and labour requirements during their farm operations. Therefore, they decided to expand their CA field area to 22 acres. A saying in Kiswahili that, *'Kizuri chajiuza kibaya chajitembeza'*, which means 'Good thing sells quite easily, bad things have to be moved around with a lot of advertisement for them to be sold' appears to work here. There is a sense that CA is now selling itself (CA SARD, 2009).

Further, Table 6 indicates that, in 2006/2007 in Mvomero District, lablab cover crop was highly accepted almost by all CA members in their farms. Initially farmers were reluctant to expand areas under CA because of their expectations of receiving farm inputs from the government. Of the 60 project participants, 71 (62.3%) CA project participating respondents demonstrated 0.5 of having planted an acre of lab lab. During the project, they were 46 (40%) respondents, and 25 (22.3%) after project closure. For a one acre, of the 60 project participants, a total of 29 (22.6%) project participating respondents mentioned to had planted lab lab, of which ten (6.7%) were participants during project, and 19 (15.9%) were after the project closure. For those with two acres, they were eight (5.8%) project participants of which three (2.5%) were during the project and five (3.3%) after the project closure. Again, with three acres, eleven (8.5%) respondents indicated to had practiced CA, one respondent during the project, and ten (7.7%) after project closure. Lastly, of the 60 respondents, there was one farmer with more than 3 acres during and after the project closure. For both maize and lab lab land sizes, there was a mean difference between them, during and after the project which was highly statistically significant at $p<0.000$ (Table 6).

Table 6: Respondents farm size during and after project closure (n=60)

Crop	Acreage	During project respondents	After project respondents	Total	χ^2 – value	p-value
Maize	0.5	19(15.9)	14 (12.7)	33(28.6)	275.567***	0.000
	1	17 (13.3)	19 (15.8)	36(29.1)		
	2	19 (15.8)	11 (9.2)	30 (25)		
	3	3 (2.5)	3 (2.5)	6 (5)		
	Above 3	2 (2.3)	13 (9.8)	15(12.3)		
Lab bab	0.5	46 (40)	25 (22.3)	71 (62.3)	134.784***	0.000
	1	10 (6.7)	19 (15.9)	29 (22.6)		
	2	3 (2.5)	5 (3.3)	8 (5.8)		
	3	1 (0.8)	10 (7.7)	11 (8.5)		
	Above 3		1 (0.8)	1 (0.8)		
	Total	60 (50)	60 (50)	120 (100)		

Note: *** is highly statically significant. Figures in parentheses are percentages and those out of parentheses are frequencies.

4.2.1 Effectiveness and its sustainability of CA technologies

Table 7 shows that, of the 120 respondents, 51 (42.5%) indicated that they adopted cover crops technology, and of these 28 (45.9%) and 23 (39.0%) of non-project and project participating respondents said so, respectively. In the application of herbicide and no-till technology, of the 120 respondents, eleven (9.2%) indicated to using of the technologies who were seven (11.5%) and four (6.8%) non-project and project participating respondents, respectively. Four (3.3%) respondents mentioned that they applied sub-soiling technology, who were one (1.6%) and three (5.1%) non-project and project participating, respectively. Again, of the 20 (16.7%) respondents, eleven (18%) who were non-project and nine (15.3%) project participating respondents said that they used hand-jab planting method. Direct seeder technology drown by oxen was implemented by seven (5.8%) of which two (4.9%) and five (6.8%) were non-project and project participating respectively. Power tiller technology was still a new, and few 4 (3.3%) respondents indicated using it in CA. For this only four (6.8%) project participating respondents used it. Few respondents used knife roller and crop rotation technologies, and these were six (5%), of which two (3.3%) and four (6.8%) were non-project and project participating respondents, respectively. Overall responses revealed an overall means difference between them was not statistically significant at p> 0.362 (Table 7).

Table 7: The effective use of technologies and its sustainability (n=120)

Type of technology used	Project participation Non-project respondents (n=60)	Project respondents (n=60)	Total	χ^2 – value	p-value
Cover crops	28 (45.9)	23 (39)	51 (42.5)	8.772 ^{ns}	0.362
Herbicide use	7 (11.5)	4 (6.8)	11 (9.2)		
No- till	7 (11.5)	4 (6.8)	11 (9.2)		
Sub –soiling	1 (1.6)	3 (5.1)	4 (3.3)		
Jab planting	11 (18)	9 (15.3)	20 (16.7)		
Direct seeder (DAP)	2 (4.9)	5 (6.8)	7 (5.8)		
Power tiller	0 (0)	4 (6.8)	4 (3.3)		
Knife roller	2 (3.3)	4 (6.8)	6 (5)		
Crop rotation	2 (3.3)	4 (6.8)	6 (5)		
Total	**60 (100)**	**60 (100)**	**120 (100)**		

Note: ns = not significant. Figures in parentheses are percentages, out of parentheses are frequencies.

4.2.2 Factors for promoting sustainable CA (N=120)

In Table 8 shows that of the 120 respondents, less than half 56 (48.2%) agreed that demonstrations plots should be used to promote CA technology, and means were not statistical significant at p<0.316. For example, 27 (46.1%) and 29 (48.3%) of the non-project and project participating respondents reported this, respectively. However Giller *et al.* (2009) indicated that success of SG 2000 in promoting CA appeared largely to have been due to promotion of a technology packages including inputs such as fertilizers, pesticides and herbicides, and that when the project support stopped farmers quickly reverted to their former crop management practices. Also, of the 120 respondents, over half, 64 (53.3%) agreed that open meeting should be used for promoting CA technology. These were more than half 37 (62.3%) non-project participating respondents, and less than half 27 (44.1%) project participating respondents, and the means were statistically significant at p<0.015.

Again, the study results showed that, of the total 120 non-project and project participating respondents less than half 36 (30%) agreed that questions and answers with researchers could be used to promote CA technology, and there was highly statistically significant difference between the means at p<0.01. Similarly of the total 120 respondents, less than half 49 (40.8%) non-project and project participating agreed that exchange visits to distance farmers could be applied to promote CA technology. There was no statistical significant difference between mean at p<0.369 between the two groups. For example, 22 (36.1%) and 27 (45.8%) of the non-project and project participating respondents agreed to the statement, respectively. Moreover, of the total 120 respondents, more than half 64 (53.3%) non-project and project participating respondents disagreed that agricultural fair shows (like nane nane in Kiswahili) could be used to promote CA technology. These were more than half (37 (62.7%) for project participating and less than half 27 (44.3%) for non-project participating respondents. The mean difference between the two groups was statistically significant at p<0.043 (Table 10). Of the 120 respondents, less than one third 28 (24.2%) of non- project and project participating respondents agreed that, field day visits could be used to promote CA technology. The means between the groups were statistically significant at p<0.004. Again, respondents were asked about their contacts with village extension officers (VEOs), and 87 (72.5%) respondents supporting being in contact with VEOs who promoted CA technology. Here, more than half 39 (69.9%) and more than three quarters, 48 (81.4%) of the respondents agreed, and of these 39 (63.9%) and 48 (81.4%) were non-project project and project participating respondents, respectively. There was a no statistical significant difference between mean at p>0.081 between the groups (Table 8).

Table 8: Factors for promoting sustainable of CA (n=120)

Variable	Response	Non-project respondents	Project respondents	Total	X^2	P
Demonstration	Uncertain	2 (3.3)	0 (0)	4 (1.8)	2.30^{ns}	0.316
	`Yes	27 (46.1)	29 (48.3)	56 (48.2)		
	No	29 (49.1)	31 (51.7)	60 (50.0)		
Open meeting	Uncertain	3 (4.9)	0 (0)	3 (2.9)	8.40 *	0.015
	Yes	37 (62.3)	27(44.1%)	64(53.3)		
	No	20 (32.8)	33 (55.9)	53 (44.2)		
Question and answers with researchers	Uncertain	12 (19.7)	14 (23.7)	26 (21.7)	17.470***	0.000
	Yes	9 (14.8)	27 (45.8)	36 (30.0)		
	No	39 (65.6)	19 (30.5)	58 (48.3)		
Farmers Exchange visit	Uncertain	1 (1.6)	0 (0)	1 (0.8)	1.992^{ns}	0.369
	Yes	22 (36.1)	27 (45.8)	49 (40.8		
	No	37 (62.3)	33 (54.2)	70 (58.3)		
Fair shows	Uncertain	0 (0)	0(0)	0(0)	4.102 *	0.043
	Yes	27 (44.3)	37 (62.7)	64 (53.3)		
	No	33 (55.7)	23 (37.3)	56 (46.7)		
Field days visit/field	Uncertain	2 (3.8)	0 (0)	2 (1.8)	11.092 **	0. .004
	Yes	10 (18.0)	18 (30.8)	28 (24.2)		
	No	48 (82.0)	41 (69.5)	90 (75.8)		
Contacted ext. officer	Uncertain	3 (4.9)	2 (1.7)	4 (3.3)	6.743^{ns}	0.081
	Yes	39 (63.9)	48 (81.4)	87 (72.5)		
	No	19 (31.1)	10 (15.3)	28 (23.3)		
Total		**60 (100)**	**60 (100)**	**120 (100)**		

Note: Figures in parentheses are percentages and those out of parentheses are frequencies. ns = not significant (p> 0.05). * Significant at (p<0.05), *** = significant at (p<0.001).

4.2.3 Use of cover crops in CA

This study assessed the main cover crops such as lab lab and other crops, which traditionally were intercropped with maize like cowpeas and cucumber. For both non-project and project participating respondents use of cover crops in food and cash crops, was mentioned by 75 (62.5%) of which 40 (66.7%) and 35 (58.4%) were non-project participating and project participating respondents, respectively (Table 9). Of the 120 respondents, 14 (11.7%) mentioned that cover crops were used to generate biomass, which suppressed weeds, and of these six (10%) were non-project participating respondents, and eight (13.3 %) were project participating respondents. A total of five (4.1%) respondents mentioned that cover crops were used as fodder during the dry season, and these were two (3.3%) no-project and three (5%) project participating respondents. Furthermore, Table 9 shows that of the 120 respondents, 26 (21.7%) who used cover crop to control soil erosion, 14 (23.3%) and 12 (20%) were non-project and project participating respondents, respectively. According to Snapp *et al.* (2005), farmers choose to grow and manage specific cover crop types based on their own needs and goals and are influenced by biological, environmental, social, cultural, and economic factors of the food system within which farmers operate. Dense cover crop stands physically slow down the velocity of rainfall before it contacts the soil surface, preventing soil splashing and erosive surface runoff (Romkens *et al.,* 1990). Some cover crops suppress weeds both during growth and after death (Blackshaw *et al.,* 2001).

> *"Cover crops are the food of the soil. Only a healthy soil can provide the necessary food to the people. Soil has life, which needs to be fed. (Farmers slogan, Swaziland*- IRR and ACT, 2005) IIRR and ACT, 2005)."
>
> However, during discussion at Msufini village, in Mvomero Ward, one respondent said that: '*If you cannot prevent livestock from getting into your fields, you might want to choose a cover crop that they do not like to eat, such as jack bean (Canavalia)'.*

Table 9: Use of cover crops in CA (n=120)

	Participating respondents		**Non-participating respondents**		**Total**	
Uses	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Food an cash	35	58.4	40	66.7	75	62.5
To generate more biomass & suppress weeds	8	13.3	6	10.0	14	11.7
To utilize as season fodder	3	5	2	3.3	5	4.1
To control soil erosion	14	23.3	12	20.0	26	21.7
Total	**60**	**100**	**60**	**100**	**120**	**100**

Plate 5: Cover crop (Canavalia) after harvesting maize at Hembeti Ward, in Mvomero District, Morogoro.

Plate 6: Cover crop remains after harvesting the main crop at Wami Luhindo village Mvomero District.

Plate 7: Knife roller at Dakawa Village, Mvomero District

Plate 8: Knife roller (SEAZ –Mbeya model) and its application

4.2.4 Awareness and knowledge on CA

Table 10 shows that, majority of 115 (95.8%) non-project participating and project participating respondents indicated that they were aware about CA technology from various sources. Less than 55 (45.8%) of non-project participating and project participating respondents reported that they had heard about CA technology from the VEOs, 56 (46.7%) said from fellow farmers, five (4.2%) indicate on radio and four (3.3%) from traders. It was encouraging to note that till in 2010 nearly 104 (93.3%) respondents of which 46 (75.4%) and 58 (98.3%) were non- project participating and project participating continued using the CA technologies after four years of project closure.

Table 10: Farmer's awareness and knowledge on CA project activities

Variable	Response	Non project farmers Frequency & %	Project farmers Frequency & %	Total	χ^2 – value	p-value
Heard about activities carried out on CA	Yes	55 (94.8)	60 (100)	115 (95.8)	2.027 ^{ns}	0.567
	No	5 (8.5)	0	5 (4.2)		
Interesting on CA	Yes	57 (95.1)	58 (96.6)	115 (95.8)	0.175 ^{ns}	0.675
	No	3 (4.9)	2 (3.4)	5 (4.2)		
Source of information about CA	Extension Officers	29 (47.5)	27 (45.8)	55 (45.8)	4.064 ^{ns}	0.397
	Fellow Farmer	28 (45.9)	28 (47.5)	56 (46.7)		
	Radio	1 (1.6)	4 (6.8)	5 (4.2)		
	Traders	2 (4.9)	1(1.7)	4 (3.3)		
Technologies still applied	Yes	46 (75.4)	58 (98.3)	104 (93.3)	13.855 **	0.001
	No	16 (24.6)	2 (1.7)	16 (6.7)		
		60 (100)	60 (100)	120 (100)		

Note: Figures in parentheses are percentages and those out of parentheses are frequencies. ns = not significant (p> 0.05). * Significant at (p<0.05), ** = significant at (p<0.001).

Technologies like conservation tillage, use of permanent or semi-permanent organic soil cover, use of crop rotations and straw mulching and low- input sustainable practices are well known practices help farmers to maintain soil structure and productivity (Bagheri *et al*., 2008; Mahdei, 2010). However, according to Bwalya, (2003), mindset barriers hinder effective and sustainable CA, which include subsistence aspirations of many farmers, a misguided commitment to ploughing (involving complete soil disturbance). Smallholder farmers are not aware of alternatives, and hence drift away from the land, particularly young ones who regard conventional agriculture as a hard work and drudgery yielding low and uncertain returns. The overall mean differences for the means of source of information about CA variable was statistically significant at $p<0.001$.

4.2.5 CA sustainability

Sustainability has been evaluated interims of who continued with the technologies after closure of the project. Of the 120 respondents, more than half 92 (72.1%) indicated that they currently practiced CA technology, and these included 39 (56%) and 53 (88.3%) non-project and project participating respondents, respectively. The response to this variable was statistically significant at $p<0.027$ (Table 11). Of the 120 respondents, 113 (93.3%) non-project and project participating respondents indicated that they were willing to continue using CA technology, and this included 56 (91.8%) non-project and 57 (94.9%) project participating respondents. The main reasons that respondents gave for continuing to use CA technology included increased crop production, incomes, able to grow different crops because of intercropping, and increased of soil fertility.

Furthermore, three quarters of non- project participating and participating respondents, 46 (78.7%) and 47 (79.7%) respectively indicated that there were constraints in adapting CA technologies. They mentioned them to include, high production costs due to high cost of inputs, drought, invasion of livestock, presence of diseases and insect pest, inputs unavailable on time, seed unavailability, inaccessible markets, and land shortages. Of the total 120 respondents, majority, 92 (75.2%) indicated that they made to make contacts with VEOs of which, more than half 41 (63.9%) were non-project, while majority, 51 (81.4%) project participating respondents. Comparing trends of VEOs contacts per year, of the 120 respondents less than half 45 (37.5%) indicated that there was an increase, while 42 (35%) said there was a decrease and 33 (27.5%) respondents indicated that there was no change. However than half, 30 (50.9%) of project participating respondents mentioned that they had increased contacts with VEOs compared to less than half, 15 (24.6%) of non-project participating respondents. Increase in frequency of contacts with VEOs by of project participating respondents showed that there was a change as a result of introduced CA project which are likely to continue. The difference between means were statistically significant at p<0.010 (Table 11). According to Haggblade and Tembo (2003), number of extension visits has a positive impact on sustainability and use of CA as farmers get exposed to new information which reduces information asymmetry.

Table 11: Sustainability of CA technologies use in the future (n=120)

Variable	Non- project participating	Project participating	Total	χ^2 – value	P
Currently using introduced CA					
Yes	39 (56)	53 (88.3)	92 (72.1)	10.959*	0.027
No	21 (44)	7 (11.7)	28 (27.9)		
Respondents will continue to use CA					
Yes	56 (91.8)	57 (94.9)	113 (93.3)	0.568 ^{ns}	0.753
No	4 (8.2)	3 (5.1)	7 (6.7)		
Constraints for using CA technologies?					
Yes	46 (78.7)	47 (79.7)	92 (75.2)	2.385 ^{ns}	0.496
No	15 (21.3)	13 (20.3)	28 (24.8)		
Made contacts with VEOs					
Yes	41 (63.9)	51 (81.4)	92 (76.7)	6.471 ^{ns}	0.091
No	19 (31.1)	9 (15.3)	28 (23.3)		
Trend of contacts VEOs per year					
Increase	15 (24.6)	30 (50.9)	45 (37.5)	13.320*	0.010
Decrease	29 (47.5)	13 (22)	42 (35)		
No change	16 (27.9)	17 (27.1)	33 (27.5)		
Total	**60 (100)**	**60 (100)**	**120 (100)**		

Note: Figures in parentheses are percentages and those out of parentheses are frequencies. ns = not significant at (p> 0.05), * Significant at (p<0.05), *** = significant at (p<0.001)

4.2.6 Reasons for continuation with CA

The study sought to know the proportion of land used for CA technologies. Of the 120 respondents, 85 (70.8%) indicated that a quarter of their farms was used for CA technologies, and of these, 46 (75.4%) were non-project and 39 (66.1%) were project participating respondents. Also, 35 (29.3%) of the respondents indicated that they used half of the farm practice CA technologies. Also, the mean differences were not statistically significant at p>0.262. Also, of the 120 respondents who were asked whether there was sufficient technical knowledge to continue with CA technologies, majority, 84 70%) agreed that there was insufficient knowledge to enable smooth continuation with CA who were non-project and project participating respondents. For the above reason, two third, 38 (62.3%) and most 46 (78%) of non-project and project participating respondents, mentioned that, respectively. Yet, there was no statistical difference between group means at p>0.060.

For weed, of the 120 respondents, 61 (51.7%) non-project participating and project participating respondents agreed that weeds in CA technologies were a problem and of these, 32 (54.1%) were non-project participating and less than half 29 (49.2%) were project participating respondents. The statistical difference between the group mean was not significant at p>0.146. Another response was on insect pests and diseases. Of the 120 respondents, over half, 72 (60%) non-project respondents and project participating respondents agreed that insect pests and diseases were a problem in conducting CA, they were majority 47 (79.6%) of non-project and one third, 25 (33.9%) of project participating respondents. The statistical difference was highly significant at p <0.000. Another reason for not adopting and continuing with CA technologies was fear to invest much. Of the 120 respondent, less than half, 44 (41.7%) of non-project and project participating respondents, agreed that investing much on CA technology is a risk taking. The statistical mean difference was significant at p <0.007. Of the 120 respondents, less than half, 38 (32.5%) agreed that buying implements was a reason for continuing with CA, included and this, 21 (37.7%) non-project and 17 (27.1%) project participating respondents. Their mean difference was not statistically significant at p>0.081. Of the 120 respondents, 81 (67.5%) non-project and project participating respondents agreed that soil erosion losses was not significant problem whereby three (6.6%) were non-project and 21 (33.9%)

project participating respondents. The mean difference was statistically significant at p<0.001 (Table 12).

Table 12: Sustainability and reasons for continuation with CA (n=120)

Reason /Criteria	Non Project participating	Project participating	Total	χ^2 – value	p-value
Proportion of farm practices CA					
Quarter	46 (75.4)	39 (66.1)	85 (70.8)	1.258 ^{ns}	0.262
Half	14 (24.6)	21 (33.9)	35 (29.2)		
Insufficient technical knowledge					
Yes	38 (62.3)	46 (78)	84 (70)	5.618 ^{ns}	0.060
No	22 (37.7)	14 (22)	36 (30)		
Weed management problems					
Yes	32(54.1)	29 (49.2)	61 (51.7)	3.846 ^{ns}	0.146
No	28 (45.9)	31 (50.8)	59 (48.3)		
Pest and disease control					
Yes	47 (79.6)	25 (33.9)	72 (60)	22.737***	0.000
No	13 (21.3)	35 (59.3)	48 (40)		
Fear of investing much					
Yes	30 (50.8)	14 (22.2)	44 (41.7)	9.883**	0.007
No	29 (49.2)	41 (67.8)	70 (58.3)		
Buying jab planter or direct seeder					
Yes	21 (37.7)	17 (27.1)	38 (32.5)	5.018 ^{ns}	0.081
No	38 (62.3)	43 (72.9)	81 (67.5)		
Erosion losses not significant					
Yes	3 (6.6)	21 (33.9)	24 (20)	14.012***	0.001
No	57 (93.4)	39 (66.1)	96 (80)		
Unavailability of valid research					
Yes	15 (25.2)	12 (18.7)	27 (22.5)	4.774 ^{ns}	0.092
No	45 (74.8)	48 (81.3)	93 (77.5)		
Livestock feeding problem in CA field					
Yes	44 (72.1)	47 (78)	90 (77.7)	2.385 ^{ns}	0.496
No	16 (27.9)	13 (22)	28 (22.3)		

Note: Figures in parentheses are percentages and those out of parentheses are frequencies. Ns = not significant at (p> 0.05).
* =Significant at (p<0.05), *** = significant at (p<0.001)

Of the 120 respondents, less than half 27 (22.5%) agreed that there was unavailability of valid research. This was reported by 15 (25.2%) non-project and 12 (18.7%) project participating respondents. The mean difference was not statistically significant at p> 0.092. Of the 120 respondents, most, 90 (77.7%) indicate that allowing livestock to feed on CA fields was a problem of which, 44 (72.1%) were non-project and 47(78%) were project participating respondents. Respondent claimed that reporting livestock keepers to the authorities gave no solution. According to El Gharras *et al.* (2009), farmers' fields are complex and have established relationships which integrate crops and livestock to produce grains and crop residues. However, CA principles based on crop residue and cover crops, becomes difficult to retain, especially during drought seasons when livestock graze on it. The mean differences of the two groups was not statistically significant at p>0.496 (Table 12).

4.2.7 Workload by gender

Workload in this study is defined as the amount of labour time required to perform a particular farm-related activity or operation. Perceptions of participating respondents on how the workload of men and women changed in the project activities were assessed. The work reduction was due to technological improvement by turning from convention to CA. Most respondents felt that the trend of workload had been reduced for woman as well as for men. Of the 120 respondents, over half females and males, 53 (88%) non-project and 42 (71.1%) project participating respondents indicated that there was a decreased in workload in CA. Also, two thirds, 37 (62.3%) males and 16 (26.3%) females of non-project participating respondents reported that there was a decrease of workload in CA. Likewise, less than half, 26 (43.3%) of males and 17 (27.8%) females project participating respondents admitted that the workload in CA has been reduced, implying that more males claimed that there was reduction of the workload in CA. According to FAO (2004), the gender division of labour in Babati District, Tanzania, was influenced by the source of farm power, activity, sex of household head and household wealth. The decrease of workload was mentioned by majority of 42 (71.1%) project participating respondents, of which 17 (27.8%) were females and 26 (43.3%) were males. Their means was statistically significant at $p<0.007$ for non-project respondents, and $p<0.001$ for project participating respondents (Table13).

Table 13: Trend of workload following adoption of CA technologies by gender

Status	Variable	Male	Female	Total	χ² – value	p-value
Non Project Farmer	Increased	2 (3.3)	1 (1.6)	3 (4.9)	12.097**	0.007
	Decreased	37 (62.3)	16 (26.3)	53 (88.6)		
	No change	3 (4.9)	1 (1.6)	4 (6.6)		
Total		**42 (70.5)**	**18 (29.5)**	**60 (100)**		
Project Farmer	Increased	7 (11.9)	1 (1.7)	8 (13.6)	16.764 **	0.001
	Decreased	26 (43.3)	17 (27.8)	42 (71.1)		
	No change	7 (11.9)	2 (3.4)	9 (15.3)		
Total		**40 (66.1)**	**20 (33.9)**	**60 (100)**		

Farmers are motivated to continue using CA because of cost and yield benefits, reduction on labour inputs and increases on return per workday however, CA has been achieved through close collaboration among farmers, researchers and extensionists in on-farm trials, farmer-driven adaptations, farmers' organizations, and through private-public partnerships (Evers and Agostini, 2001). It was revealed that, smallholder farmers require government assistance to organize spearhead CA to reduce the costs and risk of change. This study found that the average decrease of workload in CA was about 2.5 hours per day for about 3 months (Table 13, Table 14). A study of CA as a labour saving practice for vulnerable households in Babati and Karatu Districts Northern Tanzania revealed that, additional inputs of time may be required to establish a cover crop, or learn how to use the technology effectively (FAO, 2004). Smallholder households meet most of their labour inputs from household labour, meaning that they adjust to new technologies or practices.

Table 14: Number of hours per day following adoption of technologies

Status	Hours	Male	Female	Total	X² – value	p-value
Non Project Farmer	1	4 (6.6)	0	4 (6.6)	12.932 *	0.012
	2	17 (29.9)	4 (6.6)	21 (34.4)		
	3	16 (26.2)	7(13.1)	23 (39.3)		
	4	5 (8.2)	4 (6.6)	9 (14.8)		
	5	1 (1.6)	1 (1.6)	2 (3.3)		
	6	0	1 (1.6)	1 (1.6)		
	Total	**43 (70.5)**	**17 (29.5)**	**60 (100)**		
Project Farmer	1	2 (3.4)	1 (1.7)	3 (5.1)	19.652**	0.003

2	7 (11.9)	3 (5.1)	10 (16.9)
3	10 (16.9)	5 (8.5)	15 (25.4)
4	13 (22)	4 (6.8)	17 (28.8)
5	3 (5.1)	4 (6.8)	7 (11.9)
6	4 (6.8)	3 (5.1)	7 (11.9)
Total	**39 (66.1)**	**20 (33.9)**	**60 (100)**

4.2.8 Mainstreaming gender and HIV/AIDS related issues in CA

HIV/AIDS is a crosscutting issue and project sustainability would not be achieved if the problem was not addressed. Accordingly, CA project activities integrated HIV/AIDS aspect, and the results are presented in Table 16. Of the 120 respondents, 51 (42.5%) non-participating and project participating respondents reported that HIV/AIDS affected group performance. This was mentioned by 16 (16.2%) non-project participating and 35 (59.3%) project participating respondents. Lyimo and Owenya, (2002) in Karatu District found that the impacts on AIDS resulted in the sale of assets (land, livestock, household assets, houses), a reduction in household labour, children dropping out of school, and a reduction in purchased farm inputs. Also, families rented out farm land or did share cropping, family members resorting to casual labouring experienced a decline in crop and livestock production, and a fall in household cash income. This variable showed a statistical significant difference at $p<0.001$. Furthermore, 59 (49.2%) of the respondents mentioned that HIV/AIDS was a threat compared to other diseases, and over half, 37 (61%) who said so were project participating respondents, and 22 (37.7%) were non-project. There was a statistical significant different between mean at $p<0.001$. For both non-project and project participating respondents, males 40 (33.3%) and 24 (20%) females agreed that HIV/AIDS affect group performance. Yet, 41 (34%) male and 14 (11.6%) female respondents indicated that, issues related to HIV/AIDS affected CA activities compared to other diseases (Table 16). According to Kajisa *et al.* (2003), labour has become a key constraint in HIV/AIDS affected households and there is an urgent need for strategies to be developed to help small holder farmers. Reduced labour (persons/time/strength) results in less land being cultivated and less surplus to sell to the market for cash income.

Table 15: HIV/AIDS prevalence and sex in effective and sustainable CA (n =120)

Variable		Non – project participating	Project participating	Total	χ^2 – value	p-value
If HIV/AIDS affect group performance	Yes	16 (16.2) ((14,10))	35 (59.3) ((26,14))	51 (42.5) ((40,24))	19.793***	0.000
	No	44 (73.8) ((34,11))	25 (40.7) ((15,9))	69 (57.5) ((49,20))		
If HIV/AIDS is a threat compared to other diseases	Yes	22 (37.7) ((15, 4))	37 (61.0) ((26,10))	59 (49.2) ((41,14))	14.253**	0.001
	No	38 (62.3) ((26,10))	23 (39) ((13,10))	61 (50.8) ((39,20))		
Total		**60 (100)**	**60 (100)**	**120 (100)**		

Note: Figures in parentheses ( ) are percentages and (( )) are male, female, those out of parentheses are frequencies. Ns = not significant (p> 0.05). ** Significant at (p<0.05), *** = significant at (p<0.001)

4.2.9 Impacts of CA technology for improving livelihoods

Social participation is related to the propensity to practice improved technologies (Ladele *et al.* 1994). Outgoing farmers are more predisposed to accepting new ideas relevant to their livelihoods. It was on the strengths of relationships that the participating and non-participating respondents were compared about their social participation. Table 17 indicates that both categories belonged to some community organizations. In the study area, respondents joined some community organizations, which included Milama CA-SACCOS, Hembeti SACCOS, and Mvomero SACCOS. However, of the 60 respondents, 32 (52.5%) and 43 (71.2%) non-project and project participating mentioned to had joined these SACCOS. There were income earnings of more than Tanzanian shillings (Tshs) one million for the 24 (39.3%) non-project participant compared to 20 (32.2%) project participating respondents. Members who earned between Tshs 400 000 and 1 000 000 were six (9.8%) for non-project participating compared to 17 (28.8%) project participating respondents. Earnings between Tshs 150 000 and 400 000 were two (3.3%) non-project, and three (5.1%) were project participating respondents. But earnings below Tshs 150,000 were three (5.1%) project participating respondents. It is thus believed that adequate access to credit may have significant positive impact on various aggregate and household level incomes, including technology adoption, agricultural productivity, food security, nutrition, health and overall household welfare (Diagne *et al.*, 2000). For this group, there was no statistical significant difference at p>0.860 and p>0.296 (Table 17).

Table 16: Membership in community organization and annual income (T Shs) (n=60)

Community membership response		Annual Income (T Shs) Below 150,000	150,000 – 400,000	400,000 – 1,000,000	Above 1 Million	Total	χ^2 – value	p-value
Non-project participating	Yes		2 (3.3)	6 (9.8)	24(39.3)	32 (52.5)	1.306 ns	0.860
	No		3 (4.9)	7 (11.5)	18 (31.1)	28 (46.5)		
	Total		**5 (8.2)**	**13 (21.3)**	**42 (70.5)**	**60 (100)**		
Project participating	Yes	3 (5.1)	3 (5.1)	17 (28.8)	20 (32.2)	43 (71.2)	3.699 ns	0.296
	No	1 (1.7)	0	4 (6.8)	12 (20.3)	17 (28.8)		
	Total	**4 (6.8)**	**3 (5.1)**	**21 (35.6)**	**32 (52.5)**	**60 (100)**		

Note: ns = not significant

4.2.10 Regression results

A linear regression analysis was undertaken to determine qualitatively how the relevant factors interact to influence individual in accessing effective and sustainable CA technologies in the study area. The Average yield (kgs/acre) using CA technologies was thus the dependent variable and seven independent variables were tested which were age, household family size, occupation, education level and period involved in crop farming. Among the variables tested two of the non-participating respondents shows the statistical significant difference at p<0.05. The variables include age and the period respondents were involved in crop farming (Table 18). It implies that since the introduction of CA technologies was taken in a pilot initiatives, time involved in practicing was also shorter but, John (2003) observed that although older people are more experienced, their receptivity to new ideas and technologies, typically decreases with age. Since 2004, when CA was introduced, farmers who were not reluctant to take it up, although they were few who responded to the technology, reaped the benefits of increased yields and informed others.

The significance of the F-values at ($p<0.021$), and ($p<0.016$) implied that the models were significant and may well explain for 61% changes (R^2 = 0.612) due to technology introduction to the crop yield and 67% change (R^2 = 0.670) both non-project participants and participants respondents, respectively. Of the non-project participating respondents it was indicated to have 61% of the variations in regression model, thus, only 39% of variations were attributed to other factors that are not included in the model. Yet in project participating respondents, 67% of the variations were observed, 33% of variations were attributed to other factors that are not included in the regression model. Age and period involved in crop farming were statistically significant at $p<0.05$. Kaliba and Rabele (2003) found a positive and statistically significant association between wheat yield and soil conservation for Lesotho farm practices. This implies that the regression model was stronger in explaining the relationship between dependent variable and independent variables (Table 18).

Table 17: Liner regression for predicting changes due technologies introduced regarding effective and sustainable CA

	Non-project participants				Project participants			
Variables	**Coeff.**	**S.E.**	**t**	**Sig.**	**Coeff.**	**S.E.**	**T**	**Sig.**
(Constant)	1184.990	1270.910	0.932	0.356	-684.552	6734.874	-0.102	0.919
Sex	249.763	432.338	0.578	0.566	-847.144	1996.138	-0.424	0.673
Age	636.575	268.319	2.372**	0.022	528.067	1391.999	0.379	0.706
HH family size	221.034	209.461	1.055	0.296	792.881	999.941	0.793	0.432
Occupation	5.011	163.927	0.031	0.976	-79.366	855.240	-0.093	0.926

Education level	246.103	168.337	1.462	0.150	196.017	822.368	0.238	0.813
Period involved in crop farming	-271.029	128.271	-2.113**	0.040	-635.057	687.223	-0.924	0.360

Dependent Variable: Average yield (kgs/acre) using (CA) technologies
Note: ** = Significant at ($p<0.05$).
Specialty: F = 1.829* and 2.292*; R^2 = 0.67 and 0.672 for non-project and project participants.

4.2.11 The hypothesis testing

The hypotheses tested for significant differences based on the specific objectives are as indicated below:-

i) *It was hypothesized that, the introduced CA technologies are not in use by the contact farmers after the project activities closure.* Results on Table 21 show high effectiveness and sustainability rate on most project technologies use by participant farmers. The statistical mean was statistically significant at $p<0.005$. Project participating respondents practiced CA technologies introduced in the year 2004. Results from the study shows that technologies, which are not cost effective and reduced workload with increased yield, are easily adopted. Examples were the use of cover crop like lab lab and the use of jab planter. The most attractive benefit reported in Northern Tanzania, through CA-SARD project, farmers applied CA realised an average yield two to three times more as compared to conventional plots. For example, from the 2005/06 season while conventional farmers in Mlangarini village had complete crop failure, CA farmers in Arumeru harvested maize 2 to 3 bags/acre, Amani FFS group harvested 9 bags/acre, Kilimo FFS harvested 17 bags/acre; Upendo nyuki FFS Likamba village harvested 20 bags/acre (FAO, 2006). But, according to Rola *et al.* (2009), based on regression analysis results, the reason that induce farmers to continue use the CA technologies was to maintain the natural resource base and the soil quality of their farm area.

ii) *It was hypothesized that the introduced CA technologies had not spread from the contact farmers to other farmers.* The null hypothesis was rejected because due to the interest shown to the new technologies, non-participating respondents applied CA knowledge in their farms although they were less active but project farmers will continue to use CA in the future giving a span of exposure to the non-project farmers. This was indicated by showing statistical significance difference at p<0.036 and t= 2.172 (Table 19). Our hypothesis is that it is related to the enhanced knowledge, experience and managerial capacity gained via participation and experimentation. In addition to the impact on participants, the six village-level spillover effects was negative but through gradual use it predict sustainable use of techniques to non-participants located in CA villages in the future. However, according to Greene (1998), non-participant decisions are not independent in the sense that some of the same factors that influence the decision to participate are likely also to influence the decision to adopt.

iii) *It was hypothesized that farmer's awareness and knowledge level is not essential for effective and sustainability of CA technologies.* However it was revealed that, awareness and knowledge of CA farmers contributed to the crop production in CA farming, since there was statistical significant difference between the groups at p<0.007 of non-project participating and 0.018 for project participant. Project farmers influenced non project farmers to adopt CA. However, it was expected that more knowledgeable farmers will adopt more improved practices than less knowledgeable farmers. This relationship has been established by previous studies (Igodan *et al.,* 1987, Rogers, 1983).

iv) *It was hypothesized that, there is no cost effectiveness of CA technology transferred mechanisms used by the project in the interests of long term use.* The null hypothesis was rejected since there was cost effectiveness of CA technology transferred mechanism in crop and livestock production indicated by the project participant farmers with a statistical significant difference at $p<0.034$. However, to non-project participant the results indicate that no statistical significant difference in farm production due to the introduced technology, although to both parties, overall contribution was not effective in terms of cost involved in continuing with CA. But according to FAO (2001), improving land husbandry by using CA starts from a thorough understanding of the current situation of which only the farmers themselves have an intimate knowledge. That is why they have to be the architects of change from the outset and during the transition process, and even further in order to make sure that the new system is sustainable (Table 19).

Table 18: Regression analysis in investigating the effectiveness and sustainability of CA technologies for increasing farmer production

	Variables	**β**	**S.E**	**T**	**Sig.**
Non-Project participating	(Constant)	-36.215	21.243	-1.705*	0.096
1	Awareness of CA activities carried out	29.633	10.308	2.875***	0.007

	2 If the technology is still applied	-0.905	6.317	-0.143 ns	0.887
	3 Cost effectiveness of CA	0.048	4.582	0.010 ns	0.992
	4 Use of CA in the future	-1.059	5.150	-0.206 ns	0.838
	5 IHIV/AIDS threat compared to other diseases	-0.156	2.349	-0.066 ns	0.947
Project participating	(Constant)	663.109	1611.562	0.411 ns	0.683
	1 Awareness of CA activities carried out	536.187	802.270	0.668**	0.018
	2 If the technology is still applied	946.857	320.012	2.959***	0.005
	3 Cost effectiveness of CA	652.995	712.942	0.916 ns	0.034
	4 Use CA in the future	412.939	190.093	2.172**	0.036
	5 HIV/AI threat performance compared to other diseases	-318.952	254.110	-1.255 ns	0.218

Dependent Variable: Total production in Kgs/acre

CHAPTER FIVE

5.0 SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study reveals that a farmer to drop their traditional practice of preparing the land with a hoe or plough, and instead rely on fully CA practices was a gradual process. The switch also needs to encourage farmers to see their farms as a business rather than merely a way to feed their families. Moreover, for the most non-project and project participants agreed that keeping the soil covered is important in CA, but it can be difficult. Farmers have many uses for crop residues: as fodder, fencing, roofing and fuel. Livestock keepers let their animals graze on stubble. In drier areas, it is impossible to grow a cover crop in the dry season, and crop residues are a vital source of animal feed. In the study area land was a scarce commodity that makes farmers to adopt the principles of CA with a minimum of investment on their farms. However, they may be reluctant to do so if they do not have clear rights to the land they cultivate. In this period CA land needs to be well defined in favor of its sustainability.

The study observed the difficulties to get equipments required and /or seeds of cover crop. This trend may affect future CA practices due to low purchasing power. Equipment, tools and weed killers are still expensive while in another side cover crop like lab lab is highly palatable both to human being and for livestock fodder and also highly profitable that leads it to be difficult to store. It is important to keep animals out of the fields while the crops are growing, but also after the harvest because animals compact the soil and remove all the soil cover, leaving it open to erosion and gullying. In Mvomero District, problems of free grazing affected CA sustainability, and most of the reported case came out unsolved.

Regression analysis was used to analyze factors affecting sustainability of CA technologies in the study area. Given that farmers in the same sample used different sets of technologies, the results reported from the fields indicated high yielding in CA farms compared to conventional agriculture. It was observed that an increase of the investment cost in CA especially in terms of farm inputs, tools and machinery was associated with decrease of sustainable CA due to low individual purchasing power. This reflects the Government calls to undergo intervention. However, an increase use of CA technologies by project participants was positively related to effective and sustainable profitable use of the technology, and it was statistically significant at ($p<0.05$). Moreover, the spread of CA technology from project participating to non-project participant's decreases if the two parties will not linked together through different extension services, training and policy supports. However, HIV/AIDS threat to CA group performance versus other diseases had a negative relationship to sustainable CA and was statistically ($p<0.05$) significant. This may be due to the fact that more victims will affect the household if measures are not seriously taken. It was further noted that, increase awareness also resulted in increase of effectiveness and sustainability on CA technology use.

5.2 Conclusion

Widespread use of CA needs a holistic approach, encompassing technical advice, social mobilization, input supply and marketing. The CA SARD project conducted in Mvomero district has developed the technical approaches that can be used to promote CA in certain locations, and has also been able to create awareness among farmers as well as professionals. The mainstreaming of CA on a wider scale requires a larger and better funded initiative that based on the experience of the CA SARD project; can tackle the questions of input supply, CA equipment manufacturing and maintenance, and marketing. Conservation Agriculture can be considered as a successful technology to increase production and productivity in rain fed agriculture and is particularly suitable for low soil productivity situations and under difficult climatic conditions. However, CA is not a cure-all solution. The positive impact with respect to gains in yield and gains in soil fertility are site specific. Soil texture is of dominant importance. It may be difficult for instance to practice CA successfully on heavy clay soils. Generally, there are high expectations concerning the impact of CA, but there is as yet a limited body of evidence.

5.3 Recommendations

1. To ensure continuous CA technologies use in the future, extension services by both MAFC and Mvomero LGA should be promoted through farmer to farmer extension approaches within and outside Mvomero District in order to reach out more CA farmers in the face of resource constraints, example farm inputs, tools and equipment cost. Previous studies have been made by partners such as FAO, GTZ, CIRAD and RELMA, therefore, an in-depth assessment on technology development of CA should be undertaken in collaboration of MAFC and LGAs.

2. In order to have effective and sustainable CA, the spread of the technology from contact farmers to other farmers needs acquisition of knowledge and skills in CA technologies. MAFC in collaborating with LGA should promote and mainstream the management training plots as a method of CA technology delivery into public extension programmes.

3. The government of Tanzania in collaboration with NGO e.g PASS and CARE INTERNATIONAL in Morogoro should design appropriate interventions for improving CA technology use examples with farmer’s access to farm credit and training supports in order to increase agricultural production to meet the challenge

of achieving self-sufficiency in food production both at household and national levels.

4. In the case of awareness, the strong positive and significant relationship between level of participation and sustainable use of the technology shown by both participating and non-participating farmers may be an indication of the benefits of involving farmers in different phases of the project cycles. In this case it is recommended that the MAFC and LGA should always promote farmers participation in planning, implementation, monitoring and evaluation of different agricultural extension programme activities for sustained and effective dissemination of agricultural technologies. To achieve this in Mvomero District, FFS should be enhanced and promoted.

5. The extension of CA is not just a technology issue; it also involves changes of the traditional concepts in people's minds and reforming of the traditional farming systems. Local government, private sectors and NGO's should make use of their special positions and authorities to develop CA with many kinds of effective measures like administration, laws, and economics.

6. CA depends greatly on the flexibility and creativity of the practitioners and extension and research services of a place. Trial and error, is often the only reliable source of information. However, as CA is gaining momentum rapidly in Mvomero District, there is a need now to form networks of farmer organizations and groups of interested people who exchange information and experiences on CA. Initial nervousness about switching from plough-based farming to CA can be ameliorated

by forming farmer groups to exchange ideas and gain knowledge from more experienced practitioners.

7. The government should provide training and materials support to VEOs/facilitators. Whiles initial basic training of facilitators-to-be is essential and proved worthwhile in CA SARD I, it is recommended that facilitators should be given more opportunity to learn through on-the-job-training, and specially organised exposure visits to help them build both the knowledge base and confidence to support farmers in CA. This also relates to access to CA materials (reference book, magazines, posters and flyers, etc. It is suggested that every facilitator should have at least a copy of the CA manuals.

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APPENDICES

Appendix 1: Questionnaire for Farmers (Both CA Project Participating and Non-Participating)

SECTION A. GENERAL INFORMATION: *Questionnaire no____*

Date_________________ District____

Division_______________________Ward___________________Village ____________

Respondent's name______________________________ phone_____________________

Name of the group______________ how many members in the group________________

SECTION B: HOUSEHOLD BACKGROUND INFORMATION

B1: Household characteristics:

(i) Sex: 1. Male __________________ 2. Female_____________________________

(ii) Age: 18 to 30 years ( ), 31 to 45 ( ), 46 to 60 ( ), above 60 years.

(iii) Size of household ____

(iv) Household head: Male headed___________, Female headed________, Grandparents headed____________ Orphans headed_____________________

(v) What are the main household income activities?

1. Crop production
2. Livestock production
3. Both 1 and 2 [ ]
4. Wage employment
5. Others____

(vi) What is the highest level of education of the Household head?

1. No formal education
2. Adult education
3. Primary school
4. Ordinary level secondary school [ ]
5. Advance level secondary school
6. Post secondary school certificate
7. Diploma
8. University degree

B2: Respondent’s status in project

1. Project participant [ ]
2. Non-project participant

B3: How many years have you been involved in crop farming?

(i) 0 to 5 years (ii) 5 to 10 (iii) 10 to 15 (iv) 15 to 20 (v) 20 to 25 (vi) 25 or more [ ]

B4: Do your household members provide enough labour for your crop production activities

(i) Yes

(ii) No ( )

B5: Are you currently a member of any community organization?

(iii) Yes

(iv) No ( )

B6: What are the community organizations in which you are a member? And in what year did you join in each of the community organization to which you belong.

Table 1: Organization and year joined

No	**Name of the organization**	**Year joined**

B7: (i) Please indicate how many of each of the following assets does your household has? *Values of household equipments, implements and structures were estimated based on the prices in the year of purchase.*

Table 2: Respondent assets

Assets	**Before the project**		**After the project closure**	
	Number	Tshs	Number	Tshs
Total number of houses				
Houses with metal roof, burnt brick, and cement floor				
Houses with metal roofs and burnt bricks				
Houses with metal roofs only				
Radio				
Jab planter				
Oxcart				
Pairs of oxen				
Knife roller				
Sprayer				
Ripper				
Direct seeders DAP				
Direct seeders tractors				
Hoe				
Ox-plough				
Tractor				
TV				
Water pump				
Cattle				
Bicycle				
Hand phone/land phone				
Others................................				

B8. What is your annual income? ( )

(i) Below 150,000 Tsh

(ii) Between 150,000 and 400,000 Tsh

(iii) Between 401,000 and 1,000,000 Tsh

(iv) Above 1,000,000 Tsh

SECTION C: AWARENESS AND INTEREST ON CA BY NON-PARTICIPATING

C1: Have you heard about the activities being carried out by CA technologies project?

(i) Yes

(ii) No ( )

C2: From whom did you first hear of the activities being carried out by the CA project?

1. Extension officers
2. Fellow farmer
3. Radio
4. Traders
5. Others: Specify____

C3: From the technologies introduced by the CA project you have heard, is there anything that is of interest to you ?

(i) Yes or (ii) No ( )

C4: What things are of interest to you about CA?

(i)____

(ii)____

(iii)____

C5: Please explain if there is anything of no-interest to you about CA?

____

____

SECTION D: BASIC DATA:

Table 3.0 Conservation agriculture

Three main crops grown under CA	Acreage (acre)	Total production in the last season (kg)	Amount sold (kg)	Average price /unit (Tshs)

Table 3.1 Convention agriculture

Three main crops grown under Convention Agriculture	Acreage (acre)	Total production in the last season (kg)	Amount sold (kg)	Average price /unit Tshs)

Table 3.2 Compare crop production before and after project closure

Crop	Before project closure				After project closure			
	Area (acre)	Kgs/bags	Price/kg	Total Tshs	Area (Acre)	Kgs/bags	Price/kg	Total Tshs
Lab lab								
Maize								
Cannavalia								
Sorghum								
Pigeon peas								
Onion								
Paddy								

D1: Do you hire labour. Yes ( ), No ( )____

D2: How much do you pay/acre in CA in: planting ______________________, spraying,__________, harvesting, _______,Other_________, total___________________.

D3: How much do you pay/acre in Convention agriculture in: tillage: hoe_________tractor ________, planting,____________weeding,_______________spraying,______________harvesting____________,Other_____________, total____

D4: The use of cover crops as: (a) dry season fodder_________________, for food and cash,________________________, generate more biomass to suppress weeds_____________,Others____

Table 4. Difference between tillage systems for the crop:

Tillage system	Working days (from soil preparation to harvest)	Maximum area under good cultivation	Yields (kg/acre)
Hand hoe			
DAP + hand weeding			
DAP + herbicides			
No-tillage + herbicides			

E: EFFECTIVE AND SUSTAINABILITY OF CA

E1: (a) What technologies were introduced in your farm?

(i)____

(ii)____

(iii)____

(b) In which crop the technologies were introduced?

(i)_______________________(ii)____________________________(iii)__________

(c) What re the types of cover crops you are using?

(i) __________________________(ii)_______________________(iii)_____________________

E2: Indicate the type of technology used during the project, continue to use and source of information.

Table 5: CA technologies used

No.	Type of technology	Was using during project	Continue to use	Source

A3: Are you currently using the CA practices introduced by FAO/GOT?

(i) Yes

(ii) No ( )

E4: Will you continue using CA technologies in the future?

(i) Yes

(ii) No ( )

E5: What proportion of your farm practice CA technologies introduced?

(i) Quarter

(ii) Half ( )

(iii) Three quarter

(iv) All

E6: From the answer in 1 above, why do you want to continue/not to continue using these technologies? ____

____

E7: Are there any constraints that may make you not to continue using CA technologies?

(i) Yes No ( )

E8: What are the constraints encountered during the implementation of he CA introduced technologies

____

____

Table 6: Sustainability and reasons for continuing with CA or not

No	**Reasons given**	**No. of replies**
1	Insufficient technical knowledge.	
2	Weed management costs are higher.	
3	Some diseases and insects appear to spread rapidly under intercropping.	
4	Fear of investing much and getting it wrong.	
5	Think that it is necessary to buy an expensive CA implements	
6	Losses under conventional cultivation are not significant.	
7	Have not seen research results validating the technology.	
8	CA is not accepted for crop insurance.	
9	My extension officer does not recommend it.	
10	Drought	

E9: (a) Do you encounter problems of livestock feeding to your CA field? Yes________/No____

(b) If yes; what measures have been taken to solve the problem mentioned above

____

E 10: Have you contacted the village extension worker in the past 12 months?

(i) Yes (ii) No contact ( )

E11: Have your contact with extension worker in this year increased, decreased, or remained the same when compared to last year

(i) Increased ( )

(ii) Decreased

(iii)Remained the same

E12: How many times did you contact him/her in the last 12 months? ______ (numbers)

E13: What were the reasons for the contact with the extension officer?

____

____

E14: Are you getting the equipment and farm inputs easily? (i) Yes______(ii) No_______ (iii) Source____

E15: Is there any other stakeholders engaged in CA? Yes (i)____ No (ii) ________ (iii) Mention ____

E16: Other ways of sharing experiences, knowledge and awareness for CA promotion

Table7: Factors for promoting sustainable CA

No.	Event	Performed
1	Field days and visit of fields	
2	Fair show eg Nane nane	
3	Exchange visit among distance farmers	
4	Yearly meeting	
5	Question and answers with researchers	
6	Open meeting	
7	Demonstration	

SECTION F: GENDER CONSIDERATIONS

F1: Kindly indicate (a) whether there has been a change in the workload of women and men following adoption of the technologies, (b) the number of months in which labour was saved, and (c) the number of days in a month where labour is saved.

Table 5: Gender and workloads

Gender	Workload status 1=increased 2=Decreased 3=Remain the same	Hours per day	Number of months with the change
Men workload			
Women workload			

F2: Give reasons for the change ____

SECTION G: HIV/AIDS EFFECTS

G1: Has HIV/AIDS has any effect in your group? Yes ( ) No ( )

If yes explain____

G2: In your opinion, do you consider HIV/AIDS as a bigger threat in the way it affects your activities as compared to other diseases? Yes ( ) No ( )

G3: If yes, what measures have you taken? __________________________________

G4: What is your proposal____?

SECTON H. GENERAL CONSTRAINTS

H1: What other constraints do you encounter in your field operation____________________________?

H2: What is your proposal (s) towards removing the constraints in the future____?

H3: In your opinion, what should be done in future to improve the level of CA in your area____?

Thank you for your cooperation.

Appendix 2: Check list for key informers questionnaire (e.g. VEOs, DSMS, Departments offices, Village leaders and alike)

Date ______________Organization ____

Respondent Name ____

Title____

1.0 What is the importance of CA: ____

____

2.0 What are the basic farm management problems that the CA is facing?

____

____

____

____

3.0 Does the CA farming activities in Mvomero district have negative impact to the users, and community at large? Yes ( ) No ( )

4.0 If yes, what are these impacts?

____

____

5.0 If no, why? ____

6.0 What are the management strategies to sustain CA activities in Mvomero district.

____

____

7.0 What are your opinion/comments as management strategies to alleviated problems associated with CA activities in respect to?

a) Agriculture Policy____

b) Environment ____

c) Prices and availability of equipment and tools______________________________

Thank you for your cooperation.