ECONOMIC ANALYSIS OF CLIMATE SMART AGRICULTURE PRACTICES AMONG SMALLHOLDER FARMERS IN KILOSA DISTRICT

AMRI YUSUPH

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE.

MOROGORO, TANZANIA.

2014

ABSTRACT

Climate Smart Agriculture practices are climate change impact adaptation options which have been emphasized in REDD+ villages in Kilosa District, but the cost and benefits of particular CSA practices are not well known by most of the farmers. The specific objectives were to identify climate smart small scale agriculture practices in the study area, to compare the profitability of different climate smart agriculture adopted by small holder farmers, and lastly to identify factors influencing farmer's decision to adopt climate smart agriculture practices. Questionnaire was administered to a total of 100 households. A large proportion (50.9%, 43.8% and 43.6%) of the households in Ulaya-Kibaoni, Nyali and Dodoma-Isanga villages respectively reported crop rotation to be practiced by majority of the households. Cover crops were practiced by 3.6%, 16.7% and 2.6% of the households in Ulaya-Kibaoni, Nyali and Dodoma-Isanga villages respectively. Cost benefit analysis was used to compare profitability of the CSA practices. All practices had positive NPV and BCR$\geq$ 1; this means that they were economically profitable. Reduced tillage had NPV of TZS 2 024 585.4/= per hectare and high cost of production but it had higher returns than crop rotation and cover crops practices. Conventional farming was found to be less profitable with NPV TZS 940 569.92/= per hectare. Factor analysis was used to identify factors which influence farmer's decision in the adoption of CSA practices. The results show that economic factor have high loading factor 0.893 to 0.688 implying that variables loaded to this factor have more influence on the decision of farmers to adopt CSA practices, other factors include information, social factors, and environmental concern. Most CSA practises has high investment cost. Training to various CSA practices which are cost effective in terms of implementation and suit their ecological conditions is important.

DECLARATION

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

05/11/2014

Amri Yusuph

(MSc Candidate)

Date

The above declaration is confirmed

10-11-2014

Dr J.M. Abdallah

(Supervisor)

Date

COPYRIGHT

ACKNOWLEDGEMENTS

First and foremost, I would like to thank the almighty God for keeping me healthy through the whole period up to the completion of this study.

Also, I would like to extend my special acknowledgment to my supervisor Dr. J. M. Abdallah for his tireless effort for advice, comments, suggestions, and corrections towards the completion of this study.

I would also like to offer special thanks to Agricultural Field Officer, Mr. Juma Kassim for providing logistic support in data collection as well as farmers from study villages in Kilosa District for their willingness to provide useful information for this study.

I am also grateful to the entire staff of Faculty of Forest and Nature conservation, my fellow students and friends for their endless support and advice throughout the whole period of writing this dissertation.

DEDICATION

I would like to dedicate this valuable study to my beloved family.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABREVIATIONS AND SYMBOLS

$\sum$	Summation
ANOVA	Analysis of Variance
BCR	Benefit Cost Ratio
BTS	Bartlett's Test of Sphericity
CBA	Cost-Benefit Analysis
CSA	Climate Smart Agriculture
FAO	Food and Agriculture Organization
KMO	Kaiser–Meyer–Olkin
MAFC	Ministry of Agriculture Food Security and Cooperatives
MJUMITA	Community Forest Conservation Network of Tanzania
NPV	Net Present Value
PAF	Principal Axis Factor
REDD+	Reducing Emissions from Deforestation and forest Degradation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Climate change and variability are expected to affect agriculture differently in different parts of the world including Tanzania (Lobell *et al.,* 2011). In Tanzania, Agriculture is already capital constrained, but climate change will make the situation even worse. As a result of changed rainfall patterns, a decrease in fertile arable land and more extreme weather events, agricultural production is likely to decrease in the country (Rowhani *et al.,* 2011). Extreme weather events such as drought and floods make crop and animal production even more prone to failure. Rising temperatures and a decrease in water availability lead to the reduction of yields in a country which relies on agriculture as a vital sector for food security of the populations (Mary and Majule, 2009).

Agriculture not only suffers from the impacts of climate change and variability, but it also responsible for 14% of the global greenhouse gas emissions (World Bank, 2008). Thus agriculture has the potential to be an important part of the solution to the impacts of climate change and variability, through mitigating, reducing, and removing a significant amount of greenhouse gas. Despite the challenges resulting from the impacts of climate change, which in turn affect crop production, farming systems have not been static. Farmers in different parts of the country have been testing and adopting new agricultural practices over many years to cope or adapt with climatic variability (Cooper *et al.,* 2008).

Generally, most technologies which have been developed so far with the aim of increasing agricultural production have not been cost effective. The adoption of these technologies has been costly, and these begin with the indirect costs of manufacturing fertilizers and pesticides, which are passed on to the producer. Other direct costs include those related to initial field preparation, application of the fertilizers, pesticides, and harvesting, transportation and drying the crop (MAFC, 2002). Under such situations, Climate Smart Agricultural practices (CSA) seem to be the best option for solving multiple climate change related problems facing the agricultural sector.

According to FAO (2010) Climate Smart Agriculture is a practice that sustainably increases productivity, reduce climate change vulnerability through adaptation strategies, reduces/removes greenhouse gases (mitigation), and increases the chances of achieving the national food security and development goals by enhancing food security and improved livelihood of a given society. Climate Smart Agriculture involves making changes in farming systems that achieve multiple goals by increasing agricultural productivity, building resilience to climate change, and helping carbon sequestration into soil and plants to reduce GHG emissions (Nambiza, 2013).

1.2 Problem Statement and Justification of the Study

The variability and change in climatic pattern has severe consequences to agriculture in Tanzania. In recent years, there have been increased incidences of floods, droughts, pests and diseases as well as land degradation. This has resulted into poor crop production, less food availability, lower incomes, and thus forcing many households into risks of food insecurity. In many parts of Tanzania, farming at households' level has undergone a great deal of changes and has faced many challenges for a very long period of time, and these include persistent high population growth, high food prices, declining soil fertility and crop yields, poor market access, constrained access to land, and high inflation (Nelson *et al.*, 2010).

Kilosa is one of the districts where small holder farmers have been severely affected by the impacts of climate change and variability (Nambiza, 2013). Farming communities have been practicing different agricultural practices for a long period of time, aimed at, among other things, to overcome the impacts of climate change and variability. However, which CSA practice is the best and economically efficient in terms of costs and the potential to mitigate the impacts of climate change and variability, and to what extent have the CSA been effectively adopted were among the important questions that attracted this research.

Many studies on climate smart agriculture both quantitatively and qualitatively have been carried out. For example, Nambiza (2013) did a CSA study in Kilosa and Chamwino districts to assess the current uptake of climate-smart, small scale agricultural practices. The author found that 21% of small-scale farmers were implementing at least one of the climate smart agricultural practices in three study villages in Kilosa; and 27% of small-scale farmers were doing the same in Chamwino study villages. Also Mishra *et al.* (2014) did cost benefit analysis of soil and water conservation and found that for a 10-year period and with a 6% discount rate, all the indigenous soil and water conservation practices had a positive NPV and were environmentally and economically sustainable. There is, however, the information gap between what is technically feasible and what farmers are willing or able to do. Farmers will not adopt CSA practices if they do not get immediate yield benefits or profits. Thus, this study performed the economic analysis of most of the used CSA practices by smallholder farmers in the study area so as to explore the costs and returns of adaptation to climate change and variability through practicing climate-smart agriculture.

The study findings will contribute towards the understanding of the factors influencing the adoption of CSA and the costs incurred by smallholder farmers in adoption of CSA practices and their benefits. This will enable all development partners like farmers, extension officers, researchers, and other development agents involved in agriculture development to increase and extend the adoption rate. The findings will also help the Government to refine their policies and programs so as to promote and extend the use of CSA among smallholder farmers.

1.3 Objectives

1.3.1 Overall objective

The overall objective of this study was to undertake economic analysis of the adoption of climate smart small scale agriculture practices in Kilosa District.

1.3.2 Specific objectives

Specifically the study intended to:

i. identify and assess climate-smart small scale agriculture practices in the study area.

ii. compare the profitability of different climate-smart agriculture practices adopted by small holder farmers.

iii. identify factors influencing the farmer's decision to adopt climate smart agriculture practices.

1.4 Research Questions

i. What are the existing climate-smart small scale agriculture practices in the study area?

ii. Are climate smart agriculture practices more profitable than is the case with conventional farming?

iii. What factors influence farmers' decision of adoption climate smart agricultural practices?

1.5 Conceptual Framework

Farmers can significantly reduce climate change impacts by selecting agricultural practices that reduce greenhouse gas emissions or store carbon (Wollenberg *et al.*, 2012). However, they face a variety of decisions about what crops to grow, what inputs to use, and how much of each input to use in different parts of their land in order to achieve their farming objectives (Grabowski, 2011). Those who switch from conventional practice to some new techniques may do so for a variety of reasons. They may detect a more efficient and profitable way to produce or they may perceive a problem and in seeking for solutions they arrive at a new practice, such as CSA. The problems stimulating the possible change to CSA are typically soil degradation, soil erosion or declining crop yields due to deteriorating soil fertility caused by the effects of climate change and variability (Lee *et al.,* 2008).

The decision by small holder farmers to adopt CSA may depend on the socio-economic factors such as poverty, off farm income, human capital such as age, cropping pattern such as farming system, crops and livestock, land ownership of farming equipment as well as family size and demographic structure. Other factors may include capacity to borrow, levels of prices of inputs and outputs, land tenure and land availability. Some farmers adopt CSA practices because they found that immediate yield benefits or profits were attractive.

If the above factors are met, then the CSA could be put into practice and would lead to higher yields, income, and increase the standard of living and food security, and at the same time mitigate climate change and variability.

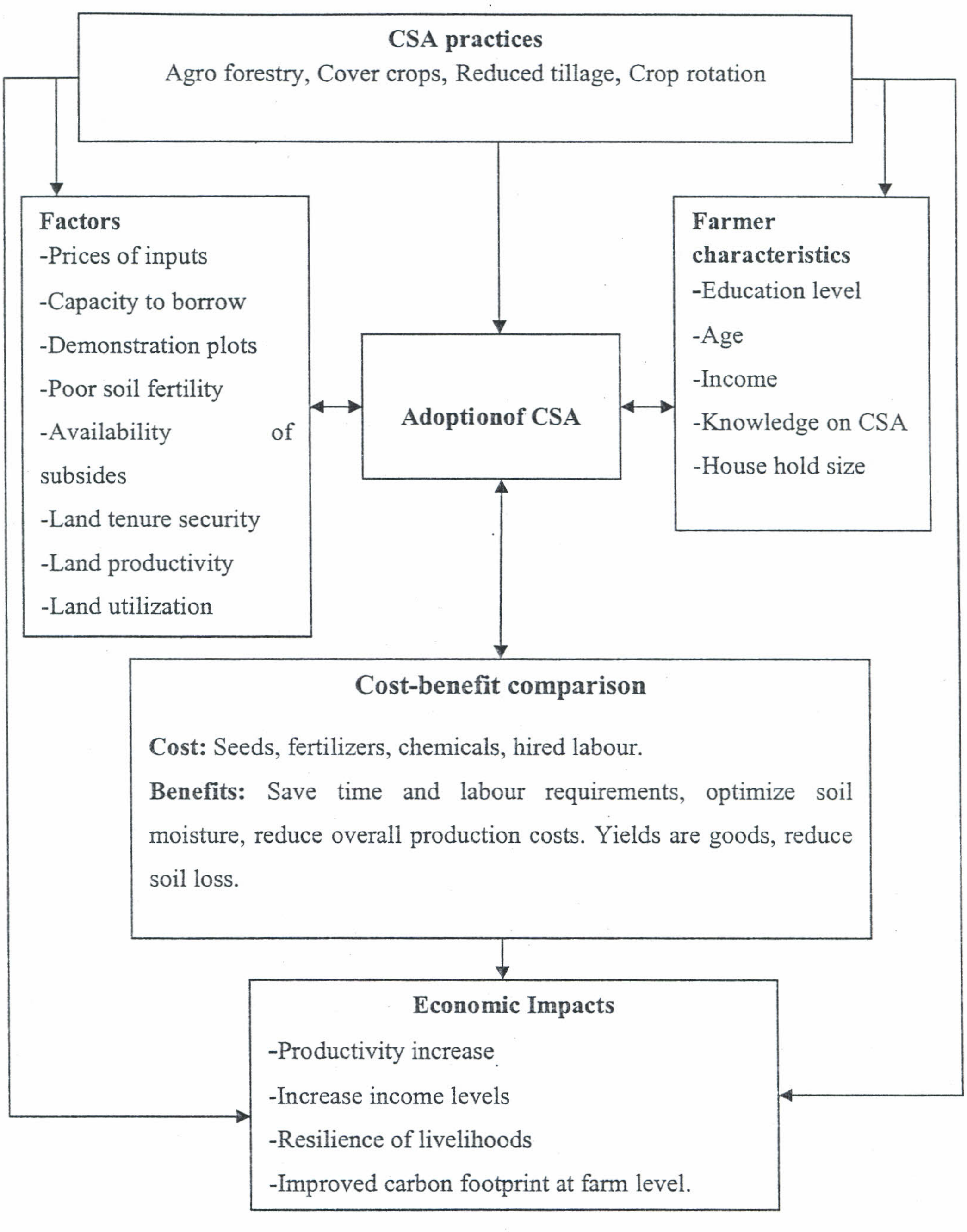

Figure 1: Conceptual framework of adoption of CSA practices

Source: Modified from FAO (2001).

Key: CSA= Climate Smart Agriculture;

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of Climate Smart small scale Agriculture

Climate smart agriculture is an adaptation strategy aimed at helping small farmers adapt to climate change by way of intensifying or diversifying livelihood strategies, and thereby reducing vulnerability (Mccarthy *et al.,* 2011). Climate smart agriculture is defined by FAO (2010) as agriculture that sustainably increases productivity, resilience, reduces or mitigates Green House Gas emissions, and enhances achievement of national food security and the Millennium Development Goals (MDG 1), which is to reduce hunger and poverty by 50% (to less than 420 million people) by 2015and (MDG 7), which is ensuring environmental sustainability. According to Mann and Change (2012) CSA is built on three pillars: increasing productivity and incomes, enhancing resilience of livelihood and ecosystems, and reducing and removing greenhouse gas emission from the atmosphere.

Shames *et al.* (2012) observe that CSA pathways towards development and food security and involve the use of proven practices; techniques and options such as conservation agriculture, livestock diversification with improved feeding and manure management practices, integrated crop-livestock management, improved use of agro forest systems, improved land and water management innovative practices using climate data and information.

The use of cover crops, for instance, is reported to increase yields due to decreased on-farm erosion and nutrient leaching, and reduced grain losses due to pest attacks. Kaumbutho *et al.* (2007) shows that maize yield increased from 1.2×10^3 to 1.8-2.0×10^3kg/ha in Kenya with the use of *Mucuna pruriens* cover crop. Cover crops and improved fallows on the other hand can increase soil carbon particularly when combined with zero or minimum tillage and thus aid soil sequestration (Govaerts *et al.*, 2009).

Crop rotations and intercropping using Nitrogen-fixing crops, such as groundnuts, beans and cowpeas may enhance soil fertility, reduce reliance on chemical fertilizers, and enrich the nutrient supply to subsequent crops leading to increased crop yields (Conant, 2010). Hine *et al.* (2008) showed that maize and bean yields increased to 3414 kg/ha and 258 kg/ha respectively in the North rift and western regions of Kenya.

Reduced tillage and crop residue management provide opportunities for increasing soil water retention. Therefore, crop yields are often higher under reduced tillage and crop residue management than under conventional tillage (Derpsch and Friedrich, 2009a). Proper water management on the other hand can help capture more rainfall, making more water available to crops, and which can be used more efficiently for increased agricultural production (Conant, 2010). However, there is an information gap between what is technically feasible and what farmers are willing and able to do. Available literature has not yet identified CSA practices which are the best in terms of cost and mitigation capabilities as opposed to other practices.

2.2 Definition of Adoption

According to Feder *et al.* (1985) adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. Rogers (2003) defines the adoption process as a mental process through which an individual goes through from first hearing about an innovation or technology to the final adoption. This implies that adoption is not a sudden event, but a process. Farmers do not accept innovations immediately; they need time to think over other things before reaching a decision (Negash, 2007).

2.3 Adoption theories

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

Theory of Reasoned Action (TRA) is another theory which has influenced adoption studies. This theory focuses on behavioural determinants of the individual instead of technological characteristics (Green, 2005). The existing research suggests that majority of contemporary technology adoption studies for example (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980) are rooted in behavioural intention, which proposes that a user's choice to adopt a new technology is a conscious undertaking which can be sufficiently explained and predicted by their behavioural intention. This theory is used to gain deeper insight into how attitudes and beliefs are correlated with individual intentions to perform (Fishbein and Ajzen, 1975).

Another adoption theory is Consumer Behaviour Theory (CBT) which influences the adoption of technologies focusing in marketing aspects. CBT states that the decision to adopt is influenced by the level of consumer involvement in the innovation and the degree of effort consumers are willing to invest in making a purchase decision (Kaine, 2004). The theory proposes that when a potential adopter's involvement is high the adopter tends to engage in complex decision making or brand loyalty depending on the degree of effort they invest (Botha, 2005).

CBT provides a framework for determining how innovations can contribute to satisfying the needs of the adopters. CBT assumes that a prospective adopter actively searches for information and devotes a great deal of time and energy in making decisions. Also, it assumes that a variety of decision processes occur when making the decision of whether or not to adopt an innovation (Botha *et al.,* 2005). Furthermore, CBT provides criteria for identifying the decision processes occurring in particular circumstances and recognises that different individuals adopt the same products for differing needs (Kaine, 2004).

This study chose to use diffusion innovation theory employing Rogers' five stages (steps) of adoption, which are: awareness, interest, evaluation, trial, and adoption in measuring the extent of adoption of CSA practices. This is due to the fact that adoption of agricultural innovations follows hierarchical stages (Rogers, 2003). According to Parminter (2011) individuals appear to have a number of adoption stages when they adopt a new technology and these stages have different requirements to encourage successful behaviour change.

2.4 Factors Influencing Uptake of Agriculture Technologies

There are various factors which determine the adoption of different agricultural innovations. Some literatures have classified these factors into the following broad categories: farmer characteristics, farm structure, institutional characteristics and managerial structure (Bonabana-Wabbi, 2002; Mccarthy *et al.,* 2011) while others classified them under social, economic and institutional categories (Barungi *et al.,* 2013; Uaiene *et al.,* 2009). Some of these factors include an increase of adoption; others deal with a decrease of adoption while others have neutral effects.

Farm size has been widely considered as the first and probably the most important determinant of adoption by many literatures (Doss and Morris, 2001). Uaiene *et al.* (2009) found inconsistent relationship between these factors. The authors observe that farmers with easy access to land are less likely to adopt land-saving technologies (e.g. fertilizer and pesticide) because land is abundant. Furthermore, the landowner is more likely to adopt other conservation technologies to preserve their land.

According to Baudron *et al.* (2007) more farmers will likely turn to technologies due to scarcity of family labour so as to save labour. Such technologies may include reduced tillage systems if they are accessible and affordable. Pandey and Mishra (2004) however, reported contrasting results whereby they reported about there being no association between the adoption of zero tillage and the ability of the family to access labour. Similar studies, for example (Doss, 2006) found that a unit increase in labour capacity increased a farmers' likelihood of the adoption of crop rotation which involves diversifying crops. It is labour intensive; hence there is likelihood for the households with more family labour to adopt such technology. Moreover, Langyintuo and Mekuria (2005) observe that educated farmers are more able to process information and search for appropriate technologies in the quest to alleviate their production limitations.

Also, there is an inverse relationship between levels of disposable income and the adoption of minimum tillage, implying that households with higher disposable income are less likely to adopt and intensify the use of minimum tillage than those with lower income (Chiputwa *et al.,* 2011). This is due to the fact that richer farmers have a greater ability to hire tractors or power tillers or *''Maksai''* to prepare their lands unlike the poorest who are more likely to opt for minimum tillage to reduce the cost especially under conditions of high rental rates for tractor power. Previous work by Haggblade and Tembo (2003b) estimated that a farmer can save up to 75% operation costs per hectare if they adopt minimum tillage as opposed to conventional tillage methods.

Apart from direct factors (farmer's demographic characteristics and institutional factors) there are indirect factors which cannot be expressed directly and which are not mentioned in many literatures but which in one way or another may affect the adoption of agriculture practices. These factors may include awareness, desires, and interest; in other words, some farmers may not be constrained by farm size and labour or income, and may not be interested in these practices, as they may have other sources of income such as livestock keeping which are more profitable. Also, there is limited available information about alternative techniques as well as limited local experience with such practices; these factors hinder the adoption of agricultural innovations.

2.5 Cost Implications of Adoption of Agricultural Technologies

Agriculture is based on the use of natural resources supplemented with material and non-material inputs to produce food and other products and services (Reed *et al.,* 2007). The decisions farmers make about the type of technologies and practices to adopt are based on the benefits and costs associated with such technologies and practices, which in turn are influenced by the ability of producers to access input supply and output market chains (Grabowski, 2011). According to Adegbola and Gardebroek (2007) farmers who are aware of a certain agricultural technology component will decide whether or not to adopt by evaluating the expected economic profitability or benefit which is anticipated to be gained, taking into account the initial investment and variable costs.

An agricultural technology is more likely to be adopted if the gain or profit exceeds the aggregate investment and variable costs (Grabowski, 2011). Improved market access which raises the returns to land and labour is therefore a critical force for the adoption of new practices in agriculture. Monetary cost and benefits are the ones which have so far been widely considered by many studies; however, little is explained about the intangible benefits associated with the adoption of agricultural practices.

2.6 Machinery costs and labour costs

As Reed *et al.* (2007) indicate that most of the large producers, conservation agriculture reduce machinery costs. A farmer may decide to use power tiller instead of a tractor to allow minimum tillage and this reduces fuel and operational cost. However, there is some complexity where farmers see conservation agriculture as a complement rather than a substitute for their existing practices because if they switch completely to conservation agriculture the fuel cost and operating costs may go up (Klytchnikova, 2008). To capture such complexity economists distinguish between short run and long-run costs, where the farmer assumes no adjustment. Knowler and Bradyshore (2005) found that short-run average costs under conservation agriculture exceeded long-run average costs by about 7%. The short-run average costs per hectare for conservation agriculture were greater than for conventional tillage. However, after adjustments to capital, conservation agriculture costs fell below those of conventional tillage in the long run.

Other costs include pesticide costs, labour costs, and fertilizers cost. All these costs have implications for the adoption of climate smart agriculture by farmers. For example, Wandel and Smithers (2000) show that; a farmer who has adopted conservation agriculture has enough time to engage in non-farm activities for income generation. Generally, agricultural innovations require greater management skills, and it may be costly for farmers to acquire these innovations. However, economic viability of the CSA could be a determinant factor for the farmer's adoption decision.

2.7 Cost Benefit Analysis of Climate Smart Agriculture Practices

The cost-benefit analysis (CBA) is a widely applied technique of economic analysis which allows for the determination and evaluation of economic costs and benefits, both direct and indirect, of a certain public initiative (Tongeren and Beghin, 2009). CBA is designed to show whether the total advantages (benefits) of a project profitability of any business can be deduced from the relationship between the costs incurred in running the farm business and the returns accruing from it (Pearce *et al.,* 2006). This essentially involves calculations of all costs and benefits in monetary terms. An adaptation option would represent a good investment if the aggregate benefits exceed the aggregate costs. CBA in its simple form, does not cover all the aspects: it ignores the distribution of the costs and benefits of adaptation options and it fails to account for those costs and benefits which cannot be reflected in monetary terms, such as ecological and health impacts, as well as welfare such as peace and security (Woodhall, 2004). As FAO (2010) reports, there is no cost benefit analysis of local CSA practices which have been implemented in the sub-sub-Saharan African countries; various CSA projects have only estimated the benefits and costs of implementation of technologies and initiatives on CSA. Therefore, it was important to undertake cost benefit analysis of the CSA, particularly in the National REDD+ pilot areas where CSA have been implemented.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

This study was conducted in Kilosa District in Morogoro Region. The area is characterised by semi humid climate, receiving an average rainfall of 800 mm annually. The district receives rainfall in eight months, with the highest levels between February and March. The district experiences a long dry season from June to October. Temperature ranges from 18°C in the hills to as high as 30°C in the lowlands (NBS, 2012). Although Kilosa District has two rainy seasons, the pattern and amount of rainfall allow for one harvest of the main staples per cropping season (Tarimo *et al.,* 2005).

The major economic activity in the district is crop farming, followed by livestock keeping which is mostly practiced by pastoralist communities (NBS, 2012). Major crops cultivated include maize, paddy, sorghum, cassava, and legumes. Major cash crops are cotton, sisal, sugarcane and oilseeds (Tarimo *et al.,* 2005).

The district was selected because of its agricultural and demographic characteristics and due to the fact that it is one of the districts which have piloted REDD+ (Reducing Emissions from Deforestation and forest Degradation) in Tanzania and where some of the CSA have been carried out. Moreover, the districts have already begun to suffer from the consequences of climate change. For example, reduced crop yield due to drought and floods leading to increased risks of food shortage and famine, change in planting dates of annual crops, reduced water availability due to frequent drought spells, a decrease in forest area and area for cultivation, increased temperatures, increased exposure to vector-borne and water-borne diseases (Baruani and Senzia, 2013). In 2009/2010 for example, over three quarters of households were affected by floods, and one third of the households were displaced from their homes (Mboera *et al.,* 2011). Small holder farming communities in Kilosa have developed a mechanism to cope with the challenges of climate change. Nambiza (2013) indicates that climate smart agriculture practices such as conservation agriculture, crop rotation, reduced tillage and terraces have been adopted in Kilosa by many farmers.

Kilosa District has been selected also because it is one of the districts which have been highly affected by farmers-pastoral conflicts; and thus CSA has been one of the solutions proposed by many scholars (Mung'ong'o *et al.*, 2003).

3.2 Study Population

The study population consisted of all households practicing CSA as well as conventional farming in the study area. Conventional farming was included so as to collect data which aided in making comparisons with other CSA practices.

3.3 Sampling Procedures

Purposive sampling was used to select three wards and then one village was selected from each ward. The focus was on villages which were implementing REDD+ projects. These villages included, Nyali, Ulaya-Kibaoni, and Dodoma-Isanga.

The following formula was used to determine the sample size, which was used in data collection (Yamane, 1967).

$$n = \frac{N}{1 + N(e)^2} \qquad \text{.......(1)}$$

Where: N is the size of the population of farmers who practice CSA and n is the size of the sample which was 100 households calculated from the formula (1); and$e$ is the level of precision (5%).

Stratified random sampling was then employed to allocate the sample size to homogeneous units based on wealth category (rich, average, and poor) (Appendix 4). The actual sample size was 33 in Dodoma-Isanga village, 32 in Nyali village and 35 in Ulaya-Kibaoni village.

3.4 Data Collection

Primary data were collected from the selected households. Both structured and semi structured questionnaire (Appendix1) was administered to the households to capture both qualitative and quantitative data. A focused group discussions (Appendix 2) were carried out to gather more information on the CSA practices which were adopted by many farmers and information on yields. In addition key informants such as village agricultural offices and village leaders were invited to provide supplementary information. Direct observation and informal discussions were also carried out to explore more information along with CSA practices.

Secondary information both published and unpublished was obtained from various reports collected from internet searches and other relevant information available inside and outside the study area. The information included social economic profile of the district, baseline information of CSA in Kilosa District.

Objective i: Identification and assessment of climate-smart small scale agriculture practises in the study area

Data on the most practiced CSA practices were collected through a questionnaire (Appendix I). The data collected involved included all CSA practiced in the study area, place of implementation, the season involved, land use and land acquisition, types of crops grown and knowledge of soil fertility management, challenges and constraints.

Objective ii: Comparison of the cost and net returns of different CSA practices adopted by farmers

Questionnaire (Appendix 1) was also used to collect these data. The areas of focus for the data collection included market prices of fertilizers and field chemicals, total family labour, purchased seeds, Oxen/tractor hiring, output prices, yields, returns, and other intangible benefits. Data on cultivation and agricultural production, total input costs and output prices, fertilizer and agrochemical application, were collected.

Objective iii: Identification of factors influencing the farmer's decision to adopt climate smart agriculture practices

A five point Likert scale was used to collect data on factors influencing the farmers' decision on the adoption of CSA practices. Also the data collected were on the sex of the respondents, education level, family size, land size, age structure of the household, working force of the household, the use of hired labour, and family income. Other collected data included credit availability, availability of non-farm income, and access to extension services, awareness of CSA, information on soil fertility, access to credit, and data on prices of inputs and outputs. In addition, constraints faced by farmers on the adoption of CSA were also collected. Questionnaire (Appendix 1) was used to collect these data.

3.5 Data Analysis

Analysis of data for objective i

The data collected from primary sources were coded and entered into SPSS computer Program. Descriptive statistics such as frequencies, mean and standard deviation were used to analyse data for objective i.

Frequency were used for analysis of types of crops grown, types of CSA, land acquisition and utilization, extent of CSA adoption and household's knowledge on CSA. Mean and standard deviation were used to analyse data on land utilization and land acquisition and other household characteristics such as age in years.

Data analysis for objective ii

Cost-benefit analysis method was employed to analyse data for objective number two. The CBA was applied to evaluate the CSA option versus conventional cultivation systems. The net present value, and the benefit-cost ratio, were calculated and compared. Sensitivity analysis was carried out to study effects of change in fluctuating factors such as input prices of products and discount rate on NPV.

The NPV of each cultivation practice was calculated using the following formula:

$$\mathrm{NPV} = \sum_{t=0}^{n} \frac{(\mathrm{B_t} - \mathrm{C_t})}{(1+r)^{\mathrm{t}}} \qquad \text{...(2)}$$

Where:

$\sum$ = is the sum of the NPVs of the cultivation practice

B = benefits at year 2013 (market value of yield at year 2013),

C = costs at year 2013(market value of inputs, wages, fertilizers),

t = the time in years i.e. 5years (t= 5), and

r = discount rate (1.4%).

Microsoft excel program was used to calculate NPVs, and BCR for different CSA practices. The CBR is the ratio obtained when the present benefit stream is divided by the present cost stream. CBR formula used is as follows:

$$CBR = \frac{\sum R_t/(1+r)^t}{\sum C_t\,/(1+r)^t} t = 0, \dots, n \quad \text{...(3)}$$

Where;

R = the total revenue

C = the total cost,

r = the interest rate,

n = the number of years.

The cost components for all CSA options included market prices of seeds, fertilizers, field chemicals, cost of ploughing, planting, basin tilling, weeding, and harvesting. All the costs were assumed to be incurred at the beginning of the farming season. That is year 0. The benefit components which were considered included the net revenue from the sales of maize, the sales of other crops such as pigeon pea, sesame, and cow pea. These benefits were considered as direct revenue.

Time horizon for analysis

The time horizon for the analysis was taken to be 5 years; this was based mainly on the assumption that:

(a) A farmer would like to realize the return of his investment in the short run, thus choosing this period, it is anticipated that the decision will be plausible for the kind of investment to choose

(b) To the farmer the expectation of receiving benefits in the future has risk and uncertainty.

Decision criterion

The aim of undertaking CBA in this study was to make a comparison between different CSA options against the conventional farming using NPV as a criterion. According to this criterion an investment was profitable only when the NPV was greater than zero. The CSA options were considered to be mutually exclusive projects, thus CSA practice with higher NPV was considered to be preferred in favour of other practices. Conventional farming was used as a do nothing alternative and thus it was compared with other CSA options.

The decision criterion was to accept all CSA practices with positive NPV, while rejecting all CSA practices with negative NPV and choosing the CSA practice with higher NPV because they were mutually exclusive projects (Khatua, 2011).

Discount rate

The discount rate of 1.4% was used in the analysis. This was adopted from Stern (2008) who used 1.4% to calculate the cost benefit analysis in global warming. According to Harrison (2010) low discount rates are often used in environmental applications, especially when the benefits accrue in the distant future.

Analysis of data for objective iii

This study employed factor analysis, particularly common factor analysis to extract factors influencing the adoption of climate smart agriculture practices. This statistical method is used to identify the underlying factor or dimension that reflects what variables share in common (Field, 2009). The following formula was used.

$$F_i = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + \cdots b_nx_n + \varepsilon \quad \text{.......................(4)}$$

Where:

F_{ij}=Estimated i^{th} factor for j^{th} household (i=1, 2 ,3)

x_1=Levels of price of inputs

x_2=Capacity to borrow

x_3=Levels of price of output

x_4=Annual income of household

x_5=Land tenure security

x_{10}=CSA demonstration plots and trainings

x_{11}= Advertisement from media

x_{12}=Shortage of rainfall

x_6=Education level

x_7=Family labour

x_8=Access to extension service

x_9=Awareness of climate change problems

b_1 to b_8 are factor weight

ε= error variation

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Households Socio-economic Characteristics

The results in Table 1 reveal that 64% of sampled households were males, while 36% were females; this implies that most households in the villages were male-headed. It also implies that males play a big role in making decisions on agricultural investment in a family. Also, some CSA technologies, for example, reduced tillage are a male-oriented activity since it involves the use of heavy equipment.

The minimum age of household head was 21 years with the mean age of 43 years. Table 1 show that 42% of the sampled households were at the age ranged from 33 to 44 years, while 33% were at the age ranging from 45to 54 years old. This show that majority of those who were engaged in farming activities were adults. Furthermore, the results reveal that 79% of the households were married. Married couple adopts new agriculture technologies as the way of diversifying their livelihood since they have some family responsibility such as feeding the dependants (Urassa and Johannes, 2013).

About 89% of the households had completed primary level of education, 2% had completed secondary education and 2% had completed tertiary education. Most of the household had basic education. Basic knowledge is important for technology adoption (Kaumbutho and Kienzle, 2007). The households that are able to read are more likely to have been exposed to information regarding the environmental benefits of climate smart agriculture practices (Matata *et al.,* 2010).

Crop farming was a major economic activity reported by 77.2% of the households. Other activities were small business (13.4%), self-employed on off farm activities, and livestock keeping. Small business and the sales of agricultural produce were reported by majority of the sampled households. According to Ellis and Mdoe (2003) rural livelihood diversification is important in overcoming livelihood shocks.

Table 1: Socio-economic characteristics of sampled households (n=100)

Household Characteristics	Dodoma-Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	Total (n=100)
Sex				
Female	11 (66.7)	15 (42.9)	10 (31.3)	36(36)
Male	22 (33.1)	20 (57.7)	22 (68.8)	64(64)
Total	**100**	**100**	**100**	**100**
Age				
21-32	5 (15.2)	2 (5.7)	6 (18.8)	13(13)
33-44	16 (48.5)	13 (37.1)	13 (40.6)	42(42)
45-54	8 (24.2)	17 (48.6)	8 (25.0)	33(33)
55-64	1 (3.0)	3 (8.6)	5 (15.6)	9(9)
65-74	3 (9.1)	0 (0)	0 (0)	3(3)
Total	**100**	**100**	**100**	**100**
Average Age	43	45	41	43
Education Level				
Primary education	28 (84.8)	30 (85.7)	31 (96.9)	89(89)
Secondary education	0 (0)	2 (5.7)	0 (0)	5(5)
Adult education	1 (3.0)	1 (2.9)	0 (0)	2(2)
Illiterate	2 (6.1)	2 (5.7)	1 (3.1)	2(2)
Total	**100**	**100**	**100**	**100**
Marital Status				
Married	26 (78.8)	24 (68.6)	22 (68.8)	72(72)
Divorced	3 (9.1)	3 (8.6)	2 (6.3)	8(8)
Separated	2 (6.1)	2 (5.7)	3 (9.4)	7(7)
Widowed	0 (0)	5 (14.3)	1 (3.1)	7(7)
Never married	2 (6.1)	1 (2.9)	4 (12.5)	6(6)
Total	**100**	**100**	**100**	**100**
Major Economic activities				
Crop farming	31 (79.5)	35 (85.4)	32 (68.1)	98(77.2)
Livestock keeping	1 (2.6)	2 (4.9)	2 (4.3)	5(3.9)
Small business	5 (12.6)	2 (4.9)	10 (21.3)	17(13.4)
Self-employment off-farm	2 (5.1)	2 (4.9)	3 (6.4)	7(5.5)
Total	**100**	**100**	**100**	**100**
Average household size	5	5	6	5
Household average annual growth income (TZS)	602 727.27	493 714.29	770 375.00	618 220

Note: Numbers in parentheses are percentages and those outside parentheses are frequencies

4.2 Identification and assessment of Climate Smart Agriculture Practices

4.2.1 Land utilization, and land acquisition

Most villages in Kilosa had land use plans that demarcated land for settlements, farming, reserved forests, and grazing. This land use plans were facilitated by REDD+. The average size of land owned by the sampled households was 2 hectares (Table 2). Out of these only 1.5 ha was used for crop farming, 0.1 ha for livestock keeping and 0.2 ha was under fallow. The amount of land cultivated was limited primarily due to the limitations on working tools and manpower. Farming households in the study area depend solely on hand hoes, which limit agricultural production.

Table 2: Land uses in (ha) for different use system in the study villages

Land uses	Villages			Overall mean	SD
	Dodoma-Isanga	Ulaya-Kibaoni	Nyali		
Crop farming	1.43	1.53	1.82	1.57	0.79
Fallow	0.32	0.28	0.33	0.26	0.67
Livestock	0.47	0.12	0.00	0.12	0.20

Further analysis using one-way ANOVA (Table 3) indicates that there was a significant difference in the amount of land used for crop farming (P<0.05) level for the three land uses in Dodoma-Isanga (F (2, 96) =39.70, P=0.000), Ulaya-Kibaoni (F (2, 98) =17.684, P= 0.000), and Nyali (F (2, 90) =58.178, P=0.000).

Table 3: ANOVA test for land uses

Name of a village	Source of variation	df	F	Sig.
Dodoma- Isanga	Between Groups	2	39.700	0.000*
	Within Groups	96		
	Total	98		
Ulaya-Kibaoni	Between Groups	2	17.648	0.000*
	Within Groups	102		
	Total	104		
Nyali	Between Groups	2	58.178	0.000*
	Within Groups	90		
	Total	92		

Note: *Significant at P<0.05

The post hoc test comparison shows that all land uses in Dodoma-Isanga and Nyali village had significance mean differences while in Ulaya-Kibaoni the land under fallow did not show any significant mean difference (0.562) with the land used for livestock (Table 4).

Table 4: Posts-Hoc-Test LSD test for land uses across villages

(I) Land uses(ha)	(J)Land use (ha)	Dodoma-Isanga			Ulaya-Kibaoni			Nyali		
		Mean Difference (I-J)	Std. Error	Sig.	Mean Difference (I-J)	Std. Error	Sig.	Mean Difference (I-J)	Std. Error	Sig.
Crop farming	Fallow	2.48485(*)	0.37278	0.00	3.45714(*)	0.63890	0.00	3.77419(*)	0.45559	0.00
	Livestock keeping	3.15152(*)	0.37278	0.00	3.08571(*)	0.63890	0.00	4.61290(*)	0.45559	0.00
Fallow	Crop farming	-2.48485(*)	0.37278	0.00	-3.45714(*)	0.63890	0.00	-3.77419(*)	0.45559	0.00
	Livestock keeping	0.66667(*)	0.37278	0.07	-0.37143	0.63890	0.56	0.83871	0.45559	0.069
Livestock keeping	Crop farming	-3.15152(*)	0.37278	0.00	-3.08571(*)	0.63890	0.00	-4.61290(*)	0.45559	0.00
	Fallow	-0.66667(*)	0.37278	0.05	0.37143	0.63890	0.56	-0.83871	0.45559	0.069

Note: * =The mean difference is significant at P<0.05.

Regard land access, majority (79%) of the households obtained land through inheritance, buying (12%), and 7% rented, and 2% borrowed (Table 5). The households that did not own land were not in position to adopt CSA practices. Moreover, the results show a statistical significance difference in the mode of acquisition of land across the villages ($\chi^2 = 20.504$; df = 2; p = 0.02).

Table 5: Distribution of households by land acquisition in the study villages (n=100)

Mode of acquisition	Dodoma-Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	χ^2	df	sig
				20.504	2	0.02*
Inherited	29(87.9)	32(91.4)	18(56.3)			
Bought	0(0)	2(5.7)	10(31.3)			
Rented	3(9.1)	1(2.9)	3(9.4)			
Borrowed	1(3.0)	0(0)	1(3.1)			

Note:*Significant at P<0.05

4.2.2 Types of crops grown

The results in Table 6 show the types of crops grown by majority of farming households in the study area. Maize seems to be the crop grown by majority (42.7%) of households, followed by cowpea (22%) and pigeon pea (16.4%). Other crops are sesame, sunflower, beans, sorghum and cotton, and ground nuts and Tobacco. Majority of households intercrop maize with pigeon pea so as to increase productivity and income.

Table 6: Types of crops grown in the study villages

Type of crop	Dodoma-Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	Total (n=100)
Maize	33(42.7)	35(47.8)	31(37.8)	99(42.7)
Sesame	10(13.0)	7(9.6)	11(13.4)	28(12.1)
Sunflower	3(3.9)	1(1.4)	2(2.4)	6(2.8)
Pigeon pea	9(1.7)	13(17.8)	16(19.5)	38(16.4)
Cow pea	16(20.8)	16(21.9)	19(23.2)	51(22.0)
Sorghum	1(1.3)	0(0)	1(1.2)	2(0.9)
Beans	4(5.2)	1(1.4)	1(1.2)	6(2.6)

4.2.3 Types of CSA practiced by households Kilosa district

Climate smart agricultural practices involve a range of different agricultural and land management practices, but the definition and suitability of use depends on agro-ecological zone of a particular locality. The main types of climate smart agriculture practiced most by households in Kilosa District are shown in Fig. 2. Reduced tillage was dominant in Dodoma-Isanga village (53.8%), followed by Nyali village (39.6%), and in Ulaya-Kibaoni village (34.5%). Reduced tillage was found to be practiced by many households in Dodoma-Isanga and Nyali villages because most of the households in these villages got training on climate smart agriculture unlike the case with farmers from Ulaya-Kibaoni village.

Crop rotation was practiced by many (50.9%) households in Ulaya-Kibaoni village followed by 43.8%, in Nyali village and 43.6% of the sampled households in Dodoma-Isanga. The other type of CSA was cover crop which was practiced by few households across all the villages.

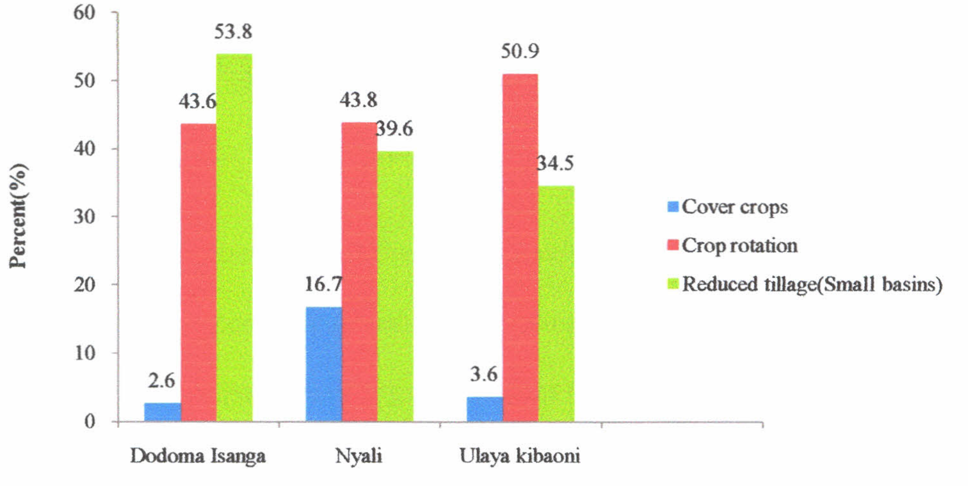

Figure 2: Types of CSA practiced in Kilosa district

Crop rotation is a diversifying crop practice which involves the successive cultivation of different crops in a specified order on the same fields (Mohler and Johnson, 2009). The choice of crops to rotate should consider differences in growing habits, nutrient requirements, and diseases and pests susceptibility/resistance to ensure maximum benefit of crop diversity (Mazvimavi *et al.,* 2010). In the study area, crop rotation was practiced by majority of households because they intercrop pigeon pea with maize and thus farmers get direct returns when selling pigeon peas as a cash crop.

Reduced tillage is a conservation approach aimed at achieving minimum disturbance of the soil in areas where seeds have to be planted, either in rows or small basins (Owenya *et al.,* 2011). The soil is first dug out to a sufficient depth to break through any hardpan, if present, and allow free drainage. The topsoil is returned, together with manure, and the remaining soil is placed around the hole to catch rainfall and concentrate it where the plants are growing (Twomlow *et al.,* 2008).

Reduced tillage found in the study area involves use of small basins, where the farm was cultivated in small permanent basins with 60 cm long, 60 cm width, and 60 cm deep. The basins were cultivated at 75 cm spacing along the planting rows and 90 cm apart between rows to form rows of small basins. Seeding and fertilizer application was done in each basin. Eight to ten (10) maize are planted in each basin (Kaczan *et al.,* 2013).

Reduced tillage attempts to solve some disadvantages of non-till systems, and improve root growth and penetration and water infiltration while maintaining surface mulch and slow down decomposition of organic residues (Twomlow *et al.,* 2008). Also, small basins are the only spots where soil is disturbed; hence they help to conserve soil and moisture. They also act as in situ rainwater harvesting and store water in the soil profile (Twomlow *et al.,* 2008).

From the interview with key informants it was observed that the average maize yield under reduced tillage practice using small basin ranged from 2200 kg/ha to 3300 kg/ha. This finding was consistent with that of (Kaczan *et al.,* 2013) who found the average maize yield to be 3054 kg/ha.

Cover crops are the type of crops which are planted in the same piece of land with the main crop in order to minimize soil erosion and conserve moisture (Mafakheri *et al.,* 2010). The types of cover crops used by many farmers as identified in literatures are *Lablab purpureus*, *Muccuna pruriens* and cowpeas (Acosta, 2009). In the study area, the cover crops which were grown by majority of farmers include cowpea. Cover crops were intercropped with the main crops and left to cover the soil even after harvesting the main crop. Agroforestry practices (fertilizer trees) was not common in Kilosa District as the households indicated that the soil is somewhat fertile and they get enough produce if there is enough rainfall for a particular cropping season.

4.3 Extent of Adoption of CSA Practices in the Study Villages

In Kilosa District climate smart agricultural practices such as reduced tillage, crop rotation, cover crops, the use of mulching, land fallowing, and terraces were introduced by REDD+ pilot projects along with alternative livelihoods such as beekeeping and poultry to discourage slash-and-burn and shifting cultivation which contributes to deforestation. Some of these practices have been adopted by households in their farms.

Households were asked about the extent of CSA practices adoption; four levels of adoption were established: These were Aware (Have heard about, and know few details but not consider using it), Evaluation (considered using, but have made no decision), Trial (Have decided to try them), Adoption (Have already been using in own farm).

The results in Fig. 3 show that 61.1% of the sampled households reported to have adopted crop rotation in Ulaya-Kibaoni village, (46.7%) in Dodoma-Isanga village and Nyali village (50%). Reduced tillage was adopted by 50% of the households in Dodoma-Isanga village, Ulaya-Kibaoni village (36.1%), and in Nyali village only 2.8%. Cover crops received very low adoption in Dodoma-Isanga village (3.3%), in Ulaya-Kibaoni (2.8%) village, and 2.8% in Nyali village.

In Dodoma-Isanga village 50% of the sampled households were reported to be in evaluation period of crop rotation and reduced tillage practices. In Ulaya-Kibaoni village, the households who were reported to be in the evaluation period constituted 67.2% for crop rotation and 33.3% for reduced tillage. In Nyali village 25% were reported to be in evaluation period for crop rotation and cover crops respectively, 50% of the households reported to have been under crop rotation evaluation.

Majority of the households have adopted crop rotation across all the villages in the study area (Fig. 3). Crop rotation was considered to be easier to adopt. Also, farmers get a direct return through selling pigeon peas. From focused group discussions, farmers revealed that they get more yield if they plant maize in the field where pigeon peas were harvested. Similar results were reported by Makumba *et al.* (2009) and Marandu *et al.* (2013) who showed an increase in maize yield due to rotations of legumes and maize.

In general the number of households practicing reduced tillage was low compared with those doing crop rotation (Fig. 3), although through interview households indicated that they get high yield of about 2200 kg/ha if they use reduced tillage. Few households across the villages were using reduced tillage and they were not sure as to whether or not they should continue with this practice in future, though they realize high yield and improvement in the moisture content unlike in the plots for which other practices are carried out. This is probably due to the fact that using reduced tillage using small basin involve a lot of extra work including tilling the basin at the recommended dimensions, removing top soil and sub soil, and then mixing the top soil with farmyard manure. These activities should be done during the dry season, the time when households do non-farm activities; therefore it compromises with their leisure time. (Mazvimavi and Twomlow, 2009) indicated that, practices which heavily draw on farmer's leisure time may inhibit adoption. However, practices that leave time for accumulation of income from other sources may promote adoption (Bonabana-Wabbi, 2002).

Focus group discussions revealed that households with either enough family labour or who can hire labour force or buy or have farmyard manure may continue practicing reduced tillage. On the other hand, farmers who don't have these facilities had been obtaining subsidies from MJUMITA for the past two years, but the rate of adoption was limited and was expected to be so in the future due to labour demand and capital.

Few households in Fig. 5 have adopted cover crops such as cowpeas. Others don't use cover crops to avoid livestock trampling, thus they abstain from using cover crops by fearing to lose yields due to livestock trampling. These results are consistent with the findings from other studies which show that farmers reduce cover crops practice due to inability to keep pastoral livestock from foraging on their lands (Matata *et al.,* 2010; Bishop-Sambrook *et al.,* 2004; Ajayi *et al.,* 2003).

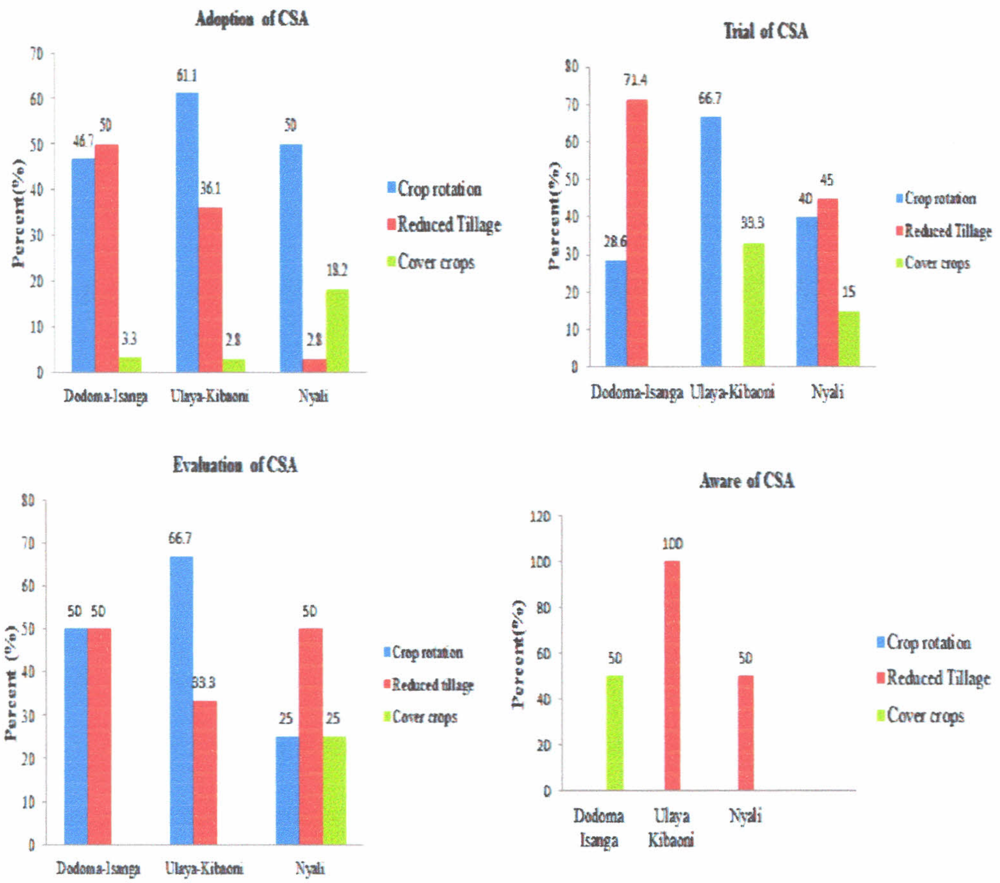

Figure 3: Extent of adoption of CSA practices in the study area

4.4 Exploratory Factor Analysis to Identify Factors Influencing Farmer's Decision to Adopt CSA Practices

A Principal Axis Factor (PAF) with an Oblimin rotation from climate smart agriculture practices was conducted on data gathered from 100 households. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy yielded an index of 0.859. The KMO measure verified the sampling adequacy for the analysis (Field, 2009).

Bartlett's test of sphericity χ^2 (136) = 849.673, ($p < 0.001$), indicated that correlations between variables were sufficiently large. This preparatory analysis confirmed that the data distribution satisfied the factor analysis to be performed. An initial analysis was run to obtain eigen-values for each component in the data. Four components had eigen-values over Kaiser's criterion of 1 and in combination explained 50.55% of the variance.

The scree plot test was used to decide the number of meaningful factors that might be in the data set. The minimum loading of an item was determined at 0.4. Four factors were extracted. The results in Table 7 show that the total variance accounted for by the four factors was 50.55%. The initial eigen-values showed that the first factor explained 38.16% of the variance, the second factor 5.15% of the variance, the third factor 3.88% of the variance and the fourth factor 3.35%. These results indicate that majority of the variance has been explained by financial and economic factors.

Table 7: Number of extracted factors, Eigen values and variances explained by each factor

Factors	Eigen-value	% of variance	% of cumulative
Financial and economic	6.487	38.160	38.160
Social	0.877	5.157	43.317
Access of Information	0.660	3.881	47.198
Environment concern	0.570	3.353	50.550

Loadings of variables on factors are reported in Table 8. Variables were ordered and grouped by size of loading to facilitate interpretation. Loadings below 0.40 were left blank. According to the extracted results, the first factor, which appeared to measure economic factors, had the highest importance in the explanatory variables. The second factor was related to "Social." The third factor was related to "informational access". The fourth factor corresponds to "Environmental concern.

The results of factor analysis in Table 8 show that six variables were loaded onto Factor 1. It is clear that all these six variables relate to financial and economic condition of a farmer. The variables loaded into this factor are; levels of price of inputs, income generation, capacity to borrow, availability of subsides, annual income of household, and level of price of output. This factor was labelled, ''Economic''.

Three variables loaded onto the second factor, which were called ''Social'' included land tenure security, education of a farmer, and family labour. Five variables load onto the third factor related to access of information on climate smart agriculture. The information on awareness of climatic change, access of climatic information, CSA demonstration plots, and access of extension services was recorded. This factor was labelled "Access of information".

Another two variables that load onto factor four related to shortage of rainfall, and poor soil fertility. This factor was labelled, "Environmental concern". From the factor analysis results, the factors influencing the adoption of climate smart agriculture practices using factor analysis among the households were therefore grouped into three main categories, namely economic and financial, environmental concern, information, and social factors.

Economic factor; the variables were highly loaded onto this factor with a loading factor of from 0.893 to 0.688. This implies that these variables exert more influence on the farmers' decision to adopt climate smart agricultural practices; a farmer will only adopt such a technology if he/she expects a high prices of the outputs, and gain income or benefit from the adoption. Availability of subsides, the capacity to borrow and annual income of the household may also influence farmers' decision to adopt the CSA because this will dictate the amount of investments to be done into such a technology.

A household, which has high annual income and has the capacity to take credits from various institutions will have the highest likelihood of adopting CSA practices.

The prevailing price of the staple crop, interest rate, the costs and level of subsidy on fertilizer, and wage rate of labour are key determinants of the relative financial attractiveness and the potential adoptability of the different soil fertility options (Ajayi *et al.,* 2007). Furthermore, household who received subsidies were likely to adopt the CSA practices such as reduced tillage which requires big manpower.In general; the higher the capacity of the household to absorb risks and finance an investment into additional activities, the greater the likelihood for the household to adopt some of these CSA practices. Similar results have been reported by (Asfaw *et al.,* 2013), (Bonabana-Wabbi, 2002), and (Mazvimavi *et al.,* 2010).

Information; Variables which are loaded onto this factor were access of extension services, awareness of climate change problems, exposure to CSA trainings, demonstration plots, and access to radio advertisements. Households that have access to information such as extension services, access to local and international news and advertisements from radio and attend to demonstration plots are more likely to adopt CSA practices because they are already exposed to information on climate change issues and have learnt to adapt to climate change and variability impacts. The higher the share of households who have received extension advice on the specific practices in the community, the higher the probability to adopt climate smart agriculture practices (Asfaw *et al.,* 2013).

Good and timely information on new technologies and techniques are essential for farmers in deciding whether or not to adopt an innovation (Asfaw *et al.,* 2013). Improving extension service both in terms of coverage and efficiency is essential in helping farmers to overcome barriers to information and adapt to climate change (Shiferaw *et al.*, 2008; Di Falco *et al.,* 2011).

Social factors; Variables loaded onto this factor were land tenure security, education level of a farmer and family labour. The household head that has a basic education can be able to learn and integrate matters and pass this information to other farmers.Also, education helps the farmer to make right decisionsabout the kinds of investments to undertake. Land tenure security on the other hand decide whether or not to undertake CSA practices.

Household head who does not possess any piece of land will not adopt these practices, because those who rent land are not allowed to undertake permanent investments in other people's farms since they only rent the land on an annual basis.Similar results have been reported by a number of studies (Deininger *et al.,* 2008a; Teklewold *et al.,* 2013) that have demonstrated that land tenure security has a significant effect on the agricultural performance of farmers. On the other hand, farming households with enough labour force are more likely to adapt to climate smart agriculture practices as opposed to households with fewer family members.

Environmental concern; the variables loaded onto this factor were shortage of rainfall and poor soil fertility with factor loading of 0.592 and 0.459. These two variables have much influence on the farmers' decision of whether or not to adopt CSA due to the fact that agricultural sector in Tanzania is dependent on rainfall availability; thus farmers search for alternative technologies which will act as in-situ rainwater harvesting so as to conserve the little moisture which is available. Households which have experienced drought in the past years are less likely to adopt soil conservation practices like organic fertilizer in the current year, instead they are more likely to adopt measures such as tree plantings and soil water conservation (Asfaw *et al.,* 2013).

Favourable rainfall outcome has a positive effect on the decisions to adopt short-term inputs such as improved seed types and the use of inorganic fertilizer whereas unfavourable rainfall outcome encourages farmers to adopt tree planting, maize-legume intercropping, the use of organic fertilizer and soil water conservation measures which in turn help in conserving soil moisture, improve soil organic matter and reduce soil loss from erosion and flooding (Asfaw *et al.,* 2013).

Table 8: Variables of each of the factors and factor loading values obtained from rotated matrix (n=100)

Factor name	Variable	Factor Loading
Economic	Levels of price of inputs	0.893
	For income generation	0.861
	Capacity to borrow	0.772
	Availability of subsides	0.754
	Levels of price of outputs	0.721
	Annual income of households	0.688
	Land tenure security	0.480
Social	Education level of a household head	0.443
	Family labour	0.403
	Access of extension services	0.757
Informational	Awareness of climate change problems	0.617
	CSA demonstration plots and trainings	0.612
	Advertisement from media	0.576
Environmental	Poor soil fertility	0.592
concern	Shortage of rainfall	0.459

4.5 Household's Knowledge and Perception on CSA

The sampled households were asked about their understanding of the concepts of CSA. Due to the fact that most of the households in the study area had received training on climate change and climate smart agriculture from MJUMITA, they therefore seem to understand some of the concepts of climate smart agriculture practices.

The results in Table 9 show that most of the farming households in Nyali and Dodoma-Isanga villages understood most of the concepts of CSA, while in Ulaya-Kibaoni few farmers seem to understand these concepts. About 35.1% of the respondents from Ulaya-Kibaoni village reported not to understand some of the concepts of CSA. This was probably due to the fact that most of them had not received any training on CSA. Further analysis indicated that farming using cover crops and reduced tillage was significantly different across villages (χ^2= 21.521, df=2, P=0.001). Knowledge on farming using crop rotation was also significantly different across villages (χ^2= 0.710, df=2, P=0.035), and households who did not understand CSA vary significantly at (χ^2= 14.259, df=2, P=0.001).

Table 9: Farmer's knowledge and understanding of CSA practices (n= 100)

Farmer's knowledge of CSA	Dodoma -Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	χ^2	df	Sig
Farming using cover crops and reduced tillage	6 (17.0)	2(5.4)	18(29.0)	21.521	2	0.001*
Using conservation agriculture	11(23.4)	5(13.5)	11(17.7)	4.425	2	0.109
Using modern agriculture technologies	6 (12.8)	2(5.4)	7(11.3)	3.815	2	0.148
Farming which does not allow shifting cultivation	6 (12.80	4(10.8)	5(8.1)	0.622	2	0.733
Mixing crops with tree(Agroforestry)	1 (2.1)	1(2.7)	1(1.6)	0.004	2	0.998
Farming using crop rotation	6 (12.8)	3(8.1)	11(17.7)	0.710	2	0.035*
Farming which increases organic matter	6 (12.8)	7 (18.9)	8 (12.9)	0.422	2	0.810
I don't know	3 (6.4)	13 (35.1)	1 (1.6)	14.259	2	0.001*

Note: Numbers in parentheses are percentages and those outside parentheses are frequencies
*= Significant at P<0.05

4.6 Food Security (Self-sufficient) and Adoption of CSA

Households were asked to indicate the quantity of food produced which would satisfy the household throughout the year. About 81% of the households indicated that the adoption of CSA has helped them to improve food security while 19% disagreed to have been any improvement. Those who admitted to have some improvement in food security as a result of CSA pointed out that selling of crops like pigeon pea, cowpea and maize has helped them to have food sufficiency and to meet other household financial requirements.

According to FAO (2010), the use of CSA practices help to tackle the multiple challenges of securing food security, mitigating and reducing the vulnerability and improvement of livelihood through diversification of income. According to Snapp *et al.* (2010), food security was improved through the use of maize, *Cajanus cajan* and groundnuts rotation. As Akinnifesi *et al.* (2008) show 94% of the farmers experienced a significant food security improvement in Malawi after adopting CSA.

4.7 Comparison of the Cost and Net returns of CSA Practices

4.7.1 Annual costs and returns of the CSA practices

The results in Table 10 show estimates of different costs and returns of the CSA practices per hectare. Crop rotation had a total cost of production per year of TZS 114 166.67/=, reduced tillage had a total cost of TZS 163 933.87/=, while cover crops had a total cost of TZS 111 425.00/=, and conventional farming had a total cost of TZS 110 416.67/=. This implies that a farmer would incur high cost if he/she decides to go for reduced tillage. This practice involved extra activities such as labour force hiring for basin preparations.

Table 10: Estimated annual costs and returns of cover crops, reduced tillage, crop rotation and conventional farming (TZS)

	Maize production			
Costs /Benefits	**Crop rotation**	**Reduced tillage**	**Cover crops**	**Conventional farming**
Costs				
Seeds	3500.00	5098.00	4207.14	4250.00
Field chemicals	12 000.00	10 681.82	8 200.00	0.00
Fertilizers	0.00	62 307.69	16 250.00	0.00
Ploughing	50 000.00	38 423.08	28 125.00	40 000.00
Basing digging	0.00	7 518.52	0.00	0.00
Planting	11 000.00	12 777.78	16 250.00	16 250.00
Weeding	26 666.67	16 571.43	25 142.86	30 250.00
Harvesting	11 000.00	10 555.56	13 250.00	19 666.67
Total costs	**114 166.67**	**163 933.87**	**111 425.00**	**110 416.67**
Benefits				
Grain yield(kg/ha)	850	1 079	1 000	343
Output price	55 000.00	50 000.00	53 000.00	50 000.00
Total revenue	**467 500.00**	**539 500.00**	**530 000.00**	**171 500.00**
Net revenue	**353 333.33**	**375 566.13**	**238 575.00**	**61 083.33**

The cost of cover crops was low did not involve much fertilizers and chemical application, but its returns were low. Farmers will only grow the kind of cover crop whose produce will be sold at the end of the season. In Kilosa District, majority of households were found growing cowpeas as a cover crop which was intercropped with maize. There were no other types of cover crops in the study area such as *Muccuna pruriens* (valvet bean) and *Lablab purpureus* (Dolichos bean) as they don't have direct benefit to farmers. Conventional farming had low production cost because do not apply fertilizers, chemical improved seeds; the only costs incurred involved hiring of labour for land preparation. However, the returns of conventional farming were lower than with other types CSA practices.

Further analysis was made to determine whether there was a significance difference in the costs of production of maize between the CSA practices. The results in Table 11 indicate that there was a significance difference F (8, 27) = 6.45735, p=0.0001 of the cost of maize production using different CSA practices.

Table 11: ANOVA test for cost of maize production using CSA practices

Source of Variation	df	F	P-value
Between Groups	8	6.457357	0.000*
Within Groups	27		
Total	**35**		

Note:*Significant at P<0.05

4.7.2 Cost benefit analysis of CSA practices

The results in Table 12 show the CBA analysis for CSA. The reduced tillage had the highest estimated NPV per hectare (TZS 2 024 585.45 /=). The BCR for this practice was 3.80. The high NPV implies the higher return per unit investment made on the reduced tillage option. Crop rotation had NPV of TZS 1 676 822.32 /= per hectare and a BCR of

4.10.The practice of cover crops had NPV of TZS 1 305 542.46/= per hectare and BCR of 4.3. Crop rotation and cover crops requires little inputs and thus they can be adopted by farmers who have no enough money. Conventional farming had TZS 940 569.92/= NPV per hectare and BCR of 3.2. This practice has a low NPV because of its return is very low. All CSA practices had positive NPVs, which means the present value of benefits exceeded the discounted present values of costs, therefore they were all technically effective. The NPV for conventional farming was low compared to other CSA practices. These results imply that, investment in crop production using climate smart agricultural practices was profitable in the long run as farmers can pay for operating costs and yet attain profits.

In deciding which practice to be put in practice by farmers, reduced tillage using small basins should be considered, followed by crop rotation and lastly cover crops. The results are consistent with the results of other studies carried out in Zambia which showed that nitrogen-fixing soil fertility technologies are more profitable than the farmers' practices of continuous maize production without external fertility inputs, but it is less profitable than the use of subsidized fertilizer (Franzel, 2004). The results also are in line with those from a study by Mishra *et al.* (2014) on the cost benefit analysis on indigenous soil and water conservation practices; the authors found out that all practices had positive NPVs. However, CBA cannot be the only indicator used by decision makers when selecting the best CSA practices (Zhou *et al.,* 2009). This is due to the fact that in the previous findings of this study it appears that the cost of reduced tillage was a big limiting factor for adoption.

Table 12: Present values, NPV and BCR of different CSA practices (TZS)

CSA type	Present values			BCR
	Benefits	Costs	NPV/ha	
Reduced tillage	2 800 346.98	776 310.84	2 024 585.45	3.80
Crop rotation	2 217 459.96	540 637.64	1 676 822.32	4.10
Cover crops	2 075626.75	519 145.17	1 556 481.58	4.3
Conventional farming	1 690 972.49	522 879.47	1 168 093.02	3.2

4.8 Sensitivity Analysis

The sensitivity analysis was carried out to test the changes in NPVs as a result of changes in market prices for inputs. Sensitivity analysis was therefore made for the increase in production cost and increase in discount rate. Results in Table 13 show that, even with higher discount rate and prices of inputs increased by (20%), all CSA practices were still economically viable.

Table 13: Sensitivity analysis for 20% increase in production costs

CSA Practices	NPV (TZS) when		
	r=5%	r=10%	r=15%
Reduced tillage	1 561 227.41	1 296 996.00	1 121 079.79
Cover crops	1 131 911.53	985 043.42	880 242.07
Crop rotation	824 453.34	715 828.22	638 316.10

4.9 Constraints Associated with the Adoption of CSA Practices

The constraints confronting farming households in adopting climate smart agriculture practices in Kilosa are presented in Table 14. Households were required to identify the constraints from the list provided. Drought, and erratic rainfall, pests and diseases, were the major constraints identified by majority of households in all the villages in the study area. Other constraints in the ascending order include lack of capital, lack of labour force, and high costs of inputs. These results conform to the findings, which were reported by Kasirye (2013).

Table 14: Distribution of households according to the associated constraints in adoption of CSA practices (n=100)

Constraints	Dodoma-Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	Total (n=100)
Shortage of land for crop production	6(2.2)	4(1.4)	3(1.4)	13(1.7)
Lack of capital	16(5.8)	20(7.2)	20(9.1)	56(7.2)
High cost of inputs	21(7.6)	18(6.5)	22(10.0)	61(7.9)
Lack of labour force	25(9.1)	22(7.9)	20(9.1)	67(8.7)
Non availability of credit/capital	17(6.2)	21(7.5)	15(6.8)	53(6.8)
Low product prices	20(7.2)	23(8.2)	14(6.4)	57(7.4)
Pest and diseases	23(8.3)	33(11.8)	23(10.5)	79(10.2)
Lack of CSA knowledge	18(6.5)	17(6.1)	15(6.8)	50(6.5)
Erratic rainfall	27(9.8)	30(10.8)	25(11.4)	82(10.6)
Availability of family labour	24(8.7)	22(7.9)	19(8.7)	65(8.4)
Droughts	28(10.1)	33(11.8)	23(10.5)	84(10.9)
Lack of markets	21(7.6)	18(6.5)	10(4.6)	49(6.3)
Disruption of livestock	13(4.7)	9(3.2)	5(2.3)	27(3.5)
Presence of farmers-livestock keepers conflicts	17(6.2)	9(3.2)	5(2.3)	31(4.0)

Note: Numbers in parentheses are percentages and those outside parentheses are frequencies

The wide spread of CSA is very much constrained by lack of information and knowledge flow (Ajayi *et al.*, 2007; Franzel *et al.*, 2004) particularly information on the type of CSA options, and which suit particular agro-ecological conditions. Lack of information will lead to the adoption of CSA options which are expensive and unsuitable to a particular locality.

Also the adoption of CSA may be perceived as a risky investment because the initial investment is high and farmers are not ensured with credits access as well as a market for their produce (Kabwe *et al.*, 2009). The costs and benefits of a particular CSA option also determine the adoptions which in turn are influenced by the ability of the producers to access input supply and output market chain.

4.10 Benefits Accrued by Households as the Results of Adoption of CSA

The results in Table 15 show the benefits of adopting CSA practices as identified by households. Reduced soil erosion, increased soil organic matter, improved yield and reduced soil loss were the key benefits identified by majority of the households in all the villages. The use of cover crops helps to reduce compaction of the soil, conserve moisture, reduce soil erosion, reduce labour, particularly hand weeding, and is assumed to increase Nitrogen in the soil (Owenya *et al.,* 2011).

Cover crops and improved fallows can increase soil carbon particularly when combined with zero or minimum tillage thus improving soil carbon sequestration (Govaerts *et al.,* 2009). The challenges in using cover crops is when the cover crops cannot be used as food crop or if they have no any other uses, they provide less incentive for adoption (Scherr *et al.,* 2012). From their study, Marandu *et al.* (2013) indicated that legumes fixed 50% of their total N requirement which was equal to 14.5 kgN/ha.

Crop rotation increases organic matter in the soil, improves soil structure, reduces soil degradation, and can result in higher yields and greater farm profitability in the long-term (Makumba *et al.,* 2009; McCarthy*et al.,* 2011). In their study, Marandu *et al.* (2013) reported that, crop yield under regime rotation were significantly higher, especially for copy-maize rotation and pigeon pea-maize rotation at 660 kg/ha and 642 kg/ha respectively. Furthermore, their results show that the effects of the legume rotation on maize grain yield were estimated using the maize grain yield response curve and which were 25 kgN/ha for cowpea, 19 kgN/ha for the pigeon pea and 16 kgN/ha for green gram rotation.

Table 15: Distribution of benefits accrued by households as the results of adoption of CSA (n=100)

Benefits	Dodoma-Isanga (n=33)	Ulaya-Kibaoni (n=35)	Nyali (n=32)	Total (n=100)
Reduced soil erosion	22 (66.7)	22 (62.9)	19 (59.4)	25(6.8)
Increase organic matter	31 (93.9)	27 (77.1)	30 (93.8)	62(16.9)
Improve yields	32 (97.0)	28 (80.0)	27 (84.4)	51(13.9)
Save time	24 (72.7)	25 (71.4)	24 (75.0)	28(7.6)
Increase moisture	28 (84.8)	26 (74.3)	28 (87.5)	45(12.3)
Reduce input cost	26 (78.8)	24 (68.6)	28 (87.5)	39(10.6)
Reduce soil loss	26 (78.8)	26 (74.3)	27 (84.4)	47(12.8)
Provide favourable climate	27 (81.8)	25 (71.4)	23 (71.9)	32(8.7)
Increase folder availability	26 (78.8)	23 (65.7)	19 (59.4)	25(6.8)
Increase fuel wood	10 (30.3)	7 (20.0)	17 (53.1)	13(3.5)

Note: Numbers in parentheses are percentages and those outside parentheses are frequencies

Reduced erosion, improved soil structure, and greater water retention, reduce yield variability due to weather events in general. Conservation tillage practices can increase farm system resilience and improve the capacity of farmers to adapt to climate change (Blanco and Lal, 2008). The increased soil organic matter enhances soil fertility and quality, improves water-holding capacity and increases productivity and resilience (Lal, 2006).

In particular, climate smart agriculture practices such as crop rotation, reduced tillage and cover crops can reduce the negative effects of drought while increasing productivity (Niggli *et al.,* 2009). Thus, farmers who use climate smart agriculture practices suffer less climate change impacts as opposed to those who use conventional farming.

4.11 Farmer's livelihood Improvement as the Results of Adoption of CSA

Households were asked whether the adoption of CSA practices has contributed to the improvement of their livelihood. The results in Fig.4shows that 25.7% of the sampled households reported to have realised improvement in terms of food security, 18.5% reported to have been able to build houses and 11.2% were able to pay for school fees while 8.6% were able to afford medical expenses. Other improvements reported by households included an increase in income, ability to start small business, and ability to purchase motorcycles. Furthermore, 5.9% of the households reported to have not realised any improvement. These results imply that households that adopt CSA practices have improved their livelihood and food security due to the improved yields.

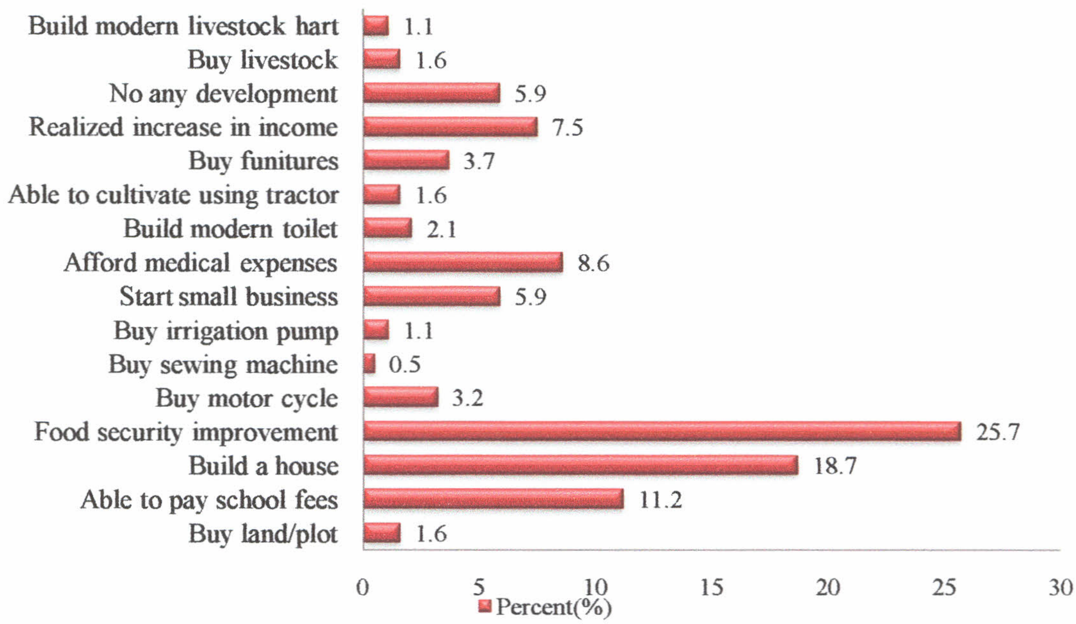

Figure 4: Farmer's livelihood improvements due to adoption of CSA practices

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

From the study three types of climate smart agriculture practices were in Kilosa District. The results show that crop rotation is the widely practiced CSA type by many households in all the three villages. This was followed by reduced tillage. Cover crops were reported to be lowly adopted by few households in Ulaya-Kibaoni, Nyali, and Dodoma-Isanga village respectively.

The CBA carried out for different kinds of CSA practices shows that all CSA practices have positive NPV and thus they were all economically profitable. Both reduced tillage using small basins and crop rotation was found to be more costly to establish than cover crops but they had higher long-term financial returns. It was also observed that CSA practices not only considered soil and water conservation measure and climate change impact mitigation, but also acted as a subsidiary source of income and increased crop yields.

The factors that influence the adoption of climate smart agriculture practices were broadly categorized into economic factors, social factors, informational factors and environmental concerns. All these factors were found to significantly influence farmer's decisions on whether or not to adopt climate smart agricultural practices.

5.2 Recommendations

Based on the previous conclusions, the study recommends the following:

i. Awareness creation through training on CSA: As it is well known that CSA involves a wide range of practices and thus farmers need to be trained in practices which suit their ecological zones. This can be done by researchers, NGOs, and other practitioners involved in the agricultural developments.

ii. Most CSA practices require high investment costs so in order to overcome the cost barriers, households need to be assisted with, funds as well as credits and means of obtaining those credits, and also the government should subsidize agriculture inputs.

iii. Households must be linked to markets for agricultural products as any farmer will not adopt any practice which does not bring about direct benefits.

REFERENCES

Acosta, S. I. C. (2009). Promoting the use of tropical legumes as cover crops in Puerto Rico. Dissertation for Award of MSc Degree at University of Puerto Rico, USA. 78pp.

Adegbola, P. and Gardebroek, C. (2007). The effect of information sources on technology adoption and modification decisions *Agricultural Economics* 37(1): 55 – 65.

Ajayi, O. C. (2007). User acceptability of soil fertility management technologies: Lessons from farmers' knowledge, attitude and practices in southern Africa. *Journal of Sustainable Agriculture* 30(3): 21–40.

Ajayi, O. C., Akinnifesi, F. K., Sileshi, G. and Chakeredza, S. (2007). Adoption of renewable soil fertility replenishment technologies in the southern African region: Lessons learnt and the way forward. *Natural Resources Forum* 31(4): 306 – 317.

Ajzen, I. and Fishbein, M. (1980).*Understanding Attitudes and Predicting Social Behavior*. Prentice Hall Publisher, Washington DC. 700pp.

Akinnifesi, F., Chirwa, P., Ajayi, O., Sileshi, G., Matakala, P., Kwesiga, F., Harawa, H. and Makumba, W. (2008) 'Contributions of agroforestry research to livelihood of smallholder farmers in southern Africa: Taking stock of the adaptation, adoption and impact of fertilizer tree options. *Agricultural Journal* 3: 58 – 75.

Asfaw, S., McCarty, N., Lipper, L., Arslan, A. and Cattaneo, A. (2013). Adaptation to climate change and food security: Micro-evidence from Malawi. [http://ageconsearch.umn.edu/bitstream/161646/2/Solomon%20Asfaw,%20Nancy%20McCarty,%20Les lie % 20Lipper.] site visited on 12/04/2013.

Baruani, B. I. and Senzia, D. A. (2013). Study to generate recommendations on how District Agricultural Development Plans can address climate change adaptation and mitigation in relation to small-scale farmers the case of kilosa and chamwino districts.[http://www.tfcg.org/pdf/DADPs%2520and%2520Climate%2520Change%2520in%2520Tanzania%25202013.p] site visited on 18/02/2014.

Barungi, M., Ng'ong'ola, D. H., Edriss, A., Mugisha, J., Waithaka, M. and Tukahirwa, J. (2013). Factors influencing the adoption of soil erosion control technologies by farmers along the slopes of Mt. Elgon in Eastern Uganda. *Journal of Sustainable Development* 6(2): 213 – 220.

Baudron, F., Mwanza, H. M., Triomphe, B. and Bwalya, M. (2007). *Conservation Agriculture in Zambia: A Case Study of Southern Province. African Conservation Tillage Network.* Food and Agriculture Organization, Rome, Italy. 57pp.

Bishop-Sambrook, C., Kienzle, J., Mariki, W., Owenya, M. and Ribeiro, F. (2004). *Conservation Agriculture As A Labour-Saving Practice for Vulnerable Households: A Study of The Suitability of Reduces Tillage and Cover Crops for Households Under Labour Stress In Babati and Karatu Districts, Northern Tanzania*. International Fund for Agricultural Development Rome, Italy. 80pp.

Blanco, H. and Lal, R. (2008). *Principles of Soil Conservation and Management.* Springer Publisher, London. 256pp.

Bonabana-Wabbi, J. (2002). Assessing factors affecting adoption of agricultural technologies: The case of integrated pest management in Kumi district, Eastern Uganda. Dissertation for Award of MSc Degree at Virginia Polytechnic Institute, State University, 146pp.

Chiputwa, B., Langyintuo, A. S. and Wall, P. (2011). Adoption of conservation agriculture technologies by smallholder farmers in the Shamva District of Zimbabwe: A Tobit application. In: *Annual Meeting of the Southern Agricultural Economics Association*, 5 – 8February 2011,Texas , USA. 28pp.

Conant, R. T. (2009). *Rebuilding Resilience: Sustainable Land Management for Climate Mitigation and Adaptation.* Technical report on land and climate change for the natural resources management and environment department. Food and Agriculture Organization, Rome, Italy. 33pp.

Cooper, .P. J. M. and Coe, R. (2011). Assessing and addressing climate induced risk in sub-Saharan rain fed agriculture. *Experimental Agriculture* 47(2): 179–184.

Cooper, P. J. M., Dimes, J., Rao, K. P. C., Shapiro, B., Shiferaw, B. and Twomlow, S. (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change? *Agriculture Ecosystems and Environment* 126: 24 – 35.

Deininger, K., Ali, D. A., Holden, S. and Zevenbergen, J. (2008a). Rural land certification in Ethiopia: Process, initial impact, and implications for other African countries. *World Development* 36(10): 1786 – 812.

Derpsch, R. and Friedrich, T. (2009a). Global overview of conservation agriculture adoption. *Proceedings Lead Paper 4thWorld Congress on Conservation Agriculture* New 4 – 7 February 2009. New Delhi, India. pp. 1 – 9.

Di Falco, S., Veronesi, M. and Yesuf, M. (2011). Does adaptation to climate change provide food security? A micro perspective from Ethiopia. *American Journal of Agricultural Economics* 93(3): 829 – 846.

Doss, C. R. (2006). Analysing technology adoption using microstudies: Limitations, challenges, and opportunities for improvement. *Agricultural Economics* 34: 207 – 219.

Ellis, F. and Mdoe, N. (2003).Rural livelihoods and poverty reduction in Tanzania. *World Development* 31(8): 1367 – 1384.

FAO (2001). *The Economics of Conservation Agriculture.* Food and Agriculture Organization, Rome, Italy. 74pp.

FAO (2011). Climate smartagriculture.[http://www.fao.org/climatechange/climatesmartpub/en/]site visited on 13/2/ 2013.

FAO(2010). *Climate-Smart Agriculture: Policies Practices and Financing for Food Security, Adaptation and Mitigation*. Food and Agriculture Organization, Rome, Italy. 49pp.

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

Field, A. (2009). *Discovering Statistics Using Spss*. SAGE Publications Ltd., London. 857pp.

Fishbein, M. and Ajzen, I. (1975). *Belief, Attitude, Intention and Behaviour:* Introduction to Theory and Research, Reading MA, Addison Wesley. 573pp.

Franzel, S. (2004). Financial analysis of agroforestry practices. In: *Valuing Agroforestry Systems*. (Edited by Alavalapati, J. R. R. and Mercer, D. E.), Kluwer Academic Publishers, Netherlands. pp. 9 – 37.

Giller, K. E., Witter, E., Corbeels, M. and Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics'view. *Field Crops Research* 114: 23 – 34.

Govaerts, B., Fuentes, M., Mezzalama, J. M., Nicol, J., Deckers, J. D., Etchevers, B., Figueroa, S. and Sayre, K. D. (2007).Infiltration, soil moisture, roots rot and nematode populations after 12 years of different tillage, residue and crop rotation managements. *Soil and Tillage Research* 94(1): 209 – 219.

Grabowski, P. P. (2011). Constraints to adoption of conservation agriculture in the angonia highlands of Mozambique: Perspectives from smallholder hand-hoe farmers. Dissertation for Award of MSc Degree of Michigan State University, USA, 112pp.

Green, I. F. R. (2005). The emancipatory potential of a new information system and its effect on technology acceptance. Dissertation for award of MSc Degree University of Pretoria, South Africa, 99pp.

Gregor, S., Jones, K. and Hausman, A. (1999). Beef producers online: Diffusion theory applied. *Information Technology and People* 12(1): 71 – 85.

Haggblade, S. and Tembo, G. (2003b). Conservation farming in Zambia. *Paper Presented at the In Went, International Food Policy Research Institute, The New Partnership for Africa's Development.* 1 – 3 December, Pretoria, South Africa. pp. 1 – 128.

Harrison, M. (2010). *Valuing the Future: The Social Discount Rate in Cost-Benefit Analysis Visiting Research Paper.* Productivity Commission, Melbourne. 192pp.

Hine, R., Peacock, J. and Pretty, J. (2008). Care farming in the UK: Contexts, benefits and links with therapeutic communities. *International Journal of Therapeutic Communities* 29(3): 245 – 260.

Kabwe, G., Bigsby, H. R. and Cullen, R. (2009).Factors influencing adoption of agroforestry among smallholder farmers in Zambia. [http://researcharc hive.linc oln.ac.nz/handle/ 10182/3425]site visited on 21/3/014.

Kaczan, D., Arslan, A. and Lipper, L. (2013). Climate smart agriculture? A review of current practice of agroforestry and conservation agriculture in Malawi andZambia. [http://www.fao.org/docrep/019/ar715e/ar715e] site visited on 23/06/2014.

Kaine, G. (2004). *Consumer Behaviour as a Theory of Innovation Adoption in Agriculture Social Research Team.* Agriculture Research, Hamilton, New Zealand. 26pp.

Kasirye, I. (2013). Constraints to agricultural technology adoption in Uganda: Evidence from the 2005/06-2009/10 Uganda National Panel Survey. *African Journal of Agricultural and Resource Economics* 8(2): 90–107.

Kaumbutho, P. and Kienzel, J. (2007).*Conservation Agriculture as Practised in Kenya*: African Conservation Tillage Network, Nairobi, Kenya. 150pp.

Khatua, S. (2011). *Project Management and Appraisal.* Oxford University Press. India. 586pp.

Klytchnikova, I. (2008). Conservation tillage promises more profitable and sustainable farms. *Development Outreach* 10(3): 41 – 43.

Knowler, D. and Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy* 32(1): 25 – 48.

Lal, R. (2006). Enhancing crop Yield in developing countries through restoration of soil organic carbon pool in agricultural lands. *Land Degradation and Development* 17: 197 – 209.

Langyintuo, A. S. and Mekuria, M. (2005). Modeling agricultural technology adoption using the software STATA. *Presented at a Training Course, Econometric Application to Modelling the Adoption of Agricultural Technologies*, 21 – 25 February, 2005, Harare, Zimbabwe. pp. 1 – 28.

Lee, H. C., Walker, R., Haneklaus, S., Philips, L., Rahmann, G. and Schnug, E. (2008). Organic farming in Europe: A potential major contribution to food security in a scenario of climate change and fossil fuel depletion. *Land bauforschung Volkenrode* 58(3): 145 – 151.

Lobell, D. B., Schlenker, W. and Costa-Roberts, J. (2011). Climate trends and global crop production since 1980.*Science* 333(6042): 616 – 620.

Mafakheri, S., Ardakani, M. R., Meighani, F., Mirhadi, M. J.and Vazan, S. (2010). Rye cover crop management affects weeds and yield of corn (Zea mays L.). *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* 38(3): 117 – 123.

MAFC (2002). *Study on the Horticulture Development in Tanzania.* Ministry of Agriculture Food Security and Cooperative, Dar es Salaam, Tanzania. 86pp.

Makumba, W., Akinnifesi, F. K. and Janssen, B. H. (2009). Spatial rooting patterns of gliricidia , pigeon pea and maize intercrops and effect on profile soil N and P distribution in southern Malawi. *African Journal of Agricultural Research* 4(4): 278 –288.

Mann, W. and Change, C. (2012). Climate smart agriculture at country level: Lessons from recent experience. *Meridian Institute Workshop on Climate Change and Agriculture*, 22– 23 October 2012, Rome, Itally. 15pp.

Marandu, A. E., Semu, E., Mrema, J. P. and Nyaki, A. S. (2013). Contribution of legume rotation to the nitrogen requirements of a subsequent maize crop on a rhodic ferralsol in Tanga, Tanzania. *Tanzania Journal of Agricultural Science* 12(1): 23 – 29.

Mary, A. L. and Majule, A. E. (2009). Impacts of climate change, variability and adaptation strategies on agriculture in semi-arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology* 3(8): 206 – 218.

Matata, P. Z., Ajayi, O. C., Oduol, P. A. and Agumya, A. (2010). Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania. *African Journal of Agricultural Research* 5(8): 818 – 823.

Mazvimavi, K. and Twomlow, S. (2009). Socio-economic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural Systems* 101: 20 – 29.

Mazvimavi, K., Ndlovu, P. V., Nyathi, P. and Minde, I. J. (2010). Conservation agriculture practices and adoption by smallholder farmers in Zimbabwe. In: *Poster Presented at 3rd African Association of Agricultural Economists Conference*. September 2010, Cape Town, South Africa. pp. 19 – 23.

Mboera, L. E. G., Mayala, B. K., Kweka, E. J. and Mazigo, H. D. (2011). Impact of climate change on human health and health systems in Tanzania. A review. *Tanzania Journal of Health Research*13: 1 – 23.

Mccarthy, N., Lipper, L. and Branca, G. (2011). *Climate Smart Agriculture: Smallholder Adoption and Implications for Climate Change Adaptation and Mitigation.* Working Paper No. 4. Mitigation of Climate Change in Agriculture, Rome, Italy. 33pp.

Mishra, P. K. and Rai, S. C. (2014). A Cost–Benefit Analysis of Indigenous Soil and Water Conservation Measures in Sikkim Himalaya, India. *Mountain Research and Development* 34(1): 27 – 35.

Mohler, C. L. and Johnson, S. E. (2009). *Crop Rotation on Organic Farms A Planning Manual.* Natural Resource, Agriculture and Engineering Service, New York. 164pp.

Mung'ong'o, C. and Mwamfupe, D. (2003). *Poverty and Changing Livelihoods of Migrant Maasai Pastoralists in Morogoro and Kilosa Districts.* Mkuki na Nyota Publishers, Dar es Salaam, Tanzania. 49pp.

Nambiza, W. (2013). Baseline study for the climate change agriculture and poverty alleviation initiative. [http://www.tfcg.org/pdf/TFCG%2520CCAP%2520Base lin e%2520Survey%2520Report%25202013%2520FINAL]. site visited on 12/05/2013.

NBS (2012). *National Sample Census of Agriculture 2007/08.* Regional Report No. 5. Morogoro, Tanzania. 335pp.

Negash, R. (2007). Determinants of adoption of improved haricot bean production package in alaba special woreda, Southern Ethiopia. Dissertation for Award of MSc Degree at Haramaya University, Dire Dawa, Ethiopia, 154pp.

Nelson, G. C., Rosegrant, M. W., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., Tokgoz, S., Zhu, T., Sulser, T. B., Ringler, C., Msangi, S. and You, L. (2010). *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options.* International Food Policy Research Institute, Washington DC, USA. 30pp.

Niggli, U., Fliebach, A., Hepperly, P. and Scialabba, N. (2009). *Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems.* Food and Agriculture Organization, Rome, Italy. 26pp.

Owenya, M. Z., Mariki, W. L., Kienzle, J., Friedrich, T. and Kassam, A. (2011). Conservation agriculture in Tanzania: The case of the Mwangaza BCA farmer field school, Rhotia Village, Karatu District, Arusha. *International Journal of Agricultural Sustainability* 9(1): 145 – 152.

Pandey, V. L. and Mishra, V. (2004). Adoption of zero tillage farming: Evidences from Haryana and Bihar. [http://ssrn.com/abstract=529222]site visited on 2/10/2013.

Panneerselvam, R. (2012). *Research Methodology.* PHI Learning Private Limited, New Delhi, India. 639pp.

Parminter, T. (2011). Pathways for innovations: Influence of industry structures and producer social networks. *Journal of Extension Farming System* 7(1): 1 – 10.

Pearce, D. W., Atikinson, G. and Mourato, S. (2006). *Cost-benefit Analysis and the Environment Recent Development.* Organisation for Economic Co-operation and Development, Paris. 314pp.

Reed, B., Chan-Halbrendt, C., Halbrendt, J., Lai, C., Radovich, T. and Timbu, P. (2012). Economic analysis of farm labor and profitability of three tribal villages in Nepal. *Presentation, 22nd Annual International Food and Agribusiness Management Association World Forum and Symposium,* Shanghai, China, 11 – 14 June, 2012. 10pp.

Rogers, E. M. (2003). *Diffusion of Innovations.* (5th Ed.), Free Press, New York. 576pp.

Rowhani, P., Lobell, D. B., Linderman, M. and Ramankutty, N. (2011). Agricultural and forest meteorology climate variability and crop production in Tanzania. *Agricultural and Forest Meteorology* 151(4): 449 – 460.

Tarimo, F. R., Munga, J. J., Tumbo, S. D., Mapulila, T. and Rwehumbiza, F. B. (2005). *Model as a Tool for Studying Farming and Conservation Measures in High Slope Areas*: A Case Study of Vidunda Village in Kilosa District. Kilosa, Morogoro, Tanzania. 12pp.

Scherr, S. J., Shames, S. and Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture and Food Security* 1(1): 1 – 12.

Senkondo, E. M. M., Msangi, A. S. K., Xavery, P., Lazaro, E. A. and Hatibu, N. (2004). Profitability of rainwater harvesting for agricultural production in selected semi-arid areas of Tanzania. *Journal of Applied Irrigation Science* 39(1): 65 – 81.

Shames, S., Friedman, R. and Havemann, T. (2012). *Coordinating Finance for Climate Smart Agriculture.* Ecoagriculture Discussion Paper No. 9. Ecoagriculture Partners, Washington DC. 29pp.

Shiferaw, B., Kebede, T. A. and You, L. (2008). Technology adoption under seed accessconstraints and the economic impacts of improved pigeonpea varieties in Tanzania. *Agricultural Economics* 39(3): 309 – 323.

Snapp, S., Blackie, M., Gilbert, R., Bezner-Kerr, R. and Kanyama-Phirie, G. (2010). Biodiversity can support a greener revolution in Africa. *National Academy of Sciences* 107(48): 20840 – 20845.

Stern, N. (2008). The economics of climate change. *American Economic Review* 98: 1 – 37.

Teklewold, H., Kassie, M. and Shiferaw, B. (2013). Adoption of multiple sustainable agricultural practices in rural Ethiopia: Adoption of multiple sustainable agricultural practices. *Journal of Agricultural Economics* 64(3): 597 – 623.

Twomlow, S. J., Urolov, J. C., Jenrich, M. andOldrieve, B. (2008). Lessons from the field–Zimbabwe's conservation agriculture task force. *Journal of SAT Agricultural Research* 6(1): 1 – 11.

Tongeren, F., Beghin, J. and Marette, S. (2009). *A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade*. Working Papers No. 21. Organization for Economic Co-operation and Development Publishing, Paris.72pp.

Uaiene, R. N., Arndt, C. and Masters, W. A. (2009). Determinants of agricultural technology adoption in Mozambique. [http://196.46.4.208/gest/documents/67E_AgTechAdo ptionMoz] site visited on 21/04/2013.

Urassa, J. K. and Johannes, R. (2013). The role of agro-dealers in influencing farmers' use of agricultural inputs. *Journal of Continuing Education and Extension* 4(1): 145 – 163.

Wandel, J. and Smithers, J. (2000). Factors affecting the adoption of conservation tillage on clay soils in South Western Ontario, Canada. *American Journal of Alternative Agriculture* 15(4): 181 – 188.

Wollenberg, E., Higman, S., Seeberg-Elverfeldt, C., Neely, C., Tapio-Biström, M. L. and Neufeldt, H. (2012). *Helping Smallholder Farmers Mitigate Climate Change.* Policy Brief No. 5. Research Program on Climate Change and Agriculture and Food Security, Copenhagen, Denmark. 8pp.

Woodhall, M. (2004). *Cost-benefit analysis in educational planning.* (4th Edition.). United Nations Educational, Scientific and Cultural Organization, Paris. 133pp.

World Bank (2008). *World Development Report, Agriculture for Development.* The World Bank, Washington DC. 32pp.

Yamane, T. (1967).*Statistics: An Introductory Analysis.* (2nd Ed.), Harper and Row, New York. 919pp.

Zhou, X., Helmers, M. J., Al-Kaisi, M. and Hanna, H. M. (2009). Cost-effectiveness and cost-benefit analysis of conservation management practices for sediment reduction in an Iowa agricultural watershed. *Journal of Soil and Water Conservation* 64(5): 314 – 323.

APPENDECIES

Appendix 1: Questionnaires for adoption of CSA practices

Questionnaire number………………….. Date of interview…………………

A: Site identification and Farmer's characteristics

Ward...................................

Village.................................

1.1 Name of respondent……………………………………(optional)

1.2 Sex of respondent **Tick (√)** 1. Female 2. Male

1.3 Age of respondent ………………..Years

1.4 Marital status of respondent. **Tick (√) one**1.Married 2. Never married 3. Widowed 4. Divorced 5. Separated

1.5 Highest level of education reached. **Tick (√) one**1. Illiterate 2. Adult education 3. Primary 4. Secondary 5. Tertiary education

1.6 Number of years a farmer has lived in the village…………………..

1.7 Main occupation of respondent. **Tick (√) one**1. Crop Farming 2. Livestock Keeping3. Other.. (Specify……………………………)

1.8 Other secondary occupation apart from main occupation…………………………

1.9 Total size of the household.......................

1.10 How many members are there in your household who assists in agricultural production: Female.................. Male......................

1.11 Major sources of income **Tick(√) one**1. Farming 2. Employment 3. Business 4. Others..specify(…………………………..…..)

1.12 What is your gross yearly income for your household...

B: **Identification and assessment of climate-smart small scale agriculture practices in the study area**

2.1 Does your household own land for agriculture?...........YES/NO

2.2 If the answer in question 1.1 is YES, what is the size (in acres) of it ....acres

2.3If NO how did you obtain land for agriculture?

a) Rented................(YES/NO) b) Borrowed............(YES/NO)

2.4 Indicate the total size of land (in acres) you use for the following

a) Crop production............b) Livestock keeping.............

d) Homestead............

d) Other uses........specify the type of use...

2.5 What do you understand about climate smart agriculture..

2.6 Indicate by choosing one option to show the extent of adoption of CSA practices

Aware (Have heard about but know few details)=1,	**Interest** (Know details but have not considered using)=2	**Evaluation** (considered using, but have made no decision)=3;	**Trial** (Have definitely decided to use)= 4;	**Adoption** (Have already been using in my farm)=5;	**Rejection** (Have definitely decided not to use)=6

2.7 Experience (years) in practicing CSA..................

2.8 Types of climate smart agriculture practices farmers has adopted

Type of CSA	Year adopted	Season	Crops grown	Yield (Kg)	Year discontinued

2.9 What is the trend of production from **CSA** practises adopted? (Choose One Option)

a) Increased b) Constant ....c) Decreased

3.0 Is there any improvement in terms of food security and income in your household ever since you adopted CSA? **YES/NO**

1.0 If YES mention the improvements

a) ....

b) ....

c) ....

2.0 **Select the most constraints that hinders you from adopting CSA practises**

1. Shortage of land for crop production	( )
2. High cost of inputs	( )
3. Lack of labour force	( )
4. Non availability of Credit/capital	( )
5. Low product prices	( )
6. Pest and Diseases	( )
7. Lack of CSA knowledge	( )
8. Shortage of rainfall	( )
9. Poor soil fertility	( )
10 Droughts	( )
11. Presence of farmers- livestock conflicts	( )
12. Soil erosion	( )
13. Lack of market access for agricultural produce	( )
14. Others (specify)	( )
15. Availability of tree seeds	( )

C: Factors influencing farmer's decision of adopting CSA practises.

4.0 The table below shows the factors assumed to influence the decision of farmers to adopt CSA practises. Indicate by putting a tick SD = Strongly Disagree, DA = Disagree, UN =Undecided, A = Agree, SA = Strongly Agree

	Factor	SD	DA	UN	A	SA
1	Age of a farmer					
2	Education level of a farmer					
3	Land tenure security					
4	Availability of subsides					
5	Capacity to borrow					
6	Level of price of inputs					
7	Level of price of output					
8	Availability of land					
10	CSA demonstration plots					
11	Access of information climatic information					
12	Access to extension services					
13	Advertisement from radios and Television					
14	Availability of subsides					
15	Soil erosion					
16	Low investment costs					
17	Annual income of the household					
18	Local rules and norms					
19	Awareness of climate change/variability problems					

1.0 Do you access market.........YES/NO

2.0 What type of market...

3.0 Problems associated with market access

a) ....

b) ....

c) ....

4.0 Did you access credit for agricultural development for the last cropping season….YES/NO?

If yes what was the purpose of borrowing.	**If no why you think you did not get credit. (Tick one)**
a) .... b) .... c) .... d)	a) Borrowing is risky ( ) b) Interest rate is too high ( ) c) Too much paperwork ( ) d) Does not know application procedures e) No lenders in this area for this purpose ( ) f) Lenders do not provide the amount needed ( )

D: Comparability of the profitability of the best selected climate-smart agriculture in small holder farmers

Checklist for cost of different climate smart agricultural practises for the year 2010/2011/2012

CSA TYPE	**Fertilizer CAN/NPK/UREA/other**		**Seed /seedlings**		**Field pest chemical**		**Hiring oxen/tractor**	**Labour force**									
	Kg	Price (TZS/Kg)	Amount (kg)	Price (TZS/kg)	Litres/Kg	Price (TZS/litre/Kg)		Ploughing, harrowing and planting	Weeding /pruning	Mulching	Harvesting	Total family labour	Total amount paid for labour (TZS	**Total cost**	**Yield(kg)**	**Output price**	**Total revenue**
1																	
2																	
3																	
4																	

CODES: 1 Crop rotation 2 cover crops 3.Reduced tillage 4 Agroforestry 5. Conventional farming

5.0 The table below shows the assumed benefits accrued as the results of adopting climate smart agriculture practises. Tick one

SD = Strongly Disagree, DA = Disagree, UN =Undecided, A = Agree, SA = Strongly Agree

	Item	**SD**	**DA**	**UN**	**A**	**SA**
1	Reduce soil erosion					
2	Increase organic matter					
3	Improves yields					
4	Save time and labour requirements					
5	Increases soil moisture					
6	Reduce overall input costs					
7	Reduce soil loss					
8	Provide favourable climate					
10	Increase in fodder availability					
11	Increase in fuel wood					

1.0 In your opinion what do you think should be done so as to improve the adoption CSA practises in your area?

a) ……………………………………

b) ……………………………………………

c) ……………………………………………

Appendix 2: Checklists for Focus Group discussion

1.0 Whom do you regard as the high income earner, middle income earner, or low income earner in the village?

Income category	**Categorical criteria**
Rich	
Average	
Poor	

2.0 What is the primary occupation of most people this village.............................

3.0 Farmers awareness and understanding of CSA practices.........................

4.0 Since when were the CSA practices introduced in your area..........................

5.0 Who introduced the CSA...

6.0 What are the most practised CSA practised in this village

a) ....

b) ....

c) ....

7.0 Do you think CSA practises are adopted by many farmers in your area........................

8.0 Has your maize yield increased ever since you adopted CSA practices?

9.0 Are CSA practises more profitable compared with conventional farming.....................

10.0 Do you think CSA practises have mitigated the impacts of climate change and variability in your area.................................

11.0 Mention the benefits of CSA

a) ....

b) ....

c) ....

11. What do you think should be done to increase the adoption of climate smart agriculture practises......................................

Appendix 3: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.869	40.406	40.406	6.487	38.160	38.160	6.174
2	1.481	8.713	49.119	0.877	5.157	43.317	1.127
3	1.238	7.282	56.401	0.660	3.881	47.198	3.251
4	1.146	6.742	63.142	0.570	3.353	50.550	1.603
5	0.967	5.689	68.831				
6	0.864	5.080	73.911				
7	0.768	4.520	78.430				
8	0.628	3.693	82.123				
9	0.589	3.464	85.587				
10	0.552	3.246	88.833				
11	0.444	2.612	91.445				
12	0.372	2.190	93.634				
13	0.367	2.156	95.791				
14	0.248	1.457	97.248				
15	0.183	1.075	98.323				
16	0.166	0.975	99.298				
17	0.119	0.702	100.000				

Extraction Method: Principal Axis Factoring.

Appendix 4: Pattern Matrix

Variables	Factor			
	1	2	3	4
Levels of prices of inputs	0.893			
For income generation	0.861			
Capacity to borrow	0.772			
Availability of subsides	0.754			
Levels of prices of outputs	0.721			
Annual income of the household	0.688			
Land tenure security		0.480		
Education level of household head		0.443		
Family labour		0.403		
Access of extension services			0.757	
Awareness of climate change/variability problems			0.617	
CSA demonstration plots and trainings			0.612	
Advertisement from media			0.576	
Poor soil fertility				0.592
Shortage of rainfall				0.459

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 11 iterations.

Appendix 5: Well-being category

Assets	Well-being categories		
	Rich	Average	Poor
House	Brick wall, cement floor and iron roof	Houses made of mud brick wall, mud floor and thatch grass/leaves or iron roof.	Houses made of pole and mud walls, mud floor and grass thatched roof
Land owned	4 hectares or more and in some cases reaching 12 hectares	0.4-1.2 hectares; may rent in land	0.2-0.25 hectares; may rent out land, Leave other pieces
Livestock	Own 10 or more cows, 10 or more goats and 10 or chicken	5-10 goats; 1-9 chicken	No livestock in most cases but occasionally may own up to 2 chicken
Motorcycle and bicycle, oxy-cart	May have a motor cycle a bicycle and oxy-cart	May have only bicycle but no motor cycle	Have neither motor cycle nor bicycle nor oxy-cart
Food security	They have plenty of food for 5-8 months a year where they get 3 or more meals a day and can choose what to eat.	Moderately food insecure for some months; they can only afford 2 meals a day.	Severely food insecure for 7 months a year getting one meal a day and may require food aid in some cases; insecure for 4 months getting two meals a day.
Labour market	Hire labour but never sell labour	May hire labour but sometimes also sell labour	Sell labour
Non-farm activities	May do trading and own Kiosk; own grain milling machine.	Petty trading of goat and hen and duck, charcoal making.	Petty trading particularly Brewing local brew
Farming system	May hire tractor or oxen, use improved varieties, may buy fertilizers and field chemicals. He is more likely to adopt to new agriculture technologies	Mostly use hand hoes and occasionally may hire oxen, incapable of buying improved varieties and fertilizers.	Use conventional faming which includes the use of hand hoe and slash and burn
Gross yearly income	Earn up to TZS 3 000 000-5 000 000/= per year	Earn TZS 600 000 - 1200 000/= per year	Earn up to TZS 120 000/= per year