FACTORS INFLUENCING ADOPTION OF SOIL CONSERVATION MEASURES, SUSTAINABILITY AND SOCIO-ECONOMIC IMPACTS AMONG SMALL-HOLDER FARMERS IN MBEYA RURAL DISTRICT TANZANIA

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ABSTRACT

Soil degradation attributed by erosion threatens agriculture production in many regions of Tanzania, consequently food insecurity and drawback poverty reduction efforts. Though various soil conservation measures (SCM) have been introduced and practiced by farmers, the extent of their adoption and sustainability are not clear. The objective of this study was to assess the factors influencing adoption of soil conservation measures, their sustainability, and socio-economic impacts among small-holder farmers in Mbeya Rural District. Specifically, the study aimed at assessing, quantifying and documenting factors that influence adoption of SCM, farmers' opinions on sustainability of SCM and the impacts of the existing SCM on crops yields. Shibolya and Usoha Muungano villages in Tembela ward were selected on the basis of SCM project receivers. A sample of 100 smallholder farmers was selected randomly. Primary data were collected through semi structured questionnaire. Secondary data were collected from various documents and sources. Descriptive analysis such as frequencies, cross tabulations, chi-square test were performed, t-test and linear regression were used for yield comparison of adopters and non-adopters and relationship establishment between adopters and socio-economic characteristics of farmers respectively. Results showed significant influence on personal factors (age and education) socio-economic factors (non- farm activities, farm size and fertilizer use), institutional factors (technical support, distance to market and training), biophysical factors (topography, types of soil erosion and soil fertility) among farmers. About 58% of opinions in regards to sustainablility of the SCM required regular soil management, 23% suggested more education on SCM. Adoption of SCM increased farmers' maize and pyrethrum yield by an average of 27.8% and 26.8% respectively above non-adopters. Thus, SCM have resulted into substantial improvement in farm yields. Educating farmers regularly, consideration of farmers' opinions and implementation of SCM are recommended.

DECLARATION

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

Rehema Barnabas Seenga Date

(MSc. Candidate)

The above declaration is confirmed

Prof. Pantaleo, K. T. Munishi Date

(Supervisor)

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DEDICATION

This dissertation is dedicated to my beloved children Benedict, Adelaida and Victor Barnabas Seenga for their love, prayers, obedience and patience.

This work is also dedicated to all SUA students and elsewhere in the world and I say that God time is the best time.

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LIST OF ABBREVIATIONS AND SYMBOLS

ARI	Agricultural Research Institute
ASDS	Agricultural Sector Development Strategy
BSc	Bachelor of Science
CIMMYT	International Maize and Wheat Improvement Center
DAEOs	District Agricultural Executive Officers
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
Ha	Hectare
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFDC	International Center for Soil Fertility and Agricultural Development
Kg	Kilogram
LEAT	Lawyers Environmental Action Team
MAFSC	Ministry of Agriculture Food Security and Co-operatives
MKUKUTA	National Strategy for Growth and Reduction of Poverty II
MSc	Master of Science
NGO	Non Governmental Organizations
PhD	Doctor of Philosophy
PRA	Participatory Rural Appraisal
SCM	Soil Conservation Measures
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
TEP	Tanzania Economy Profile
TNADA	Tanzania National Data

TSH	Tanzania Shillings
UN	United Nations
URT	United Republic of Tanzania
VAEOs	Village Agricultural Extension Officers

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Soil degradation is a global environmental problem that requires urgent intervention measures. It is responsible for 84% of degraded acreage (Blanco and Lal, 2010). The primary causes of soil degradation are rainfall and wind which causes soil erosion leading to low agricultural production, hence food insecurity, malnutrition and poverty (FAO, 1999). The majority of Sub-Saharan Africa's population lives in rural areas, where poverty and deprivation are most severe, almost all rural households depend directly or indirectly on agriculture.

The Agriculture sector is the leading sector of the economy of Tanzania accounting for more than one quarter of GDP, provides 85% of export and employs about 80% of the workforce (TEP, 2012). More than 80% of the population live and earn their living in rural areas with agriculture as the main stay of their living (ASDS, 2001). There are diverse views about reasons for the low agricultural productivity in Tanzanian context. Among other things, it is attributed to low adoption of the existing technologies, soil erosion, drought, shortage and unreliable rainfall, pests and diseases, insecurity of land tenure, population pressure, overgrazing, deforestation, lack of efficient rural organizations and weak institutional support (LEAT, 2012).

The primary cause of soil erosion are rainfall and wind leading to low agricultural productivity, hence food insecurity, malnutrition and poverty (FAO, 1999). Soil errosion is affecting many regions of Tanzania including Mbeya region in the southern highlands of Tanzania. For a long time, Mbeya region, has been reported to be among the biggest four food producing regions in the country compared with other regions in the country

(Bisanda *et al.,* 1998). However, recently, there has been a decline in food production trends which has resulted in low yields and income earnings to households (URT, 2010). This decline probably is caused by soil erosion due to unstable and inappropriate soil conservation measures among other factors.

Soil erosion causes on-site and off-site effects. On-site effects include removal of valuable topsoil, covering emerged crops, growth and yield are directly affected through the loss of natural nutrients and applied fertilizers. Seeds and plants can be disturbed or completely removed from the eroded site. Organic matter from the soil, residues and any applied manure, is relatively light-weight and can be readily transported off the field. Pesticides may also be carried off the site with the eroded soil. Soil quality, structure, stability and texture can be affected by the loss of soil. Through off-site effects, the eroded soil is deposited down slope and inhibit or delay the emergence of seeds, bury small seedling and necessitate replanting in the affected areas. Sediments can be deposited on down slope and can contribute to infrastructure damage.

Soil erosion can be controlled by employing appropriate soil conservation measures such as physical/mechanical/ technical; biological/vegetative and agronomical/ management practices (Kruger *et al*., 1997). All these conservation measures can be used depending on existing situation and conservation objectives. Soil conservation control runoff and thus prevent loss of soil by erosion, reduces soil compaction, maintain or improve soil fertility, conserve or drain water and harvest excess water (Magayane, 1995). Considering the slow rate of soil formation and the importance of agricultural production for rural communities, the severity of this problem cannot be underestimated. To alleviate soil erosion problem, a number of policy measures have been undertaken by the government, although their success is highly minimal. The focus of this research is, therefore, to asses the factors influencing adoption of these conservation measures, their sustainability and how they have impacted on social economy of the community.

1.2 Problem Statement

Soil degradation attributed to erosion is one of the most serious environmental problems in Mbeya rural district. Despite the fact that various soil conservation methods such as contours “fanya chini” and cover crops were introduced by the government through Agricultural district office in collaboration with ARI-Uyole in Southern Highland Zone and practiced by farmers in their fields, the extent of adoption and the sustainability of these measures are not clear and soil erosion continues to be a serious problem leading to low yields due to loss of soil fertlity. Intensive farming on steep slopes and fragile lands and other factors like population pressure contribute significantly to low agricultural productivity and thus food insecurity and poverty intesification.

The current problem concerns the factors influencing the adoption and sustainability of soil conservation measures. Various studies have been done on soil conservation measures in different areas in Tanzania and worldwide and in different projects with different objectives (Asfaw, 2010; Kessler, 2006; Krishana e*t al*., 2008; Chomba, 2004; Aberha, 2008; Kalineza and Mdoe, 1999). However, little is known on the factors influencing adoption, sustainability and socio-economic impacts of these measures to the society. No systematic assessment and documentation of the sustainability and the potential of these measures in influencing the socio-economy of the society at large in the study area and the information to that effect remains unclear. This study intends to establish the factors that influence the adoption, sustainability and socio economic impacts of soil conservation measures particularly in Mbeya rural District.

1.3 Justification of the study

Knowledge of the factors that influence farmer adoption of soil conservation measures is an important step in the effort of fighting severe soil erosion, low crop yields and food insecurity in Tanzania and elsewhere in the world. This is in line with the Millennium Development Goal one, which is to eradicate extreme poverty and hunger with its first and second targets of halving the proportion of people whose income is less than one dollar a day and halving the proportion of people who suffer from hunger respectively between year 1990 and 2015 (UN, 2010). Therefore, understanding of the existing situation and documentation of the study will generate useful knowledge to farmers, development planners, policy makers, reseachers and practitioners in formulation and implementation of the policy interventions designed to induce voluntary adoption of soil conservation measures and other development efforts in Mbeya rural district in order to improve food availability and income generation.

1.4 Objectives

1.4.1 Main objective

The main objective of this study was to establish the factors influencing the adoption of soil conservation measures, sustainability of soil conservation measures and their socio-economic impacts among smallholder farmers.

1.4.2 Specific objectives

Specific objectives were to:

i. Assess and document the factors that influence adoption of soil conservation measures among smallholder farmers.
ii. Assess the farmers’ opinion on improving sustainability of soil conservation measures.

iii. Assess and quantify the impacts of the existing soil conservation measures on crop yield.

1.5 Research Questions

i. What are the major factors that influence adoption of soil conservation measures?
ii. What are the farmers’ opinions on improving sustainability of soil conservation measures?
iii. What are the impacts of the existing soil conservation measures on crop yield?

CHAPTER TWO

2.1 LITERATURAL REVIEW

2.1.1 The Concept of Soil Conservation Measures

Soil conservation measures are the technologies/practices employed on soil aiming at the preservation of soil against deterioration or erosion, and the maintenance of the fertility enhancing elements for crop production (Ervin and Ervin, 1982). Conservation is the preservation and careful management of the environment and natural resources. There are three types of soil conservation measures: physical, biological and agronomical (Krüger *et al*., 1997).

Physical measures include various engineering techniques and structure. This practices aim at the following objectives: to divide a long slope of land into a series of shorter ones in order to reduce the velocity of run off water, to retain the water on the soil for long period so as to allow maximum water to be absorbed and held in the soil and less water flows down the slope of the land at non-erosive velocity and to protect the soil against erosion by water.

Biological soil conservation involves the use of vegetation: Crops and vegetations which cover the ground surface well and have extensive root system that reduce soil erosion. Plant canopy protect the soil from the adverse effect of rainfall. The grasses and legumes produce dense sod which helps in reducing soil erosion. The vegetation provides organic matter to the soil. As a result, the fertility of soil increases and the physical condition of soil is improved.

Agronomical soil conservation measures involve the use of agronomic practices such as mulching, crop rotation, addition of organic manure, good tillage among others. Bayard (2006), defined soil conservation as a conscious process by man to preserve and or to restore land to optimum conditions of productivity with major objective of maintaining the soil to its optimum productivity. Thus, adoption of soil conservation technology reduces soil erosion and soil loss and also results in increasing quality and quantity of agricultural products thereby increasing household food security. Soil conservation as a way of solving problems of land degradation has been viewed through single decision of conservation practices that utilized single model of adoption in most research work (Ajala, 2001).

Several conservation technologies have been developed and promoted however, their adoption have not been widespread because some farmers still remain adamant and by implication, land resource utilization in terms of expansion becomes a problem to farmers with limited undegraded land (Lapar and Pandey, 1999). Soil conservation is an integral effort of stakeholders (local farmers, governmental organisations and non-governmental organisations (NGO's) in ensuring the preservation of soil structures and at the same time facilitating the retention and or augmentation of soil nutrients. It is all about preventing soil from being damaged, destroyed or lost. Some local soil conservation approaches include: Shifting cultivation/bush fallow, crop rotation, organic manure application, mulching, terracing, contouring, taungya farming, heap making, planting of special hedge plant (e.g. cactus, euphobia). Modern methods include planting of cover crops, alley farming, making of ridges and bars, application of organic and inorganic fertilisers "Fanya juu"/"Fanya chini" contours.

2.1.2 Sustainability of soil conservation measures

Sustainability in soil conservation measures is the ability to keep in existence, maintain or prolong and provide sustenance for the soil conservation measures. This means farmers maintain, replicate and continue to use soil conservation measures in their farmland resulting into control of soil erosion which in turn reduces soil degradation consequently increasing crop production per unit area (Aberha, 2008).

2.1.3 Impact of soil conservation measures

Impact is the effect expected to result after practising a certain practice/measure and can be positive or negative depending on the performance. The impact can be measured by assessing the economic variables and determine how far economically an individual have achieved e.g improved welfare (Asfaw, 2010). Few empirical studies have used econometric and cross-sectional data to directly examine the impacts of soil conservation measures on mean yield in developing countries (e.g. Byiringrio and Reardon 1996; Shively 1999; 1998a; Holden e*t al.,* 2001; Bekele 2005; Kaliba and Rabele 2004; Benin 2006; Kassie and Holden 2006; Pender and Gebremedhin, 2006).

According to Byiringiro and Reardon (1996), using farm-level data in Rwanda, farms with greater investments in soil conservation had much greater land productivity than other farms. In the Philippines, Shively (1998a; 1998b) found that conservation via contour hedgerows had a positive and statistically significant impact on yield, as assessed using farm-level data. In Lesotho, Kaliba and Rabele (2004) found that short and long-term soil conservation measures had significantly positive effects on wheat yield. Several studies have estimated the impacts of soil conservation measures in the Ethiopian highlands using econometric analysis of cross-sectional survey data. Pender and Gebremedhin (2006) conducted a survey of 500 households representing the semi-arid highlands of Tigray, and found higher crop yields from plots with stone terraces (an average yield increase of 23%), and estimated the average rate of return to stone terrace investment to be 46%.

2.1.4 Adoption

There are various definitions for the adoption of soil conservation activities. Rogers (1995) has defined the adoption process as "the mental process an individual passes through, from first hearing about an innovation to final adoption." Adoption typically is a continuous process that involves evaluation of rewards from early adopters, which may trigger bandwagon in adoption as such this positive relationship that existed between profit as a result of innovation and adoption index is thus, a motivating factor for innovation spread Feder *et al*. (1985). De Graaff *et al.* (2008), categorize adoption in three phases in the adoption process: the acceptance phase, the actual adoption phase and the continued use phase.

The acceptance phase generally includes the awareness, evaluation and the trial stages and eventually leads to starting investing in certain measures. The actual adoption phase is the stage whereby efforts or investments are made to implement soil conservation measures on more than trial basis. The third phase of final adoption is the stage in which the existing soil conservation measures are maintained over many years and new ones are replicated on other fields. Kessler (2006) considers that soil conservation measures are totally adopted only when their implementation is sustained and fully integrated in the household farming system. Farmers adopt ridge construction across the slope as a way of controlling erosion. They adopt cover crops because of their low cost and simplicity. A farmer is considered an adopter if he/she implement one or more of the introduced soil conservation measures.

2.2 Personal Factors in Relation to Adoption of Soil Conservation Measures

2.2.1 Age structure

Compostion of household members in terms of age distribution has some implications for the household members who are capable of being involved in productive activities are only confined within a certain age limits. For instance very young members conventionally taken as below 18 years and very old members assumed to be over 64 years are considered not economically productive because they cannot participate in production activities due to their physiological incapability (URT, 1991). Normally household members in these age groups are dependent on the economically active member to fulfill their needs. Constructing and managing soil conservation structures are labor intensive, therefore the household which has many old people or many very young ones would have low labour of constructing or managing soil conservation structures.

2.2.2 Education

There is mixed evidence regarding the relationship between farmer's education levels and their adoption of sustainable land management practices. Indeed, education be it specific or general, commonly correlate positively with adoption of conservation agriculture practices (Okoye, 1998; Gould *et al*., 1989). However, some studies have found education to be an insignificant factor (Clay and Kangasniemi, 1998) or even negatively correlate with adoption (Warriner and Mould, 1992). In both theoretical and practical terms, education level of the member of household, plays a significant role in enabling household access to food. Skills and education increase working efficiency and productivity making household with more educated members more entitled to income and food (Turyahabwe *et al*., 2013).

Basic education is a foundation for developing the flexible skills needed to participate in knowledge-intensive economic activity. Those who lack access to basic education are likely to be an increasing risks of falling behind in their ability to participate in development (King and Alderman, 2001). Traore *et al*. (1998), observed that more educated farmers are able to understand information about environmental problems. That observation was supported by the positive and significant coefficient of education variable in the model. Aberha (2008) reported that, generally better-educated households have a more realistic perception about soil erosion problems, have more knowledge related to soil conservation and hence can more easily be involved in conservation activities.

2.2.3 Gender

Gender is not a synonym for women but it considers both men and women and their interdependent relationship. It is a cultural construct related to the behavior learned by men and women and it affects what they do and how they do it within a specific social setting (Katani, 1999). Gender differentiation comes about as a result of the specific experience, knowledge and skills, which, women and men developed as socially constructed. Gender is related to how we are perceived and expected to think and act as women and men because of the way in which the society is organized. The kind of relationship which exists between these two sets of actors affects hierachies of access, use and priorities for the innovations adoption, processing, preserving and marketing products. Gender relations are contextually specific and often change in response to altering economic circumstances, and vary widely both within and between culture (Lyimo-Macha, 2000). Aberha (2008) found that women-headed households are not involved in the continued use of soil conservation structures because female-headed households have limited access to the information on soil conservation and to land and other resources, due to tradition barriers. Women are also more involved in regular household activities than males.

2.2.4 Household size

The number of members in the household has an important socio-economic implication in household's ability to access enough food. A large number imply more to feed, more people to share the household budget and sometimes can provide more labour. The issue is especially relevant in the case of Tanzania where large family sizes are common because of extended family network (Mhinte, 2000).

2.3 Economic Factors in Relation to Adoption of Soil Conservation Measures

2.3.1 Household income

When disparities in wealth are relatively large, per capital income or economic status is good, it positively contribute to household food security (Becker *et al.*, 1986). FAO (1980) and Mahmoud (1983) demostrated some relationship between economic status and food consumption even in poor rural households. The authors reported that when income is low there is inadequate portion of the income spent on food. But as income increases, it will buy more food though a smaller proportion of that income is spent on food. Brown *at al.* (1995), reported that income is one of the key determinants of household food consumption as low income earning means low purchasing power a situation that leads to household food insecurity.

2.3.2 Nonfarm activities

When the farmer and his family is more involved in non-farm employment activities, the time spent on their farmland will be limited and hence the family will be discouraged from being involved in construction and maintanance of soil conservation structures.

On the other hand, non-farm activities can be a source of income and could encourage investment on farming and soil conservation activities (Aberha, 2008). The involvement in non-farm activities negatively influenced the continued use of soil conservation technology because famers spent more time in non-farm activities and less time on farming activities (Tenge *et al*., 2004).

2.3.3 Fertilizer use by farmers

Africa's food production lags behind most parts of the world because its soils are low in nutrients, low in organic matter, and have poor water holding capacity; until those conditions are reversed Africa's soils will continue to degrade and its food situation will continue to deteriorate (Borlaug, 2007). IFDC (2007) estimated that Africa loses 8 million metric tons of soil nutrients per year and over 95 million hectares of land have been degraded to the point of greatly reduced productivity (Henao and Baanante, 2006). At least 85% of African countries are estimated to have nutrient mining of above 30 kg of nutrients per hectare per year and 40% of countries experience losses of over 60 kg of nutrients per hectare per year (World Bank, 2001; Henao and Baanante, 2006).

A study by Chomba (2004) stated that, if fertilizer application would be increased, the likelihood of a farmer to follow conservation practices would also increase, because conservation measures prevent fertilizers from being washed away by erosion hence are needed more. The study by Shiferaw and Holders (2000), observed that an increase in fertilizer application has a negative influence on farmers choice for conservation measures. This is because the increment on fertilizer save as a replacement for soil conservation measures and hence discourages farmers'continuos use of soil consevation structures.

2.3.4 Annual income and access to credit

Kessler (2006), observe that a greater income from the land encourages farmers to invest more in conservation measures. Income has a profound effect on the dependency of people to their biological resources. It is argued by Katani (1999) that people with higher income usually have more of the available resources including land and may invest in long term projects than people with low income.

Income of farmers can be estimated by looking on income from crop production, which is calculated as annual production value of farm products minus paid-out costs (costs of seeds, fertilizer, chemicals, hired labor and oxen rental including own oxen). Consumption expenditure capture six major categories including: food gains, livestock products (e.g. meat), vegetables and other items (e.g. sugar, salt,), beverages (coffee, tea leaves), clothing and energy (kerosene, firewood) and social activities (contribution to churches or local organization, education and medical expenditure, over the twelve months). Krishna *et al*. (2008) observed that, farmers who receive loans from various institutions for the cultivation of new crops and for the livestock farming were significantly more involved in soil conservation technology.

2.3.5 Farm size

Amsalu and De-Graaff (2007) found that, farmers who have large farms are more likely to invest in soil conservation measures. Farmers with more land can take more risks, including a relatively high investment required in order to protect crops against pests, hailstones, drought and excess rainfall. Also it is related to the wealth status of the farmers, which helps them to encourage the farmers on sustainability of soil conservation structures in their fields as they get large amounts of income from the field.

2.4 Institutional Factors in Relation to Adoption of Soil Conservation Measures

2.4.1 Land tenure

Sutcliffe (1995) in his study of soil conservation in the highlands of Ethiopia, found that land tenure security is ‘not sufficient enough for farmers to invest in soil conservation works. Yeraswork (2000) concluded that Ethiopian farmers lack concern for land conservation because of the insecure tenure. Kajembe (1994), insist that land tenure security also provides incentives for long term planning and management. These help farmers to invest in medium and long term soil conservation measures. Fedder *et al.* (1985) argue that increased security of tenure tend to increase incentive for land productivity via the long planning horizon that land ownership permit better access to credit and other inputs. In Tanzania, the issue of women and land ownership touches traditions and customary law. These are shaped by tribal customs and traditions, which often create barriers for women to equal rights of ownership to land, property ownership and inheritance (Natai, 2004).

2.4.2 Market distance

Farmers who live far away from the market are more involved in the work of soil conservation. Proximity to markets creates disincentive for participation in soil conservation measures because farmers living close to the market has alternative sources of livelihood example, paid employment in cities and towns, instead of working on the farm. It can be easily observed that it is very customary for farmers near the towns to leave for the urban areas even when they do not have anything to do there (Aberha, 2008).

2.4.3 Techinical support

Chomba (2004) in his study in Zambia indicated that, a large proportion of farmers who had contacts with agricultural support programs did not continue the improved practices. This is because the extension support provided is not aimed at the promotion of conservation practices and is more focused on crop production and other agricultural activities. This shows that it is not sufficient to have extension support but the aim or purpose of extension service should also relate to the continuation of conservation work.

2.5 Biophysical Factors in Relation to Adoption Soil Conservation Measures

2.5.1 Level of soil fertility

Farmers with poor soils or plot with low and medium fertility are more involved in conservation work than those who have fertile land. This is because farmers have an interest to improve the level of soil fertility and the productivity of the land at the plot level. However, farmers with very fertile land possibly do not see the negative effects of erosion on their plots in the short term (Aberha, 2008).

2.5.2 Type of soil erosion

According to Aberha (2008) farmers that suffer from severe gully erosion are more involved in conservation work because they had to conserve their soil from erosion and to prevent the total loss of the land. Farmers are more likely to maintain and replicate conservation measures on plots that are highly prone to soil erosion and when erosion feature are visible (Bekele and Drake, 2003; Swinton, 2003).

2.5.3 Slope

A positive relationship was observed between the gradient of the slope and the sustainability of soil conservation measures. Farmers with land that has steep slopes are more involved in continued use of soil conservation measures than those who own flat or gently sloping farmland. On steep slopes farmers construct soil bunds and fanyajuu on their farmland to prevent soil erosion (Aberha, 2008). The effect of steep slope on continued use of stone terraces is found to be significantly positive. The farmers were encouraged to continue to use the stone terraces due to effectiveness of the measure for erosion control on steep slopes (Amsalu, 2006).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location and size

This study was carried out in Mbeya rural District within two villages, nammely Usoha Muungano and Shibolya in the southern highlands of Tanzania. Mbeya rural District is located in the southern zone of Tanzania and it lies between Latitudes 7º and 9º South of Equator and between Longitudes 33º and 35º East of Greenwich. The district has a total land area of 2432 square km equivalent to 243 200 hectares of which 189 818 hectares are arable land ideal for agricultural production. Whilst about 47 354 hectares are covered by forests and 6028 hectares are under water bodies as well as unarable land (URT, 2002). It borders Mbarali District council to the East, Rungwe and Ileje districts to the South, Mbozi District to the West and Chunya district to the North (Fig. 1).

3.1.2 Population size and growth

Mbeya rural District had a population of 305 319 people by the year 2012 after the national population and housing census conducted in August-September 2012. The population density in the district is 125 people per square kilometers comparatively greater than the national average population density which is 51 people per square kilometer and regional 45 people per square kilometer by 2012 (TNADA, 2012).

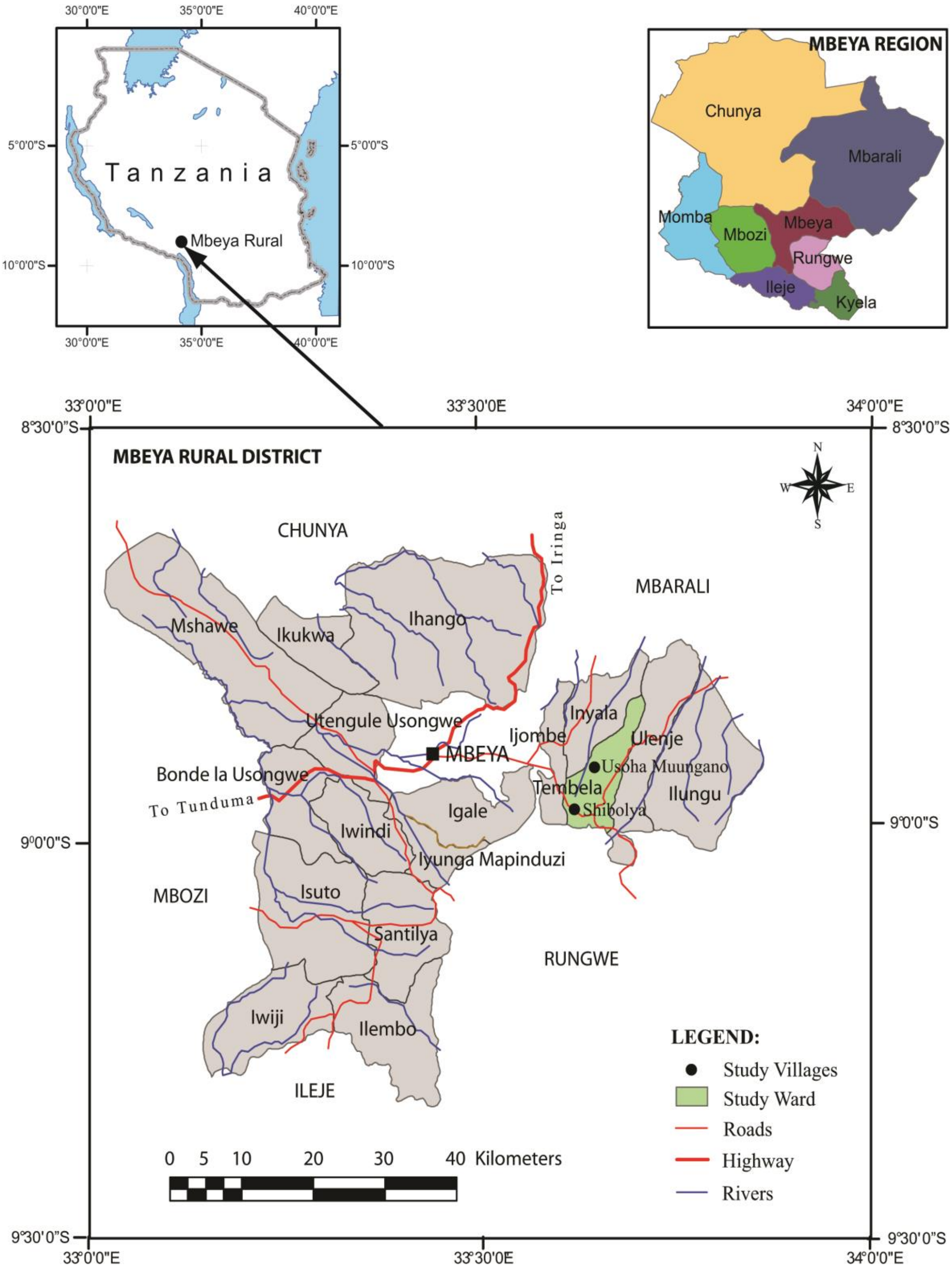

Figure 1: Map of Mbeya Rural District showing study sites

3.1.3 Topography

Mbeya Rural District is characterized by highlands, mountainous peaks and lowlands of Songwe valley (Plate 1). The most predominant natural vegetation includes tropical, savannah and wooded grassland which lie at an altitude ranging from 2300 – 2800 meters above sea level. The average temperature ranges between 12^0C- 30^0C annually. Mean annual rainfall ranges between 650mm- 2700mm, (URT, 2010).

Plate 1: Topography of Some Parts of Mbeya Rural District

3.1.4 Socio Economic activities

Economically, Mbeya District is based on agriculture, livestock, forestry and mining as the main sources of income. More than 85% of the district gross domestic product comes from agriculture (URT, 2010).

3.2 Research Design

A cross sectional study design was used, whereby data was collected at a single point from a sample collected to represent a large population. According to Bailey (1998) this design can be used for descriptive study as well as determination of the relationship between variables and allows data to be collected at a single point in time.

3.2.1 Sampling procedure and sample size

One ward and two sample villages were purposely selected from the district where soil conservation measures were introduced. Random sampling method was used to select individual households for the study based on the extent to which they participated in the program. A representative sample for the study from each village based on Boyd's formula n/N x 100=c, where "c" represents the figure greater or equal to five percent of the villages household population, "N" is the total number of households in the selected villages and "n" is the total number of households in a particular selected village (Boyd *et al.*, 1981).

With the help of the village leaders, a fixed whole number of the households was selected by Boyd's formula resulting into 50 households in Usoha Muungano village and 50 households in Shibolya village. The total, number of households in the villages was 1020 in Usoha Muungano village and 1030 in Shibolya village.

Fifty farmers from each village were selected randomly using random number table (Stattrek, 2013) and villages register as a sampling frame. With this method, every individual in the population has an equal chance of inclusion in a sample and its sampling error can be estimated (Kothari, 2004). The selection of 50 farmers in each category was adopted in order to keep the sample size above 30 which is the minimum sample size to which statistical analysis can be applied.

3.2.2 Primary data collection

In the collection of primary data, household questionnaire was administerd to randomly selected farmers and relevant PRA methods (transect walk and focus group discussions) was used. A transect walks across the village enabled the acquisition of the necessary information on the practise of each farmer selected for the study and determined the questions that were added or ommited from the questionnaire as well as familiarization with the study area. To ensure validity and reliability, the first draft of the questionnaire was pre-tested in 15 households. Based on the pretesting and the transect walk in farmers' fields, necessary changes were done before it was finally administered.

3.2.2.1 Assessment of factors influencing adoption of soil conservation measures among smallholder farmers

This objective was achieved by household interviews conducted using questionnaires with open and closed ended questions (Appendix 1). The questionnaires were used to seek information on assumed factors that influence adoption of soil conservation measures among small holder farmers. Such factors were categorized into personal, socio-economic, institutional and biophysical. Further information on household socio-economic characteristics was collected for both adopters and non-adopters. This information enabled the use of logistic regression model to determine the most significant factors that influenced adoption of soil conservation measures among the community.

3.2.2.2 Assessment of farmers' opinions on improving sustainability of soil conservation measures

A household questionnaire with open and closed ended questions was used (Appendix 1). The information collected in this respect included whether the soil conservation measures were sustainable and how the sustainability of these measures will be improved.

3.2.2.3 Assessment of the socio-economic impacts of the soil conservation measures

This objective was achieved by use of a checklist of questions (Appendix 2) which availed the information on farm productivity among adopters and non-adopters. Each farmer was asked to indicate annual harvests over three years. The annual crop production was used as a measure of improvements resulting from practicing soil conservation measures among different farmers. Additional information was obtained from the district agricultural offices on average yield data per hectare on soil conservation measures (SCM) adopters and non- adopters.

3.2.3 Secondary data

The secondary data was collected from various government offices (regional and district offices), reports, websites, past thesis; journals and articles and related books in the Sokoine National Agricultural Library of SUA.

3.2.4 Data analysis

Qualitative and quantitative data was summarized, coded and analyzed, using SPSS to obtain the measures of central tendency - means percentages and summarized in tables and bar charts. Farmer opinions on improvement of sustainability of soil conservation measures were summarized into pie chart and percentages showing the farmer response on different aspects of sustainability. To analyze information on factors influencing implementation of soil conservation measures, cross tabulation and chi square tests with symmetric measures were employed, while Linear regression model was used to estimate the effect of the factors influencing crop yield as shown in Equation 1 and 2.

i. Factors contributing to differential mean yields for maize among farmers were estimated by using linear regression model 1.

$$Y_m = A + \beta_1 EDU + \beta_2 GEN + \beta_3 FSIZE + \beta_4 DHM + \beta_5 NFA + \beta_6 AGE + \beta_7 MSZ + \acute{\varepsilon} \ldots\ldots\ldots (1)$$

While,

ii. Factors contributing to differential mean yields for pyrethrum among farmers were estimated by using linear regression model 2.

Y_P=A+β_1FSZ+β_2EDU+β_3GEN+β_4DHM+β_5NFA+β_6AGE+β_7PSZ+έ………… (2)

Where: Y_m = Maize annual yield per hectare

Y_p= Pyrethrum annual yield per hectare

FSZ= Family size

EDU= Education level,

GEN= Respondent's gender

DHM=Distance from farmer's households to the market place

NFA= Average duration of involvement in nonfarm activities,

AGE= Respondent's age

MSZ= Maize farm size,

PSZ= Pyrethrum farm size,

έ = The random error term representing unexplained variations in the model.

To analyze farmers' opinions on improvement of sustainability for soil conservation measures, the descriptive statistics on frequencies was used. However, the socio-economic impacts of adopting soil conservation measures were analyzed by use of independent t-test as presented by the formulae hereunder.

$$t = \frac{\text{difference between means}}{\frac{\text{variance}}{\text{sample size}}}$$

……………………………………………………………….. (3)

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

…………………………………………….(4)

Where,

$\bar{X}_1$= Mean of sample 1

$\bar{X}_2$= Mean of sample 2

N_1=Number of observations in sample 1

N_2= Number of observations in sample 2

S_1^2 = Variance of sample 1 $= \frac{(X_1 - \bar{X}_1)}{N_1}$

S_2^2 = Variance of sample 2 $= \frac{(X_2 - \bar{X}_2)}{N_2}$

In this case, adopters and non adopters were compared in terms of their crops' yields. The effect size (Strength of the difference) was used to determine the magnitude of the differences. The effect size statistic was the Eta squared whose calculation involved the use of the t-values obtained in t-test analysis calculated using the above formulae. The formula used for obtaining the effect size was as shown in Equation 5.

$$\text{Eta squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)} \quad \text{...} (5)$$

Where

Eta squared= the magnitude of the difference in means

t= t-value; N1= number of people in group one; N2= number of people in group two.

According to Cohen (1988), when there is an indication of difference between the two groups is statistically significant, Eta squared will give a set of statistics ranging from 0 to 1. Thus, the interpretation of strength of Eta squared values is based on the following range of values, whereby if the value is $\geq$ 0.01but <0.06 indicates Small effect; while if 0.06 $\leq$ Eta squared < 0.14 indicates Moderate effect; whereas if 0.14 $\leq$ Eta squared indicates large effect (*ibid*).

CHAPTER FOUR

4.1 RESULTS AND DISCUSSIONS

The soil conservation measures which were introduced in the study area were “fanya chini” contours and cover crops (*Desmodium spp and Mucuna spp*).

4.1.1 Soil conservation measures recommended for implementation

Farmers who participated in the programme were recommended to construct “fanya chini” contours and plant cover crops. They implemented these technologies in order to control soil erosion and improve soil fertility. The study show that 59% of the population had constructed contours and planted cover crops, 14% have contours only and cover crops no longer existed though they were implemented in five years ago. On the other hand 27% did not implement any of the technologies at all (Table 1). Discussions with key informants showed that the cover crops had been destructed by livestock which were allowed to graze on farmlands after harvesting crops, mole rats and also other cover crops failed to grow.

Table 1: Soil conservation measures implemented by households in Mbeya Rural District

Type of SCM	Usoha village		Shibolya village		Total	
	Frequency	(%)	(%)	(%)	Frequency	(%)
Fanya chini contour and cover crops	40	86.0	10	32.0	50	59.0
Fanya chini contour only	10	14.0	2	0.0	12	14.0
Not implemented the SCM	0	0.0	38	68.0	38	27.0
Total	50	100	50	100	100	100

4.1.2 Respondent Characteristics

Household characteristics of farmers examined in the study were age, education, marital status, household head gender, major source of income and family size. The aim of choosing these parameters was to obtain the general overview of the characteristics of respondents and how could these influence the adoption of SCM, their sustainability and social economic impact of the technologies.

4.1.2.1 Age

The study found age distribution of farmers varying from 18 to 64 years. Majority of the farmers (49%) were in the age group of 40-64% years. Where 9% were above 64 years, 42% were those with age groups ranging from 18 to 40 (Table 2). This implies that most of the farmers were in the economically productive age group and therefore, there is large labor force in the study area with potential for adopting innovations such as soil conservation practices.

Table 2: Age and Education of the respondents in Mbeya Rural District

Variable	Usoha Muungano (%)	Shibolya (%)	Total
Age			
18-40	22.0	20.0	42.0
40-64	22.0	27.0	49.0
Above 64	6.0	3.0	9.0
Total	50.0	50.0	100
Education level			
No formal education	9.0	9.0	18.0
Primary education	39.0	37.0	76.0
Secondary education	2.0	4.0	6.0
Total	50	50.0	100

According to Mandara (1998) household members are considered economically productive from the age of 18 to 64 years. The age groups below 18 years are children who are attending schools and others are too young to participate in farming activities. The age group above 64 years is considered less economically active because the members are too old and are not energetic enough to participate in labor intensive production activities.

4.1.2.2 Education

The education levels of the respondents are as shown in the Table 2. Majority (76%) had primary education, 18% no education and 6% secondary education. However, generally, except for the few (18%) who had no formal education, most of the respondents were educated. This implies that, the introduction of various SCM in the study area are likely to be adopted because majority could not only be trained by soil conservation experts but also, are able to read from books, leaflets, brochures and other sources of information.

4.1.2.3 Marital status and household head gender

Table 3 shows marital status of the farmers in the study area. Out of 100 farmers, the highest (72%) were males while 26% were females. Females had smaller percent presentation regardless of the fact that, they are key players in most of the household's farm activities. Probably the reason behind is that, the study aimed at the heads of the households as responsible main decision makers about household affairs. Therefore, except for the few households, which were headed by females which were either widow, divorced and separated, the majority were males. Sometimes, females had to respond on behalf of their husbands if absent thus, combining some of the households which were headed by males and others by females, all the interviewed farmers were heads of households. This implies that most useful information regarding the topic in question was obtained because the heads of the household provided it. The findings also show that 82% of the respondents were married, 10% widowed, and 4% separated and 4% divorced, high involvement of married people in agriculture activities could be contributed by the need to generate income to meet family needs.

Table 3: Marital status and household head gender of the respondents in Mbeya Rural District

Variable	Villages Usoha Muungano (%)	Shibolya (%)	Total
Marital status			
Widow	5.0	5.0	10.0
Married	42.0	40.0	82.0
Separated	1.0	3.0	4.0
Divorced	2.0	2.0	4.0
Total	50	50	100
Household head gender			
Female	12.0	14.0	26.0
Male	38.0	36.0	74.0
Total	50.0	50.0	100

4.1.2.4 Major source of income

Table 4 show the major source of income of respondent, 34% of farmers in Usoha Muungano village were involved in farming only, while in Shibolya village was 15%. Farming and livestock keeping, 16% were those from Usoha Muungano and 13% were from Shibolya. There were no farmers involved in non-farm activities in Usoha Muungano village while 22% of farmers in Shibolya were involved in non-farm activities.

4.1.2.5 Household size

According to the study result (Table 4), the average number of household members for the study villages was 4-6 which were (32%) and (37%) and (69%) for Usoha Muungano, Shibolya villages and the study area respectively. A large number of members in the household mean more people to feed and share the household budget (Mhinte, 2000). Furthermore, family size is also an important factor in determining the extent to which labor is available in any economic activity and it reflects household’s ability to access enough food, health services and other basic needs. Therefore, the household with a large number of people are more likely to adopt SCM in comparison to small household size because they are interested in obtaining high yields to feed their families.

Table 4: Major source of income and household size of the respondents in Mbeya Rural District

Variable	Villages: Usoha Muungano (%)	Shibolya (%)	Total
Major source of income			
Farming only	34.0	15.0	49.0
Farming and livestock keeping	16.0	13.0	29.0
Non-farm activities	0.0	22.0	22.0
Total	50.0	50.0	100
Household size			
1-3	8.0	8.0	16.0
4-6	32.0	37.0	69.0
7-10	9.0	5.0	14.0
> 10	1.0	0.0	1.0
Total	50.0	50.0	100

4.1.3 Factors Influencing Adoption of Soil Conservation Measures

4.1.3.1 Personal factors

(a) Age of the respondent

There were three age groups among SCM adopters and non-adopters: young people ages between 18-40, middle aged between 40-64 years and old people were those with age above 64 years (Table 5). Most of the farmers in the study area belong to the young and the middle-aged groups which is an indication that there is a sufficiently large labor force.

Forty eight percent of young people were the SCM adopters, those among the middle age 43% were the adopters. However, adoption among the old people was 100%. Adoption among the old people was high compared to other age groups because the project provided labor to all farmers aged above 64 years for construction of contours and planting cover crops. This showed that, increase in number of years one lives, is accompanied by decrease in energy/strength and ability to provide labor though there is increase in experience in understanding on the importance of SCM and thus increases adoption of the conservation measures among farmers.

Moreover, results show that, the relationship between age and SCM adoption among farmers was statistically significant (0.006) at $p < 0.05$ and positive though weak. These study results were in line with what was reported by URT (2003) that, composition of household members in terms of age distribution has some implications for the household members who are capable of being involved in productive activities as only confined within a certain age limits.

Table 5: Influence of age on adoption of SCM in Mbeya Rural District

Variable	Adoption Category of SCM			
Age Groups (Years)	Adopters		Non adopters	
	Count	(%)	Count	(%)
18-40 (n=42)	20	48.0	22	52.0
40-64 (n=49)	21	43.0	28	57.0
Above 64 (n=9)	9	100	0	0.0
Significance				
Chi square	Value	10.095		
	Assymp.sig.	0.006		
Symmetric measures (interval by interval)	Value	0.174		
	Approx.sig.	0.009		

(b) Education Level

Among respondents 28% of farmers without formal education adopted the SCM, whereas 58% of farmers who had the level of primary education adopted SCM. However, 83% of farmers with secondary level of education did not adopt the SCM. From these results, adoption of SCM was significantly related to farmer's education level at $p < 0.05$. Nevertheless the relationship was weak. It was observed that, there was higher number of adopters of SCM within farmers who had primary education than in farmers with no formal education. On the other hand, adoption of SCM among respondents with secondary education (17%) was less than adopters among respondents with no formal education (28%) and primary education (58%). The relationship between education and adoption of SCM was negative meaning that increasing people with formal education reduces the potential for adoption of SCM.

This study contradict to what was reported by Traore *et al.* (1998), who stated that, educated farmers are able to understand information about environmental problems. This could be due to the fact that, those with secondary education were not dependent solely on farm production income generating activities compared to the other levels of education because they has flexible skills to be employed and to do other income generating activities like business in the study area.

Table 6: Influence of education on adoption of the SCM in Mbeya Rural District

Variable	Adoption Category			
	Adopters		Non adopters	
	Count	(%)	Count	(%)
Respondent's Education Level				
Non formal Education (n=18)	5	28.0	13	72.0
Primary Education (n=76)	44	58.0	32	42.0
Secondary Education (n=6)	1	17.0	5	83.0
Chi square	Value	8.117		
	Assymp.sig.	0.017		
Symmetric measures	Value	-0.144		
	Approx.sig.	0.015		

4.1.3.2 Socio - economic factors

(a) Involvement in non-farm activities

About 64% of farmers not engaged in nonfarm activities adopted the SCM. However, 21% of those engaged in nonfarm activities adopted the SCM. These results showed that, there was a negative but weak significant relationship between adoption of SCM and engagement in nonfarm activities ($p < 0.05$). Implication of these result is that, for higher adoption of SCM among respondents who had not been engaged in non-farm activities than those who had non-farm activities, could have been due to lack of direct effect on their livelihood activities as compared to their counterparts to whom agriculture is the main source of livelihood. This study is in line with what was reported by Tenge *et al.* (2004) that, the involvement in non- farm activities negatively influenced the continued use of soil conservation technology, because, famers spent more time in non- farm activities and less time on farming activities (Table 7).

Table 7: Influence of non-farm activities on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	(%)	Count	(%)
Non- farm activities				
Involved in farm activities. (n= 67)	43	64.0	24	36.0
Involved in nonfarm activities (n= 33)	7	21.0	26	79.0
Chi square	Value	16.327		
	Assymp.Sig.	0.000		
Symmetric measures	Value	-0.404		
	Approx.sig	0.000		

(b) Influence of farm size on adoption of SCM among farmers

Table 8 shows how the farm size was related to adoption of the SCM. There was variation in adoption of SCM across respondents with different farm sizes in the study area. Adoption of SCM increased as farm size increased from less than an acre to more than 4 acres by 47%, 54%, 100% and 100% respectively. Increasing trend of adoption with increasing farm sizes showed that, a large farm size gives the farmer more flexibility in using various technologies than it is for farmers having small land size. Though weak, the relationship between farm size and adoption of SCM was positive and statistically significant ($p < 0.05$).

Table 8: Influence of farm size on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	(%)	Count	(%)
Farm size of the farmer (ha)				
Less than 1 (n=17)	8	47.0	9	53.0
1-2 (n=39)	9	23.0	30	77.0
2-3 (n=24)	13	54.0	11	46.0
3-4 (n=14)	14	100	0	0.0
More than 4 (n=6)	6	100	0	0.0
Chi square	Value Assymp.sig.	Value Assymp.Sig.	31.533 0.012	
Symmetric measures	Value Approx.sig.	Value Approx.sig.	0.442 0.000	

These results showed that, land size an individual farmer owns, is more likely to influence adoption of soil conservation measures, as the larger the farms owned, the more likely to adopt SCM, because of flexibilities in diversification of farm enterprises to be undertaken. These findings support what was reported by Amsalu and Graaf (2007) that, farmers who have large farms are more likely to invest in soil conservation measures.

(c) Fertilizer use and its influence on adoption of SCM

Results in this study showed that, 82% of the farmers not using fertilizers adopted SCM while 18% did not adopt. However, among respondents farmers using fertilizers 25% of the respondents adopted SCM while 75% did not adopt (Table 9). The use of fertilizer by farmers showed a strong and negative, but highly significant relationship with the adoption of SCM at ($p < 0.05$). The significant relationship between fertilizer use and adoption of SCM observed implies that, a large percent of farmers who used fertilizers were those who did not use SCM such as “fanya chini” contours, probaly due to the fact that fertilizers were washed away by erosion. Thus, they needed frequent application of fertilizer for optimum growth of their crops.

Table 9: Influence of fertilizer use on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	(%)	Count	(%)
Fertilizer use by farmers				
Use the fertilizer (n=56)	42	25.0	14	75.0
Not use fertilizer (n=44)	8	82.0	36	18.0
Chi square	Value	31.818		
	Assymp.Sig.	0.000		
Symmetric measures	Value	-0.564		
	Approx.sig	0.000		

Despite the fact that, during the interview conducted to key informants, farmers had the belief that, their soils were fertile because of frequent application of fertilizers, and therefore claimed that, there was no need of using *fanya chini* contours. This observation is in agreement to those reported by Shiferaw and Holders (2000) that, increment on fertilizers use by farmers made farmers to believe that, fertilizer application saves as a replacement for soil conservation measures which discourages farmers continually using soil consevation measures.

4.1.3.3 Institutional

(a) Technical support

Results of this study have shown significant relationships between the SCM and most of the variables considered that were identified as institutional factors except the land tenure. Results presented in Table 10, show that the level of technical support provided to farmers in terms of the number of visits by extension staff, was significantly related to the adoption of SCM by farmers, ($p < 0.05$). However, the relationship was weak and negative as shown by symmetric measures Pearson's correlation coefficient. This implies that, increase in number of visits was accompanied by decrease in the adoption of the SCM. Data indicates that, among the respondents farmers who were not visited by extension staff for extension support, 68% adopted SCM, while, 32% did not adopt. However, among the farmers who were visited once per year 33% adopted the SCM while 67% did not adopt. Moreover, those who were visited twice per year 6% adopted the SCM, whereas 94% did not adopt.

These results showed that an inverse relationship existed between the extension services and adoption of SCM in the study area, as it is shown that, as the number of visits increased, the percentage of farmers who adopted the SCM decreased. This probably was due to the fact that, most of the extension services provided were targeting at solving farmer problems on short term basis, which was done in order to make sure that farmers realize crop yield results within a short period (or within particular season) of time.

Table 10: Influence of number of visits made by extension officer on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	%	Count	%
Number of visits made by extension officer				
Not visited (n=62)	42	68	20	32
Visited once (n=21)	7	33	14	67
Visited twice (n=17)	1	6	16	94
Chi square	Value	23.38		
	Assymp.sig.	0.000		
Symmetric measures	Value	-0.453		
	Approx.sig.	0.000		

This study is in line with what was reported by Chomba (2004), in his study conducted in Zambia which reported that, a large proportion of farmers who had contacts with agricultural support programs did not continue with using the improved SCM practices. This shows that, it is not enough to have extension support but the aim or purpose of extension services should also relate to the continuation of conservation work.

(b) Distance to markets

Results presented in Table 11, show that, the distance from the farmers house to the market was significantly and positively correlated to adoption of the SCM among farmers ($p < 0.05$). A positive relationship implies that, the nearer the farmer is to the market, the less likely it becomes for the farmer to adopt the SCM. This may be due to the fact that, farmers who are closer to the market are very active in conducting nonfarm activities which are related to the market activities and which might be more paying in comparison to farm activities. For example 100% of those who stayed at a distance between 0.5-5 km did not adopt the SCM. On the other hand 100% of those who stayed far from markets adopted SCM.

Table 11: Influence of distance to market on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	%	Count	%
Distance from the farmer house to the market place(km)				
0.5-5 (n=50)	0	0.0	50	100
5-10 (n=13)	13	100	0	0.0
10-20 (n=37)	37	100	0	0.0
Chi square	Value	100		
	Assymp.sig.	0.000		
Symmetric measures	Value	0.942		
	Approx.sig.	0.000		

Farmers who lived far away from the market were more involved in the SCM probably because their main source of income depended much on farming activities while those who lived close to the market might have other source of income than agriculture which reduced their dependence on farming. This study is in agreement with what was reported by Aberha (2008) that, farmers who live far away from the market are more involved in the work of soil conservation, because, proximity to markets creates disincentive for participation in soil conservation measures, since living close to the market provides other livelihood options especially business related instead of working on the farm. It can be easily observed that it is very customary for farmers near the towns to leave for the market even when they do not have anything to do there (Aberha, 2008).

(c) Training on SCM

Training was among the institutional factors which have shown strong, positive and significant relationship with adoption of SCM ($p < 0.05$) (Table 12). This implies that, attendance to SCM training was associated with increase in the adoption of SCM. The results show that, among farmers who attended training on SCM provided by project facilitators, 90% adopted the SCM, while only 10% did not adopt. For example, among the farmers who didn’t attend SCM training 88% did not adopt the SCM, though few 12% adopted the SCM. This shows that, training is very important for any intervention to succeed, because it make farmers become aware of the importance of controlling soil erosion by using soil conservation technologies and easily adopt them.

Table 12: Influence of training on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	%	Count	%
Training on SCM by project facilitators				
Attended training (n=49)	44	90.0	5	10.0
Not Attended training (n=51)	6	12.0	45	88.0
Chi square	Value	60.86		
	Assymp.Sig.	0.000		
Symmetric measures	Value	0.78		
	Approx.sig	0.000		

4.1.3.4 Biophysical factors influencing adoption of SCM

(a) Topography

Results showed that topography of the farmland has significant but weak and positive relationship with adoption of the SCM $p < 0.05$ (Table 13). The steeper the slope, the more, the need to adopt SCM among farmers. For example it is shown that, none of the farmers whose farmlands were located on flat landscape practiced SCM technologies. However, those with farmlands located on gentle, moderate, steep and very steep slopes had higher adoption percentages. Thus adoption increased with increasing slope. The reverse was true in none adopting the SCM.

Table 13: Influence of topography on SCM adoption in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
Topography of farmland	Count	%	Count	%
Flat (n=1)	0	0.0	1	100
Gentle (n=2)	1	50.0	1	50.0
Moderate (n=18)	3	17.0	5	83.0
Steep (n=76)	44	58.0	32	42.0
Very steep (n=3)	2	66.0	1	33.0
Chi square	Value	11.23		
	Assymp.sig.	0.024		
Symmetric measures	Value	0.28		
	Approx.sig.	0.005		

(b) Type of soil erosion

Table 14 presents the different types of soil erosion in the study area. There are three types of soil erosion in the study area; sheet, rill and gully erosion. Among the farmers affected by gullies (Plate 2) 59% adopted “fanya chini” contours while 41% did not adopt “fanya chini” contours. Of the farmers affected by rill erosion 7% adopted the technology while 93% did not and those affected by sheet erosion 55% adopted the technology while 45% did not adopt. This mean that a large percent of farmers who are affected by gullies were forced to implement SCM. These results are in line to findings reported by Aberha

(2008) which indicated farmers who suffer from severe gully erosion are more involved in conservation work because they had to conserve their soil from erosion and to prevent the total loss of the land.

Plate 2: Gully due to soil erosion which may lead into severe land degradation in Shibolya village Mbeya Rural District

Table 14: Influence of types of soil erosion on SCM adoption in Mbeya Rural District

Variable		Adoption Category of SCM			
		Adopters		Non adopters	
		Count	%	Count	%
Types of soil erosion					
Rill	(n=15)	1	7	14	93
Sheet	(n=11)	6	55	5	45
Gullies	(n=73)	43	59	30	41
Chi square		Value	13.66		
		Assymp.sig.	0.001		
Symmetric measures		Value	0.35		
		Approx.sig.	0.000		

(c) Fertility of farmlands

Soil fertility status among the farmlands with respect to adopting SCM, was another biophysical factor that influenced adoption of SCM. According to results presented in Table 15, the relationship between statuses of farmers' farmlands that had been practicing SCM was significantly different from those who had not been practicing SCM. For example, all farmers indicated that the fertility of the soil in their farms improved significantly due to use of SCM while, 94% had high soil fertility improvement, 91% had medium soil fertility improvement and none observed low soil improvement among adopters of SCM. Non adopters few had fertile soils at all levels of soil erosion. This implies that failure to adopt SCM resulted into 100% low soil fertility. Statistically the relationship between adoption of SCM and improvement in soil fertility was positive and strongly significant ($p < 0.05$) (Table 15). In attempt to improve soil fertility, farmers in the study area had been practicing SCM like construction of fanya chini contours (Plate 3) as observed in Usoha Muungano village.

Table 15: Influence of adoption of SCM on perceived soil fertility in Mbeya Rural District

Variable	Adoption Category of SCM			
	Adopters		Non adopters	
	Count	%	Count	%
Status of soil fertility				
Medium (n=34)	31	91.0	3	9.0
High (n=50)	47	94.0	3	6.0
Very high (n=9)	9	100	0	0.0
Chi square	Value	77.78		
	Assymp.sig.	0.000		
Symmetric measures	Value	0.52		
	Approx.sig.	0.000		

Plate 3: Existing " fanya chini" contours in Usoha Muungano village Mbeya Rural Dsitrict

4.1.4 Farmers' opinion on improving sustainability of SCM

Factors which were considered as essential in improving sustainability of SCM are as shown in Fig. 2. About 58% of the farmers had the opinion that regular soil management would improve the sustainability of the SCM. On the other hand 23% thought that more education on SCM would make a difference in sustainability. Furthermore, 10%, 4%, and 3% thought access to financial capital, bylaws on livestock invasion into farms, regular visits by extension staff, were also among aspects for sustainability of SCM respectively.

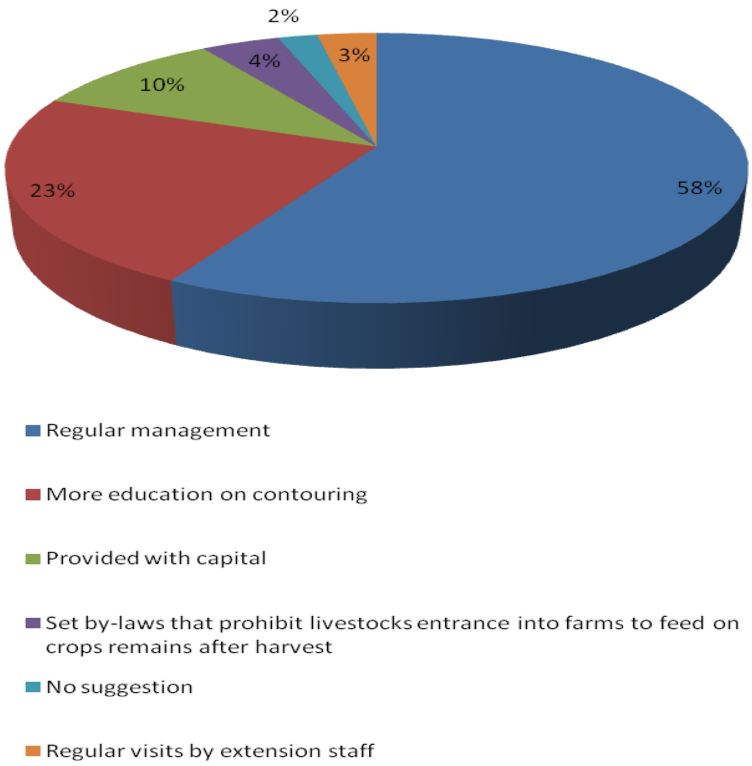

Figure 2: Farmers opinion on improving sustainability of SCM in Mbeya Rural District

4.1.5 Socio-economic impacts on soil conservation measures basing on crop yields

Comparison was made by use of an independent sample t-test on the yields of maize and pyrethrum as major crops grown by adopters of the SCM and non adopters. It was observed that, maize mean yield obtained by farmers who adopted the SCM was 2960 kg/ha whiles the mean yield of maize for farmers who did not adopt the SCM was 1455 kg/ha (Table 16). From the t-test results, it is observed that maize mean yield difference between adopters and non adopters of SCM was statistically significant (t=9.951, p=0.000) and that the magnitude of the difference was large as indicated by Eta squared (effect size) of about 0.503 calculated using the formula presented by equation 5 in the methodology and t-values obtained in Table 16 of the results section that is, Eta squared= $9.95^2/((9.95^2+(50+50-2))= 0.503$.

Table 16: T- Test showing mean yield of maize among adopters and non adopters of SCM in Mbeya Rural District

Maize yield (kg/ha) 2012 season				T-Test for equality of means	Group statistics		
					Maize yield (kg/ha) 2012		
	t-value	Df	Sig.(2-tailed)	Mean (kg/ha)	Adoption status	Mean (kg/ha)	Std. Deviation
Equal variance assumed	9.951	97	0.000	602	Adopters (Yes)	2 960	827.72
Equal variance not assumed	9.930	92.321	0.000	602	Non adopters (No)	1 455	671.40

On the other hand, pyrethrum mean yield for farmers who have adopted the technologies was 832 kg/ha (Table 17) while that of farmers who did not adopt was 487 kg/ha. This difference in the mean yields by the two categories of farmers was statistically significant (t=10.24, p=0.000). The higher mean yields of pyrethrum for the adopters than it was for non adopters indicated that, soil erosion was controlled and therefore soil fertility improved to give adopters more yield from the crops than their counterparts.

Table 17: T- Test showing mean yield of pyrethrum among adopters and non adopters of SCM in Mbeya Rural District

Pyrethrum yield (kg/ha) 2012				T-test for equality of means	Group statistics		
					Pyreth. yield (kg/ha) 2012		
	t-value	Df	Sig.(2-tailed)	Mean (kg/ha)	Adoption status	Mean (kg/ha)	Std. Deviation
Equal variance assumed	10.209	97	0.000	138.199	Adopters (Yes)	832	138.115
Equal variance not assumed	10.243	88.725	0.000	138.199	Non Adopters (No)	487	194.452

However, the calculated effect size (as in section 4.1.5 above) to test magnitude of difference in crop yield mean between adopters and non adopters was 0.51 indicating that the mean yield difference was also large for pyrethrum growers between adopters and non adopters. This implies that farmers who adopt adaptive technologies are more likely to be better-off when compared to non adopters.

The T-test was used only to know whether there were significant differences in mean yields between farmers who practiced SCM and those who did not. However, we lacked information on the factors that contributed to the differences in yield. Thus, in order to understand these factors, an Ordinary Least Square Estimation was performed, using models described in the methodology whose results are as presented in Table 18 and 19.

4.1.5.1 Factors contributing to differential mean yields for maize among farmers

Table 18 presents, estimates of the specified factors that influence maize yield such as education level, household head gender, household size, distance from the house of the farmer to market, involvement in nonfarm activities, respondent's age and farmer's maize land size as presented by equation 1 in section 3.2.4. According to the results (Table 18), the R-square value was 0.523 showing that, 52.3% of the variations in maize yield were accounted for by the specified independent variables in the model, while the remaining 47.7% of the variations in maize yield were due to other unexplained factors in the model. The significance of the F value shows that, there were model fit between the dependent and independent variable.

Table 18: Factors contributing to differences in yields for maize among farmers in Mbeya Rural District

Model variables	Unstandardized B	Coefficients Standard Error	t-value	Significance
(Constant)	2.142	0.354	6.048	0.000***
1. Education level	-24.315	40.070	-0.607	0.545 ns
2. Gender (1=Female, 0 = Otherwise)	-0.307	0.127	-2.414	0.023*
3. Household size	0.30	0.151	1.969	0.012*
4. Distance to market place(km)	293.374	41.871	7.007	0.000***
5. Involvement in non-farm activities	-62.510	75.170	-0.832	0.408 ns
6. Respondent age	-0.785	41.755	-0.019	0.985 ns
7. Farmer's land size for Maize production	14.941	34.092	0.438	0.662 ns
R= 0.723; R-square =0.523; F= 8.873; Sig.=0.000				

Dependent Variable: Maize yield (kg/ha) 2012; *significant at $p < 0.05$; *** significant at $p < 0.001$; ns= no significant difference

All other factors specified in the model, were not significant at 5%, 1% and 0.1% significant levels, except gender, household size and the distance to the market place. From model results, it is shown that, if all the factors specified in the model were to be equal to zero, maize yield would significantly increase by 5.40 kg/ha, this is because of the fact that, maize yield does not absolutely depend on the specified factors but also on unexplained factors. From Table 7, it is shown that, maize yield and distance from farmer house to market place were significantly related ($p < 0.01$).

Thus, for every increase of one unit km, results in increased maize yield by 733.40 kg/ ha. This implies that, being far from the market increases farm yield. This could be due to the fact that, being close to the market an individual has more opportunity to engage in nonfarm activities than the one who is far from the market, which make the latter to produce more of the farm products in order to compensate on what would be obtained from off farm undertakings. The study also has shown that, being female farmer significantly reduced yield by 0.77 kg/ha (approximately equal to 31%) above that of being male farmer. This could be due to the fact that, female farmers might have not been in position to access agricultural extension services, which resulted into lowering their maize farm yields. Moreover, results show that, there were significant relationships between maize yield and household size at $p < 0.01$. Every one unit increase in household members increased maize yield by 0.3 kg/ha. This is because, of the importance of household labor for implementation of the SCM.

4.1.5.2 Estimation of factors contributing to yield differences for pyrethrum among adopters and non adopters in 2012 season

Results presented in Table 19 show that, all the factors specified in the model had contributed to the significant differences in yields of pyrethrum among farmers, except the household size and respondent farmer's age. The R-Square and F-statistic significance showed that, model fitted the variables. The R- square 0.482 shows that, 48.2% of the variations in pyrethrum yield were accounted for by the specified independent variables, while the remaining 51.8% of the variations in yield were accounted for by unknown factors to the researcher, but which were known to the farmer (Table 19).

The values of the parameters coefficients showed that, if there would be no consideration of all the specified independent variable in the model, the amount of pyrethrum yield would still increase by 4.586 kg/ha while, the increase in a year of schooling by the farmer would significantly reduce pyrethrum yield by 21.4% (0.214 kg/ha) within the production season. This implies that, more educated people do not depend on crop production and the more educated the farmer becomes the more it is for the farmer to engage in other business undertaking because of other opportunities which are more paying than pyrethrum production. Results also showed that, being a male, significantly reduced yield by 23% below that of being female. This implies that, the crop was not so much paying to make more men fully engage and invest more in producing the crop, which then was the opportunity for the other sex to produce more of it due to lack of competition between people of different sex. On the other hand, one increase in unit distance from the farmer's household to the market place significantly increased pyrethrum yield by 0.37 kg/ ha.

These results implied that, farmers located far away from the market had crop production as the only option for income generation and thus had to invest much in producing this crop. The unit increase in the average duration of involvement in nonfarm activities significantly reduced pyrethrum yield by 1.50 kg/ ha (which is 59.9%), however, increase in one unit acreage under pyrethrum significantly increased crop yield by 0.55 kg /ha which about 21.8%. This implies that, in order for a farmer to increase production of pyrethrum the best option would be to increase the area under cultivation.

Table 19: Regression results from model estimation on factors influencing pyrethrum yield differences among farmers in Mbeya Rural District

Model Variables	Unstandardized Coefficients		t-value	Sig.	R-square	ANOVA 'F' statistic	
	B	Std. Error				Value	Sig.
(Constant)	4.586	1.130	4.057	0.000***	0.482	16.096	0.000 ***
Household size	-0.205	0.133	-1.547	0.125ns			
Education level	-0.214	0.098	-2.172	0.032*			
Gender (1=Male, 0= otherwise)	-0.230	0.102	-2.264	0.026*			
Distance to market place (km)	0.481	0.080	6.041	0.000***			
Average duration of involvement in non-farm activities	-0.599	0.280	-2.138	0.035*			
Respondent's Age	-0.148	0.144	-1.028	0.307ns			
Farm Size	0.218	0.078	2.809	0.006**			

Dependent Variable: Pyrethrum yield kg/ha for 2012 season; * significant at p < 0.05, ** significant at p < 0.01;*** significant at p < 0.001; ns= no significant difference

4.1.5.3 Yield of maize across adoption of SCM

Figure 3 shows that overall there were differences in the yields for maize between adopters and non adopters of the SCM and yields of adopters increased at a higher rate compared to non adopters over time. The results showed that, yield trend for both categories (adopters and non adopters) increased. However, the mean annual maize yield trend for adopters was higher than that for non adopters (Fig. 3). For example, in the first year 2010 the maize yield was 1531 kg/ha and 1021 kg/ha for SCM adopters and non adopters respectively. Year 2010 the yield difference was 510 kg/ ha which was equal to 20% yield difference.

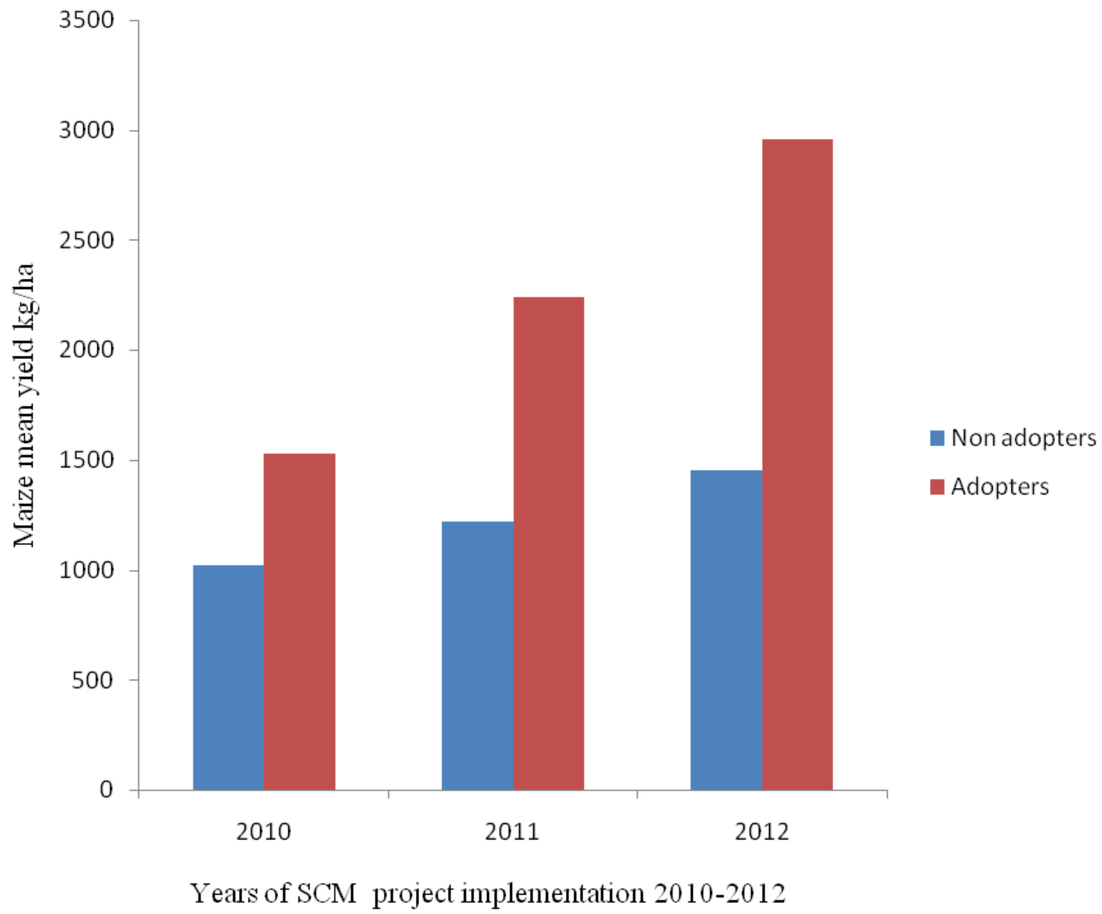

Figure 3: Maize mean yields trends for adopters and non adopters of SCM in Mbeya Rural District (2010-2012)

The second year 2011, yield mean for maize between adopters and non adopters was 2239 and 1222 kg/ha respectively. The mean difference between the two groups was 1017 kg/ha, this was equal to 29.4% of the mean annual maize yield difference between adopters and non adopters. The third year (2012), mean yield difference was 1505 kg/ha which was equal to 34% of the mean difference among adopters and non adopters of the SCM. These results therefore implied that, adoption of SCM increased farmers' maize yield by an average of 27.8% above those who did not use SCM in the study area. However, the increasing trend in the yields for SCM non adopters was probably, due to high use of fertilizers.

4.1.5.4 Yield for pyrethrum across adoption of SCM

Figure 4 presents the annual mean yield trend differences between pyrethrum producers across SCM adoption. Results show that, there were increasing trends of the annual mean yields of pyrethrum for both adopters of the SCM and non adopters. However, the trend line for non adopters remained below that of adopters. For example, in the year 2010 the mean yields were 594 and 341 kg/ha for adopters and non adopters respectively. Their mean yield difference was 253 kg/ha which was equal to 27% yield mean difference.

In the year 2011 pyrethrum annual mean yield was 716 and 410 kg/ha for adopters and non adopters respectively. Their mean annual yield difference for pyrethrum was 306 kg/ha which was equal to 27.2% mean annual yields. On the other hand, in 2012, mean annual yields for pyrethrum was 834 and 487 kg/ha for adopters and non adopters respectively. The difference in this year between the two groups was about 347 kg/ha, this equals to 26.3% mean difference. These results therefore implied that, adoption of SCM increased farmers' pyrethrum yield by an average of 26.8% above those who did not use SCM in the study area.

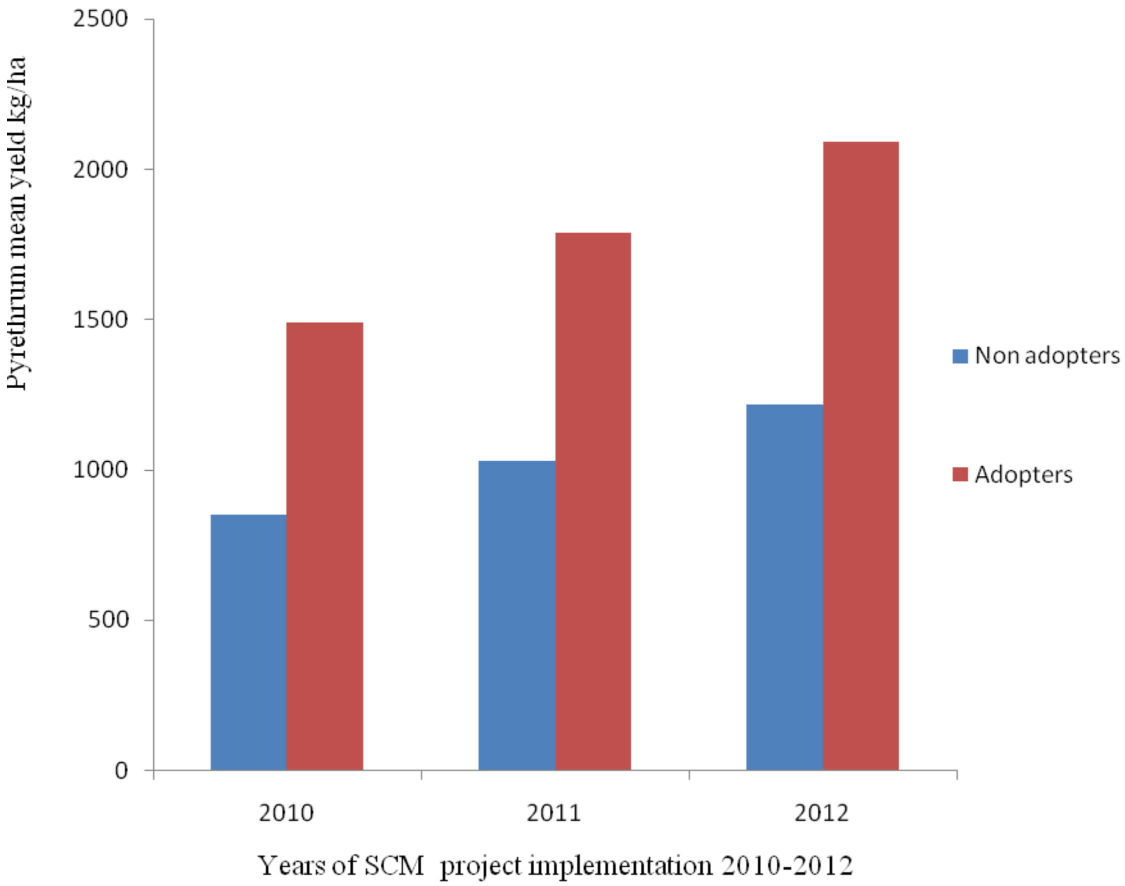

Figure 4: Pyrethrum mean yields trends for adopters and non adopters in Mbeya Rural District (2010-2012)

Higher yields observed among adopters of SCM implied that, soil erosion was well controlled and therefore, there was soil fertility improvement, while low yields in non adopters of SCM was an indication that there was soil erosion problem in the farmlands and soil fertility was low. Hence, adoption of SCM had more positive impact on farmers' yield for SCM adopters than it was for non adopters.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Adoption of soil conservation measures is significantly influenced by both personal socio-economic, institutional and biophysical factors. However, some of the socio economic (marital status) and institutional factors (access to credit facilities and land tenure) did not have significant influence on adoption of SCM.

According to the farmers opinions, regular soil management, education and acess to financial capital would improve the sustainability of SCM. From the findings, it was evident that soil conservation measure adoption resulted into substantial increase in crop yields of maize and pyrethrum whereby the average yield difference between adopters and non adopters was 27.8% and 26.8% for maize and pyrethrum respectively.

5.2 Recommendations

With reference to the above conclusions, the following recommendations are made.

(ii) Educating farmers on soil conservation measures and proper soil management techniques is a prerequisite for adoption of SCM and improvement in crop yields.

(iii) Identified factors that influence adoption of SCM should be considered during introduction of SCM interventions/projects for adoption and implementation.

(iv) Farmers' opinions should be well thought-out for sustaining and scaling up of SCM/ practices. This should be the duty of all stakeholders whose concerted efforts would build farmers' capacities to adopt various technologies which are targeted at sustainable increase in crop production, productivity, household income and food security.

REFERENCES

Aberha, E. T. (2008). Erosion and soil and water conservation group and environmental Policy group. Continue use of soil and water conservation practices. A Case Study in Tulla District, Ethiopia. Dissertaion for Award of MSc Degree at Wagenigen University, The Nertherlands, 57pp.

Ajala, B. A. (2001). Adoption of soil conservation practices in Oyo State. Dissertation for Award of MSc Degree at University of Ibadan, Nigeria,145pp.

Amsalu, A. and De Graaf, J. (2007). Determinants of adoption and Continue Use of Stone terraces for soil and water Conservation in an Ethiopian Highland watershade. *Journal of Ecological Economics* 61: 294 – 302.

Amsalu, A. (2006). Best practices in soil and water conservation in Beressa watershed, highlands of Ethiopia. Thesis for Award of PhD Degree at Wageningen University, Netherlands, 157pp.

ASDS (2001). *Country Environment Profile: Environmental and Social Policy*. Ministry of Agriculture Food Security and Co-oprative, Dar es Salaam, Tanzania. 73pp.

Asfaw, S. (2010). Estimating welfare effect of modern agricultural technologies: A micro-perspective from Tanzania and Ethiopia. *International Crops Research Institute for the Semi-Arid Tropics , Paper Presented at the Meeting*, 27 May 2010 in Nairobi, Kenya. pp. 16 – 18.

Bailey, K. D. (1998). *Methods of Social Research.* Free Press Collier Macmillan Publisher, New York. 589pp.

Bayard, B., Jolly, C. M. and Dennis, A. S. (2006). The adoption and management of soil conservation practices in Haiti: The Case of Rock Walls. *Agricultural Economics and Rural Sociology* 7(2): 35 – 36.

Becker, S., Black, R. E., Brown, K. H. and Nahar, S. (1986). Relation between socio-economic status and morbidity, food intake and growth in young children in two villages in Bangladesh. *Journal of Ecology of Food and Nutrition* 18(5): 215 – 264.

Bekele, W. (2005). Stochastic dominance analysis of soil and water conservation in subsistence crop production in the Eastern Ethiopian highlands: The case of Hunde-Lafto area. *Journal of Environmental Resource Economics* 32(4): 533 – 550.

Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: A case study of the Hunde-Lafto area. *Journal of Ecological Economics* 46: 437 – 451.

Benin, S. (2006). *Policies and Programs Affecting Land Management Practices, Input Use and Productivity in the Highlands of Amhara Region, Ethiopia. In: Strategies for Sustainable Land Management In The East African Highlands*. (Edited by. Pender, J. F. and Place, S. E.), International Food Policy Research Institute, Washington DC. pp. 340 – 377.

Bisanda, S., Mwangi, W., Verkuijl, H., Moshi, J. A. and Anandajayasekeram, P. (1998). *Adoption of Maize Production Technologies in the Southern Highlands of Tanzania. Sustainable Agriculture*. International Maize and Wheat Improvement Center, Mexico, USA. 49pp.

Blanco, H. C. and Lal, R. (2010). Principles of soil conservation and management. [Htt://www.bokus.com/bok/9789048179626/principles-of-soilconservation-and-manag ement/] site visited on 10/09/2012.

Borlaug, N. (2007). *Agricultural Development Initiative II: Increasing Small Scale Farmer Productivity through Improved Inputs and Management Systems.* Muscle Shoals, Alabama, USA. 60pp.

Boyd, H. K., Westfall, P. and Stasch S. F. (1981). *Marketing Research. Text and Causes*. Richard, D. Irwin Incorporation, Illinois. 80pp.

Brown, L. R., Feldstein, H. S., Haddad, L.Pena, C. and Quinsumbing, A. (1995). *Women The Key To Food Security. Food Policy Report.* The International Food Policy Research Institute, Washington DC. 22pp.

Byiringiro, F. and Reardon, T. (1996). Farm productivity in Rwanda: Effects of farm size erosion and soil conservation investments. *Jounal of Agricultural Economics* 15(2): 127 – 136.

Chomba, G. N. (2004). Factors affecting smallholder farmers adoption of soil and water conservation practices in Zambia. Dissertation for Award of MSc Degree at Michigan State University, 118pp.

CIMMYT Economic Programme (1993). *The adoption of Agricultural Technology: A Guide for Survey Design*. International Maize and Wheat Improvement Center, Mexico. 98pp.

Clay, D. R. and Kangasniemi, J. (1998). Sustainable intesification in the higland tropics: Rwanda farmers investments in land conservation and soil fertility. *Journal of Economic Development and Cultural Change* 45(2): 351 – 378.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Science*. Hillsdale NJ Publisher, Erlbaum. 210pp.

Ervin, C. A. and Ervin, D. E. (1982). Factors affecting the use of soil conservation practices: Hypothesis, evidence and policy implications. *Journal of Land Economics* 58(3): 277 – 292.

FAO (1980). *The State of Food And Agriculture*. Food and Agriculture Organization, Rome, Italy. 45pp.

FAO (1999). Biodiversity and land degradation. *Environment Statistics Course Farming, a Vision for Organic Farming in the 21st Century*, Royal Agricultural College, Cirencester. 122pp.

Fedder, G., Just, E. R. and Zilberman, D. (1985). Adoption of agricultural innovation in developing countries: *Economic Development and Cultural Change* 33(2) : 255 – 298.

Freie Universitat (2007). Berlin 3 types of soil conservation measures. [http/w.w.w.cms.fu-berlin-de/geo/fb/e-learning/geolerning/en/soil-erosion/types/] site visited on 06/10/2012.

Gebremedhin, B. and Swinton, S. M. (2006). Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. *Journal of Agricultural Economics* 29(1749): 69 – 84.

Gould, B. W., William, E. S. and Klemme, R. M. (1989). Conservation tillage: The role of farm and operator characteristics and the perception of soil erosion. *Journal of Land Economics* 65(2): 167 – 182.

Henao, J. and Baanante, C. A. (2006). *Agricultural Production and Soil Nutrient Mining in Africa: Implications for Resource Conservation and Policy Development.* International Center for Soil Fertility and Agricultural Development, Muscle Shoals, Alabama. USA. 35pp.

Holden, S. T., Shiferaw, B. and Pender, J. (2001). Market imperfections and profitability of land use in the Ethiopian Highlands: A comparison of selection models with heteroskedasticity. *Journal of Agriultural Economic* 52(2): 53 – 70.

IFDC (2007*). A Six-Country Survey of Fertilizer Supply and Costs in Africa.* Fertilizer supply and costs in Africa, the bill and Melinda gates foundation, Chemonics International Inc., Muscle Shoals, Albama. 133pp.

Kajembe, G. C. (1994). Indiginous management system as a basic for community forest in Tanzania. A case study of Dodoma urban and Lushoto districts. Dissertation for Award of PhD at Wagenigen University of Agriculture, The Nertherlands. 194pp.

Kaliba, A. R. and Rabele, T. (2004). Impact of adopting soil conservation practices on wheat yield in Lesotho. Department of economics, National University of Lesotho. *Journal of Agricultural and Applied Economics* 42(2): 595 – 608.

Kalineza, H. M. M., Mdoe, N. S. Y. and Mlozi, M. R. S.(1999). *Factors inluencing Adoption of Soil Conservation Technologies in Tanzania:* A case study in Gairo. Sokoine University of Agricultural, Morogoro,Tanzania. 8pp.

Kassie, M. and Holden, T. S. (2006). Parametric and non-parametric estimation of soil conservation adoption impact on yield. *Paper Presented At The International Association of Agricultural Economists Conference, Gold Coast*, Australia, 12 – 18 August 2006. pp. 1 – 16.

Katani, J Z. (1999). Coping strategies against deforestation: Impact of socio-economic factors with special attention to gender-based indiginous knowledge: A case study of Mwanza District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 110pp.

Kessler, A. (2006). Decisive key factors influencing farm household soil and water conservation investments. *Applied Geography* 26(3): 540 – 660.

King, E. M. and Alderman, H. (2001). Empowering women to achieve food security and education. [http.//www.ifpri.org.focus/focus06/focus06.pdf] site visited on 25/09/2012.

Kothari, C. R. (2004). *Research Methodology Methods and Techniques*. Second Edition. New Age International Limited Publishers, New Delhi. 401pp.

Krishana, R., Bishal, K., Ingrid, L. P. N. and Giridhari, S. P. (2008). Determinants of farmers adoption of improved soil conservation technology in a middle mountain watershed of Central Nepal. *Journal of Environmental Management* 42: 210 – 222.

Kruger, H. J. (1997). The development of farmer friendly conservation measures. *Ethiopian Soil Conservation News* 15: 14 – 18.

Lapar, M. L. A. and Pandey, S. (1999)**.** Adoption of soil conservation: The Case of the Philippine. *Journal of Agricultural Economics* 21(3): 241 – 256.

LEAT (2012). Environmental law alliance worldwide. [http://www.leat/or.tz] site visited on 07/10/2012.

Lyimo-Macha, J. G. (2000). Gender roles in management of natural Resources and sustainable agriculture. *Paper Presented at the 9th Management of Natural Resources Short Course Institute of Continuing Education,* Sokoine university of Agriculture, Morogoro, Tanzania. pp. 1 – 17.

Magayane, F. T. (1995). Farmers'adaptive effort to soil erosion and land productivity decline: The case of Uluguru Mountains, Tanzania. Thesis for Award of PhD at the Graduate College of the University of Illnois, Urban-Champaign, 139pp.

Mahmoud, M. A. A. (1983). *A study Survey on Pattern Energy Protein Malnutrition and Possible Contributing Factors amongs Under Five Years Children of Peri Urban* Areas. Report No. 806. Tanzania Food and Nutrition Centre, Zanzibar, Tanzania. 100pp.

Mandara, E. G. (1998). Assessment of factors influencing womens' participation in off-farm income generating activities. Disertation for Award of MSc Degree at Sokoine Unversity of Agriculture, Morogoro, Tanzania, 101pp.

Mhinte, A. R. (2000). Analysis of rural households coping strategies against seasonal food insecurity in Kilosa District. Dissertation for Award of MSc Degree at Sokoine University of agriculture, Morogoro, Tanzania, 121pp.

Natai, M. M. (2004). Assessment of socio-economic Factors influencing women participating in environment management in Dar es Salaam City,Tanzania. Dissertation for Award of MSc Degree at Sokoine university of Agriculture, Morogoro, Tanzania, 84pp.

Okoye, C. (1998). Comparative analysis of factors in the adoption of traditional and recommended soil erosion control practices in Nigeria. Department of Natural Resources Mangement and Environment. *Journal of Soil and Tillage Research* 45: 251 – 263.

Pender, J. and Gebremedhin, B. (2006). Strategies to improve and management, crop production and household income in the highlands of tigray, Northern Ethiopia. *Paper Presented at the American Agricultural Economics Association Annual Meeting International Food Policy Research Institute*, Denver, Colorado, 1 – 4 July 2004. Washington DC. pp. 107 – 139.

Pimentel, D. (2001). Soil erosion: A food security and the environment threat. *Collage of Agriculture and Life Sciences* 8: 119 – 137.

Rogers, E. M. (1995). *Diffusion of Innovations.* Free Press, New York. (4th Edition). 75pp.

Shiferaw, B. and Holden, S. T. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian highlands: A case study in Andit Tid, North Shewa. *Journal of Aqricultural Economics* 18: 233 – 247.

Shively, G. E. (1998a). Modelling impacts of soil conservation on productivity and yield variability: Evidence from a heteroskedastic switching regression. *Paper Presented At Annual Meeting of The American Agricultural Economics Association*, 2 – 5 August 1998, Salt Lake City, Utah. 1 – 12pp.

Shively, G. E. (1999). Risks and returns from soil conservation: Evidence from low-income farms in the Philippines. *Journal of Agricultural Economics* 21(1): 53 – 67.

Stattrek (2013). Random number generator. [http//www.stattrek.com/statistics/ random - numbergenerator.aspx] site visitedon 30/10/2012.

Sutcliffe J. P. (1995). Soil conservation and land tenure in highland Ethiopia. Agriculture, natural resources and environmental development technology. *Ethiopian Journal of Development Research* 17(1): 63 – 88.

Swinton, S. M. and Quiroz, R. (2003). Poverty and deterioration of natural soils in the peruvian Altiplano. *Environment Development and Sustainability* 5(11): 477 – 490.

Tenge, A., de Graaff, J. and Hella, J. P. (2004). Social and economic factors affecting the adoption of soil and water conservation in West Usambara Highlands. Tanzania. . *Journal of Land Degradation and Development* 15(2): 99 – 114.

TEP (2012). CIA World Fact Book. Economy overview. [http://w.w.w.t heodora.com/ wibcur rent/tanzania/tanzania_economy html] site visited on 18/4/2012.

TNADA (2012). Population and housing census 2012 data base. National Bureau of Statistics. Dar es Salaam, Tanzania. [http://www.nbs.go.tz/] site visited on 17/8/2013.

Traore, N., Landry, R. and Amara, N. (1998). On-farm adoption of conservation practices: The role of farm and farmer characteristics,perceptions and health hazads. *Journal of land Economics*, 74(1) : 114 – 127.

Turyahabwe, N., Kakuru, W., Tweheyo, M. and Tumusiime, D. M. (2013). *Contribution of Wetlands Resource to Household Food security in Uganda* 2(5): 2048 – 7010.

UN (2010). Statement by secretary general we can end poverty by 2015. *Report Presenting the Yearly Assessment of Global Progress towards the Millennium Development Goals*, 23 June 2010, New York. 6pp.

URT (1991). *National Sample Census of Agriculture 1994/1995 Tanzania Mainland*. Ministry of Agriculture and Planning Commission, Dar es Salaam, Tanzania. 48pp.

URT (2002). *Mbeya Region Socio-Economic Profile.* Government Printer, Dar es Salaam, Tanzania. 206pp.

URT (2002). *Population and Housing Sensus General Report Central Census Office*. National Bureau of Statistics, President's office, Planning and Privitization. Dar es Salaam,Tanzania. 77pp.

URT (2010). *Investment District Profile*. Mbeya District Council, Mbeya, Tanzania. 31pp.

Wall, G., Baldwin, C. S. and Shelton, I. J. (2003). *Soil Erosion Causes and Effects.* Ontario Institute of Pedology, Ontario. 6pp.

Warriner, G. K. and Mould,T. M. (1992). Communication network influences on the adoption of agriculture conservation technology. *Jounal of Rural Studies* 8(3): 279 – 291.

World Bank (2001). *Tanzania at the Turn of the Country:* From Reforms to Sustained Growth and Poverty Reduction, Washington DC. 86pp.

Yeraswork, A. (2000). *Twenty Years to Nowhere: Property Rights*. Land Management and Conservation in Red Sea Press, Addis Ababa, Ethiopia. 347pp.

APPENDICES

Appendix 1: Household Questionnaire Form

SOIL CONSERVATION STUDY QUESTIONNAIRE FOR MBEYA RURAL DISTRICT OCTOBER 2012-SEPTEMBER 2013

Title: Factors Influencing Adoption of Soil Conservation Measures, Sustainability Socio-Economic Impacts among Smallholder Farmers in Mbeya Rural District

A: GENERAL INFORMATION:

Date of interview..............................

Name of the village......................................Ward...

Division..District...

Region...Respondent identification Number....................

B. Personal Factors

1. What is your age?

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2. What is your marital status?

I). Single
II). Married
III). Divorced
IV). Widowed
V). Separated

3. Education level

I). No formal education

II). Adult education

III). Primary education

IV). Secondary education

V). Higher education

4. House Hold members by age composition

	Age	Male	Female
S/N			
1			
2			
3			

5. Gender (male=1, Female=2)

I). Female headed household

II). Male headed household

C. Socio-Economic Factors

6. What are your major sources of income?

I). Farming

II). Employment

III). Off-farm activities

IV). Others specify

7. Can you describe to me the following?

Source of income	**Cost**	**Gross income**
Crop production		
Livestock		
Non-farm activities		
Remittances		
Rentals		

8. Are you involved in non-farm activities?

I). NO II).YES

9. What is average duration of involvement?

I). One month II).Two months III).Three months V).More than three months

10. Did you implement soil conservation measures?

I. NO II. YES

11. If yes what type of SCM did you implemented?

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12. Do you have access to credit?

I). NO II). YES

13. If no, where did you obtain money for construction/ implementation of soil conservation measures?

I). Own financial

II).Research project

III).NGO

IV).Others (specify)

14. What is the size of your farm?

I) ---

II) --

15. What is your main source of labour?

I). Family/household

II). Hired labour only

III). Both of the above

16. How much amount of fertilizer did you use in the 2011/12 agriculture year?

Fertilizer type	Amount used in 2011/12 (kg)	Cost	Acreage	Crop type

D. Institutional Factors

17. Are you satisfied with technical support you are receiving from extension officers?

I). No

II). YES

18. If no why?

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19. How many times are you visited by an extension officer during the 2011/12 agriculture season?

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20. Have you got any training?

I). NO II). YES

21. If yes, I would like to know those who provided you with the training?

I). Extension workers

II). Researchers

III). Religion institutions

IV). NGOs

V). others (specify)

22. What type of training have you obtained?

I). Proper spacing for planting maize and beans

II). Appropriate type of fertilizer to use and type

III). Soil conservation measures

IV). Use of insecticides

V). others (specify)

23. I would like to know ownership of the land. How did you obtain the land you are cultivating?

I). Own land

II). Hired

III). Inherited

24. What is the distance from your house to the market place in km. /minutes?

E. Biophysical Factors

25. Can you please let me know the topography where your farm is located?

I). Flat

II). Gentle

III).Moderate

IV). Steep

V). Very steep

26. Can you explain to me how the fertility of your farm is?

I). Low

II). Medium

III). High

IV).Very high

27. Do you experience soil erosion problems in your farm?

I). NO II). YES

28. If yes what are the signs which show you that there is soil erosion

I) ---

II) --

29. How much soil erosion a problem in your farm?

I).Low

II). Moderate

III). High

IV). Very high

30. What do you do to solve some of soil erosion problems you are experiencing? (Say yes or no)

I). Planting more crops on annual ridges

II). Planting more crops on permanent ridges

III). Leaving crops residues on fields after harvesting

IV). Planting trees on areas with landslides

V). Planting cover crops along contours

F. Farmers' Opinions on Sustainability of Soil Conservation Measures

31. What do you think this project is about?

A Likert scale to identify farmers opinions on sustainability of SCM

S/N	Opinions Statement	Connotation	Disagree 1	Undecided 2	Agree 3
32	Lack of capital leads into sustainability of SCM	-			
33	Availability of capital enhance sustainability of SCM	+			
34	Low labour is required to establish and maintain contours	-			
35	High labour is required to establish and maintain contours	+			
36	High maintenance costs contribute to sustainability of SCM	+			
37	High maintenance costs contribute to un-sustainability of SCM	-			
38	Sustainability of SCM leads into low return to land	-			
39	Sustainability of SCM leads into high return to land	+			

40. What should be done to improve the sustainability of SCM?

----

41. After the project ended how you did went on with the improvement of this project?

G. Farm income/farm based income

42. How many contours have you replicated in your farm for the past 3 years?

----

43. How many times per year did you manage your structure if you are using contours?

----

44. Do you use hired labour in managing your contours?

I). YES II).NO

45. If YES how many days do one person spent in the following?

S/N	Activity	Mandays/Acre	Costs
1	Construction of contours		
2	Planting cover crops		
3	Planting fodder trees		
4	Management of contours		

46. What are the four major food crops did you grow along the contours for the past three years?

Crop	Yield/acre/year 2012	Yield/acre/year 2011	Yield/acre/year 2010	Costs	Gross income

47. What are the four major cash crops did you grow along the contours for the past three years?

Crop	Yield/acre/year 2012	Yield/acre/year 2011	Yield/acre/year 2010	Costs	Gross income

48. What types of cover crops did you grow along the contours?

II) --

II) --

III) --

49. What types of fodder trees did you grow along the contours?

I) ---

II) --

III) --

50. What is the production situation with respect to your food crops?

I). Increasing---------------------- II).Decreasing------------- III). Stagnating-----

51. If increasing/decreasing why?

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52. Do you own livestock?

I. No II. Yes

53. If yes, can you describe to me the following?

Livestock	Number	Produce	Gross income
Cattle			
Goats			
Sheep			
Chicken			

54. Do you use fertilizer on your farm?

I. No II. Yes

55. Do you have access to credit?

I. No II. Yes

56. If yes, for what activities did you use credit for?

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57. Where do you sell your products?

I) ---

II) ---

58. What is your suggestion on improvement of your farm productivity?

I) ---

II) ---

"THANK YOU FOR YOUR COOPERATION"

Appendix 2: Checklist for Key Informants

1. What are the factors influencing adoption of soil conservation measures in this village?
2. What are the major sources of income?
3. What are the estimates of annual farm income?
4. What is average duration of involvement in non-farm activities?
5. What are the estimates of annual non- farm income?
6. How is your fertilizer expenditure per acre?
7. How many contours were replicated in your farms for the past 3 years?
8. How many times contours are managed per year?
9. What are your opinions on adoption of SCM
10. What are the advantages and disadvantages of using SCM?
11. What are your opinions on sustainability of SCM
12. What are the four major food crops did you grow along the contours for the past three years?
13. What are the four major cash crops did you grow along the contours for the past three years?
14. What do you suggest to increase productivity of your farm?
15. What should be done in order to improve sustainability of SCM?

Appendix 3: Checklist for Focus Group Discussion

1. How much is soil erosion a problem in this ward?
2. How is fertilizer expenditure per acre?
3. Does the use of SCM in this village increasing or decreasing?
4. What is average duration of involvement in non-farm activities?
5. What are the estimates of annual non- farm income?
6. How many times contours are manage per year?
7. What are the four major food crops grown along the contours for the past three years?
8. What are the four major cash crops grown along the contours for the past three years?
9. What are the estimates of annual farm income?
11. What are the types of soil erosion prevailing in this ward?
12. How many times extension officer visits the farmers per month?
13. What are the types of SCM commonly practiced/employed by farmers?