BARRIERS TO MITIGATION STRATEGIES OF LAND DEGRADATION IN MIOMBO WOODLANDS: A CASE OF KASULU DISTRICT, TANZANIA

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ABSTRACT

This study aimed at finding out challenges that cause low adoption of the land degradation mitigation strategies by smallholder maize farmers in Kasulu District. It specifically aimed at: identifying the rate and effectiveness of the adopted degradation mitigation measures, assess factors that influence the adoption, and identifying the potentials and barriers of the interventions. A total of 140 respondents were involved through simple random, stratified and purposeful sampling. Household questionnaire survey and field observations were used for primary data collection. The findings revealed adoption of mitigation measures resulted into significantly higher maize productivity compared to non adoption. Furthermore the study indicateda significant link between social economic factors and degradation mitigation measures adoption. Binary Logistic Regression Analysis Model showsthe duration a farmer has adopted the practice, the household wealth status, and awareness on land conservation, farm size, and involvement in alternative income sources influenced adoption differently. To conserve the land, peasants moderately practised terracing, crop rotations, traditional bush fallow, and inorganic fertilizer application. This was because most farmers could not afford to pay for the extra labour cost required to pay for some mitigation measures. The key identified challenges were lack of sufficient access to extension services, increased costs of the farm inputs, increased costs in farm labour activities, and conservatism. The study concluded that, existence of challenges have perpetuated land degradation which have as the result significantly affected the production of maize by smallholder farmers in miombo areas.

COPYRIGIIT

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DEDICATION

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LIST OF ACRONYMS

CARE	Coopcrative for Assistance and Relief Everywhere
CBFM	Community Based Forest Management
CBO	Community Based Organization
CIFOR	Centre for International Forestry Research
DALDO	District Agricultural and Livestock Development Office
DANIDA	Danish International Development Agency
DFID	Department Forfor International Development
DNRO	District Natural Resources Officer
DWT	Diocese of Western Tanganyika
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FY	Financial Year
GDP	Gross Domestic Product
GEF	Global Environment Facility
IFPRI	International Food Policy Research Institute
INRM	Integrated Natural Resources Management
KaDP	Kasulu Development Program
NGO	Non Governmental Organization
NRM	Natural Resources Management
NSGRP	National Strategy for Growth and Reduction of Poverty (in Swahili commonly known as MKUKUTA in Tanzania)
PFM	Participatory Forest Management
SNAL	Sokoine National Agricultural Libraly
SSA	Sub- Saharan Africa

SUALDWC	Strategy for Urgent Actions on Land Degradation and Water Catchments
UN	United Nations
UNEP	United Nations Environmental Program
UNHCR	United Nations High Commissioner for Refugees
URT	United Republic of Tanzania
USAID	United States Agency for International Developemnt

CHAPTER ONE

1.0 INTRODUCTION

Tanzania has a total land area of 945 087km^2 which includes a land area of 883 749 km^2 (881 289 km^2 of the Mainland, 2460 km^2 for Zanzibar), and 61 238 km^2 inland water (URT, 2009b; 2009c; 2013c). The country is endowed with a wide range of resources offering considerable social and economic potentials, including extensive areas of arable land estimated to be 44 million ha, or 46% of the total land area (URT, 2009c). However, it is estimated that only 10.8 million ha or 23% of this arable land is under cultivation (URT, 2009b). There are also coastal and marine zones, wildlife reserves and parks, rivers, and lakes (URT, 2013c). Forest and wood land ecosystems in Tanzania occupy 335 000 km^2 or (35%) of the total land area, more than two thirds of which are made up of the Miombo woodland (Nduwamungu *et al.*, 2008).

Agriculture is regarded by many as the foundation of the Tanzanian economy (URT, 2009b, 2010). The economy depends heavily on agriculture, which accounts for 26.5% of Gross Domestic Product (GDP), provides 85% of exports products (30 per cent of export earnings), provides 95% of food requirement and employs about 80% of the work force (URT, 2009b, 2010; FAO, 2013). Food crop production has grown at a rate of about 2.8% accounting for about 65% of agricultural GDP while cash crops account for only about 10 %, and livestock account for 13%, the rest is covered by fisheries and other natural resources products (URT, 2010; 2011b). Maize is the most important food crop accounting for over 20% of total agricultural GDP (URT, 2009b, 2010).

Agriculture in Tanzania is dominated by smallholder farmers (peasants) cultivating an average farm sizes of between 0.9 hectares and 3.0 hectares each (URT, 2011b). About

70% of Tanzania's crop area is cultivated by hand hoe, 20% by ox plough and 10% by tractor and it is mostly rain-fed agriculture (URT, 2009b). Agriculture in Tanzania is dominated by food crop production, of the 10.8 million hectares cultivated annually, 85% is under food crops and women constitute the main part of agricultural labour force (URT, 2011b, 2013e). Maize cultivated land in Tanzania has been the largest accounting for about 45% covering 4.9 million hactares among the 10.8 million hacteres cultivated annually (Lyimo *et al.*, 2014; URT, 2013e). The next in coverage are pulses (legumes) at 14.9% and sorghum at 11.1%. Others are cassava (10.2%), potatoes (8.9%), paddy (8.7%) and other crops (1.2%) (URT, 2009b, 2010).

Land is the integrating component of all livelihoods depending on farm, forest, rangeland, or water (rivers, lakes, coastal marine) habitats. Due to varying political, social, and economic factors, the heavy use of natural resources to supply a rapidly growing global population and economy has resulted in the unintended mismanagement and degradation of land and ecosystems (World Bank, 2006).

In the last two decades, several important and innovative policies and laws have been passed in Tanzania, designed in part to enhance rural livelihoods by strengthening rights of people – especially the rural poor – to natural resources. The most notable of these are National Environmental Policy (1997), the Land Policy 1995 and National Land Act No 5 (1999), all of which contain provisions to protect existing local rights on one side, and promote local level participation in resource management on the other. The National Environment Policy (1997) identified six environmental problems which need urgent intervention in Tanzania. These problems are i) land degradation which reduces productivity of soils, ii) loss of wildlife habitat and biodiversity, iii) environmental pollution, iv) deterioration of aquatic ecosystem, v) deforestation due to clearance of

forests and woodlands, and vi) poor access of quality water to urban and rural communities. These problems are likely to continue as poverty and climate change impacts take their toll, thus increasing vulnerability to unsustainable livelihood of both urban and rural people as well as further degradation of natural resources and environment which provide livelihood to these communities (UN, 2009).

In the past, shifting cultivation in miombo woodland was not considered to be amongst unsustainable agricultural practices due to long fallow period allowing enough time for regeneration (Luoga, 2000). Today due to increased politicaland population pressures, high demand of cereals and growth of urban markets for forest products (economic demands), shifting cultivation has been intensified with fallow period reduced from 25 years to less than 3 years (Luoga, 2000; Mwampamba, 2009).

Other reasons encouraging land degradation include diversity uses of miombo woodland like mushroom harvesting, beekeeping, smallholder cultivation, extensive grazing, source of construction materials, and source of rural and urban household energy (firewood and charcoal). Prevailing of all these is due to the fact that there are limited options for exploiting biodiversity, unavailability of friendly alternatives of income generating activities (to support livelihoods) and challenge of accommodating an increasing immigrants from other over-populated areas (FAO, 2007; GEF, 2011).

To countercheck these challenges as a developing country, Tanzania and other miombo countries are in the process of reviewing their current policies on the environment to acquire those which will favor balanced economic development, woodland sustainable management, demands for new agricultural land, and the longer term costs of the loss of woodland cover (UN, 2009).

At the field level, farmers have been supported through different initiatives to promote natural regeneration, terracing, early burning, agro forestry, beekeeping, land use planning, organic farming, use of energy effccient cooking stoves, alternative income generating activities and strengthening of the village natural resources management committees to discourage the land degradation resulting activities (DALDO, 2012).

Despite the above mentioned support through initiatives implemented within the last decade, degradation is reported to continue (DNRO, 2012). This study proposed to assess the challenges facing the land degradation mitigation strategies and hence persistence of the problem.

1.1 Problem Statements

Degradation of Miombo woodlands is well pronounced in Tanzania, which has the second highest rate of deforestation in the Miombo belt (GEF, 2011). It is estimated that of all factors, shifting cultivation alone contribute more than 50% of the deforestation in Tanzania (Whitmore, 1997; Luoga, 2000; URT, 2002; Mwampamba, 2009). The Forestry and Beekeeping Division of Tanzania estimates between 2005 and 2010, high rates of deforestation led to a loss of 403 000 ha of forest per year which was equivalent to 1.16% of forest area (URT, 2013b). Agriculture expansion (involving shifting cultivation) has also been mentioned as one of the direct causes of deforestation and forest degradation and that the process of land degradation usually starts with deforestation (URT, 2013b; Blay *et al.*, 2004).

At present, one of the challenges facing Kasulu District maize farming activities has been the land degradation experienced in lowland parts of the District (DALDO, 2012). In order to reverse or mitigate the effects of land degradation, a number of initiatives have

at different times been introduced in the study area. These include the KaDP (Kasulu Development Program) during 1998/02 and the DWT (Anglican Diocese of Western Tanganyika) community development department initiative.Another program was the Integrated Natural Resources Management Program (INRM) implemented between 2003/06 in the same District (DALDO and CARE, 2012).These initiatives supported development of land use plans, community based forestry management, introduction of biogas systems, capacity building to village based institutions, sustainable farming practices / organic farming with new crops (for example vanilla) introduction, promotion of energy saving stoves, village savings and loans groups, beekeeping and tree planting.

Irrespective of the above mentioned initiatives on community development, land degradation problem has persisted. This has resulted into continued shifting cultivation (600ha of miombo forest cleared annually) and low maize production (DNRO and DALDO, 2012). The yield of maize in Kigoma Region decreased from 1.26 $tonsha^{-1}$ during year 2003 agriculture census to 1.19 $tonsha^{-1}$ recorded during the 2008 growing season (URT, 2012a). In Kasulu District, where this study was conducted the most recent yield was recordedat 0.82$tonha^{-1}$(URT, 2012a; DALDO, 2012). Hence thisstudy explored the challcnges facing the land degradation mitigation strategies/measures and the reasons why there is persistence of the problem.

1.2 Justification of the Study

The reasons for either ineffectiveness or the low rate of adoption of the interventions that would improve land fertility minimize land degradation due to shifting cultivation and consequently improve maize productivity in Kasulu are not clearly understood. This study is considered to be an important step towards bridging this information gap.

The focus of this research is therefore, to contribute to the understanding of the challenges uncounted in practicing the mitigation measures and the factors that influence farmers' decisions on the adoption of land conservation practices in the miombo woodlands of Kasulu District. The findings of the study are expected to contribute towards an understanding of the dynamics of land degradation in Kasulu district and Kigoma Region as a whole. The output from this study will inform a number of policies and strategies (national and local) that greatly address the land degradation issues.

The proposed study therefore targets to further explore the challenges and opportunities towards achieving the Strategy for Urgent Actions on Land Degradation and Water Catchments (SUALDWC) of 2006, National Strategy for Growth and Reduction of Poverty (NSGRP), National Environmental Action Programme (NEAP), Millennium Development Goal number 7; Tanzania Development Vision 2025 and *Kilimo Kwanza* initiative.

1.3 Objectives

1.3.1 Overall objectives

The overall objective of the study was to identify and assess the key challenges facing the land degradation mitigation strategies in miombo areas in selected villages of Kasulu District.

1.3.2 Specific objectives

The Specific objectives of this study include:

i) identifying interventions for mitigation of land degradation practised by smallholder farmers in maize farms;

ii) evaluating farmers' adoption of the interventions and assess factors influencing the adoption;

iii) assessing the effectiveness of interventions for mitigation of land degradation in maize yield; and

iv) evaluating potentials and barriers of the interventions based on farmers' knowledge and experience

1.3.3 Research questions

a) What land conservation farming practices are adopted by smallholder farmers to restrain the land degradation in their maize farms?

b) How many farmers have learnt and adopted the land conservation farming practices? And what factors are influencing a farmer to adopt land degradation mitigation practices?

c) What are the results following the farmers' adoption or non adoption of land degaradation mitigation practices during maize production?

d) What are opportunities and challenges on learning and adopting the sustainable farming practices in maize production?

1.4 Conceptual Framework

The following conceptual framework (Fig.1) demonstrates interrelationships among socio-economic factors, institutional factors and challenges facing smallholder farmers in adoption of land degaradation mitigation interventions for improved maize productivity and income.

Agricultural production and land conditions are affected by land management practices, including both private decisions made by farm households and collective decisions made

by groups of farmers and communities. For example, depending on social economic status, farm households make decisions about land use (whether, for example, cropland or grazing land), the crop types to plant, the amount of labor to use, and the types and amountof inputs, investments, and agronomic practices to use to conserve soil and water, improve soil fertility and reduce pest losses. Communities can also influence land management through their collective decisions. They may regulate use of communal land (e.g., restrictions on use of grazing areas) or private lands (e.g., developing by-laws limiting burning, shifting cultivation, water sources protection or random cutting of trees). The household and collective decisions under the given policy environment affect current agricultural production and income and affect the condition of land resources, thus influencing potential future agricultural production and income.

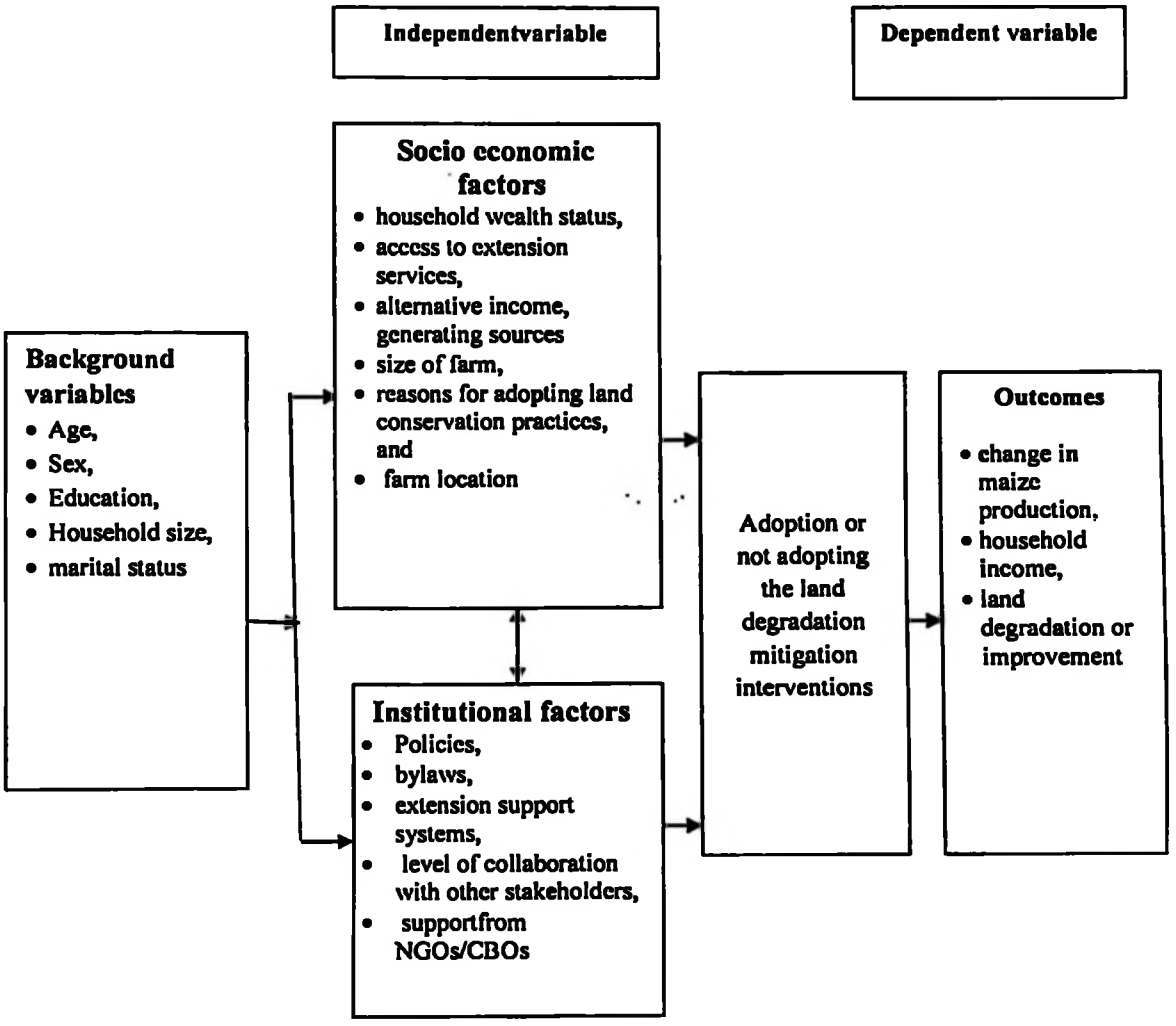

Figure 1: Conceptual framework for challenges facing land degradation interventions in miombo land areas Kasulu District

Source: Modified from Geist and Lambin (2002) five broad Clusters of Forces Driving Tropical Deforestation and Land degradation

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Background

Kigoma Region is covered with large woodland. Of the total forest area of 2 037 100 hectares 873 722 hectares (43%) are forest reserve and the remaining 1 163 378 hectares (57%) fall under open public forests (URT, 2008). The 1999 National Land Act and Village Land Act provide the legal framework for Tanzania's three land tenure categories: village, general and reserved land. 'Village land' constitutes all land in the village area, and is sub-divided into communal village land, private land, and unoccupied and used village land. 'Reserved land' denotes land set aside by the state for special purposes, including forest reserves, game parks/reserves, public utilities/highways land, and land designated under the Town and Country Planning Ordinance; 'General land' refers to public land which is not reserved or village land, and is not in use. It is the residual left over from the other two land categories.

Most rural land in Tanzania is managed under the customary land tenure system which provides tenure until one move to a different piece of land (Alemneh *et al.*, 1997). In Kasulu District most villages'lands are not yet formally registered and as a result, their land is therefore managed under the customary land tenure system.While it has been observed that security of tenure is an essential instrument in sustainable forest management, in Tanzania about 50% of forestland is in general land and is more or less under open access regime (Zahabu *et al.*, 2009). This system is mostly insecure and also closely associated with shifting cultivation which increases vulnerability of land to degradation. This is following the fact that the local population has often been excluded

from the management of forest resources, hence sees these resources as a form of land use in competition with the use that meets their immediate needs (Matiku *et al.*, 2013).

In order to address land degradation and desertification, Tanzania formulated a National Action Programme (NAP) in 1999, which was revised in 2004. Unlike other strategies, very few activities identified under NAP have been supported and implemented. Although the government attaches high priority in this area, there is inadequate support from the international community to address land degradation and desertification in the country. This is following the fact that in the financial year 2010/11, only 67% of Government spending was financed from domestic revenues (URT, 2012d; FAO, 2013) and therefore most of the activities implemented so far are supported by the insufficient government resources (UN, 2009). To intensify these efforts, in March 2006, the government launched a National Strategy for Urgent Action on Land Degradation and Conservation of Water Catchment Areas (SUALDCWC), which has helped recovery of many environmentally sensitive and important areas like Ihefu basin in Mbeya Region.

This study is guided by the theory of collective goods that according to Watcher (1992) states that a pure collective good has three properties; non excludability (nobody can be excluded from consumption so anybody can benefit), non-rivalry in consumption (one person's consumption does not impair that of another) and externalities (the possibility of free riding because of the non excludability). Many environmental goods have the properties of collective goods, particularly non excludability and externalities. However, most environmental problems arise when non rivalry no longer applies. According to this theory, environmental problems such as land degradation emerge when users can exploit scarce environmental goods such fertile lands or grazing areas, without

contributing to their maintenance or conservation. No one has an incentive to conserve the land because the benefits of conservation are dissipated among all users (Watcher, 1992).

In Kasulu District, smallholder maize farmers are reluctant to invest in measures to conserve land resources (in Kagerankanda forest farming area) because their future rights to use these resources are not secure (unsecured land tenure). The kind of property rights that lead to this situation is an open access resources (DNRO and DALDO, 2012). While there is limited litcrature on factors for maize productivity flactuation in Kasulu, few information from the District Agricultural and Livestock Development Office (DALDO) acknowledge that the maize productivity is significantly affected by land degradation and that the causes of land degradation in Kasulu District include poor farming practices/over-cultivation of crop lands, deforestation due to shifting cultivation or charcoal production, insecure land tenure resulting from absence of land use planning, over exploitation of wood resources due to population increase, low enforcement of policies and wild fires.

According to Nduwamungu *et al.* (2008), an open access land resources are those which anyone, in particular the poor and otherwise landless, can use, without rights of continuing usufruct or tenure. This applies mostly to forest lands, nominally under government ownership, under this arrangement its is a serious cause of deforestation from shifting cultivation, unsustainable farming practices, overgrazing and illegal charcoal making followed by soil erosion in some instances and hence land degradation.

According to FAO (2009), Kigoma Region and specifically Kasulu District is one among the areas where major crops grown are maize and legumes and the characteristics of the farming system includes land not scarce, shifting and fallowing cultivation practiced by a

large number ofsmallholder farmers and most of the marketed maize is produced from this system. The key environmental problems observed in such areas include land degradation due to bush fires, soil erosion, uncontrolled grazing, poor farming practices, shifting cultivation, deforestation and poor mining practices (Nduwamungu *et al.*, 2008). Consequently, as stated in the theory of collective goods, it has also been documented that the open access to the miombo woodlands of Kasulu and Tabora is endangering their ecological integrity, their functions and ability to deliver ecosystem goods and services for local economic development including soil fertility, wood, poles, biodiversity, watershed protection and indigenous cultural uses (GEF, 2011).

2.2 Miombo Woodland

'Miombo' is a colloquial term locally used to describe those central, southern and eastern African woodlands dominated by the genera *Brachystegia*, *Julbernardia* and/or *Isoberlinia*, three losely related genera from the legume family (Fabaceae, subfamily Caesalpinioideae) (Hein *et al.*, 2008). Miombo is named after the Swahili word for a *Brachystegia* species. There are 21 species of *Brachystegia* in miombo woodland and three species of each of the related genera (Dewees, 2011). In Tanzania, miombo woodlands constitute about 90% of all forested land, equivalent to 44.6 million ha covering 40% of Tanzania's total land (GEF, 2011). The woodlands occur in two major blocks that reflect the wet and dry regional sub-types. The relatively dry miombo woodlands cover extensive areas of Shinyanga, Kigoma, Tabora, Rukwa, Mbeya and Iringa regions. The wet miombo woodlands occupy a larger and richer area in the moist west of Tanzania, bordering the Congolian Forest patches of Mahale Mountains (Mbwambo and Nshubemuki, 2007).

2. 3 Global Significance of Miombo Woodland

The Miombo woodlands are biologically rich and diverse with up to 8500 vascular plant species, 4590 of them endemic, together with 35 endemic mammals, 51 endemic birds, 52 endemic reptiles, 25 endemic amphibians and an unknown number of endemic invertebrates (GEF, 2011). It is estimated that over 75 million people live within the miombo biome, with 40 million depending on the woodlands directly for food as it maintains soil fertility, fibre, fuelwood and a further 25 million in urban areas drawing food, fibre, fuelwood and charcoal (Campbell *et al.*, 2010; Dewees *et al.*, 2011). The woodlands are also central to the spiritual needs of the people, with specified trees and even blocks of woodland being conserved by communities for cultural reasons. Sacred groves associated with spirits of the dead or with territorial rain deities are found throughout the miombo region (Dewees *et al.*, 2011).

The woodlands are also a crucial source of essential subsistence goods such as materials for tool handles and houschold utensils, leaf litter, grazing and browse. They also have high potential for bee-keeping. Therefore, the woodlands provide a rich variety of alternative livelihoods and income (GEF, 2011). In addition, the woodlands provide ecosystem services in harboring biodiversity, maintaining carbon stocks (and therefore regulating climate), controlling soil erosion, providing shade and modifying hydrological cycles (CIFOR, 2004).

2.4 Land Degradation in Miombo Woodlands

The thin layer of soil that covers most of the earth's land surface is the key to human well-being and survival. Without it, there would be no plants, no crops, no animals, no forests, no rivers, noaquatic plants, and no people. However, about 40% of the earth's land surface and more than one billion people are affected by land degradation. Degraded lands are

home to the poorest segments of the rural population (IFAD, 2002). Poverty reduction is Tanzania's major goal that is emphasized in most government policy statements. Although the country has shown a strong improvement in macro economy indicators, evidence from the rural poor still indicate that poverty is increasing (URT, 2009a, 2013d). This anomaly is likely due to the skewed income distribution and the broad definition of poverty, which includes more than income. Natural resource and environmental degradation is likely to exacerbate poverty since the poor depend largely on natural resources to sustain their livelihoods (Ephraim *et al.*, 2008).

Tanzanians have practiced poor agricultural practices leading further to land degradation (GEF, 2011; URT, 2010). Shifting cultivation, lack of proper crop rotations and a lack of technology have increased the problem (URT, 2002). Globally, shifting cultivation is considered as a major driver of deforestation, until the year 1991, Shifting cultivation had accounted for 61% of overall tropical forest destruction (Cramb, 1993). But some recent studies show that, in addition to the former drivers, increased population, fast increasing urbanization, large commercial agriculture and timber enterprises are the also principal agents of tropical deforestation (Doug *et al.*, 2011). Nevertheless, the practice persists since it provides subsistence livelihoods to at least 300 to 500 million people worldwide and is intricately linked to social, cultural, ecological, and economic aspects of communities (Teegalapalli *et al.*, 2009).

As one of the causes of deforestation and consequently land degradation, shifting cultivation is a form of land use among resource poor communities with a rotation of cultivation and fallow in the same unit of land. It involves the clearing of certain patches of forests by slashing and/or burning (in many cases), followed by short span of crop cultivation and long span of fallow period (Cohen, 2002; Campbell*et al.*, 2010). It

involves the cyclical shifting of cultivation sites. In general, the shifting cultivation plots are cultivated for shorter periods than they are fallowed (Gandhiv, 2011).

In the past, shifting cultivation was not considered to be amongst unsustainable agricultural practices due to long fallow period allowing enough time for regeneration (Luoga, 2000). This practice does not allow sufficient time for revegetation and recovery of soil fertility. As a result, large tracts of land have lost their vegetation cover and are exposed to further degradation through soil erosion, or infestation by weeds, pests, and diseases. The decrease in yields often makes the clearing of more virgin forest land increasingly necessary (Nduwamungu *et al.*, 2008; Doug *et al.*, 2011). Shifting cultivation has also in some cases resulted in encroachment of natural Forest Reserves like the incidence that happenned in Kasulu during year 2011 whereby smallholder maize farmers opened new farms in South Makere Forest Reserve near Kagerankanda and Mvinza villages (DNRO, 2012).

Land degradation has been viewed differently by different authors especially about its composition. While some take land degradation as a stand alone concept, others view it as a collection of many human activities and natural related phenomena that decrease the productivity of land. Cohen (2002) defined land degradation as the reduction or loss in the above areas of the biological or economic productivity and complexity of the land, resulting from land use or a combination of human activities and habitation patterns, such as soil erosion caused by wind and/or water. In other words degradation of land refers to loss of its potential production capability as a result of degradation of soil quality and also its loss for effective use.

Land degradation can also be defined as the loss of land productivity through one or more processes, such as reduced soil biological diversity and activity, the loss of soil structure, soil removal due to wind and water erosion, acidification, salinization, water logging, soil nutrient mining, and pollution (UNEP, 2012). Land degradation is a global phenomenon that endangers the livelihoods of rural farmers, of the population at large as well as a country's ability to produce crops, livestock, and products from other natural resources (World Bank, 2006).

It is estimated that nearly 2 billion ha of soil resources in the world have been degraded, in other words approximately 22% of the total cropland, pasture, forest, and woodland are degraded (Hong and Ju, 2006). Land degradation and poverty are inextricably intertwined. The consequence of this linkage is a vicious cycle in which poverty causes the degradation of the land and as such degradation in turn perpetuates more poverty. Generally, poverty and land degradation are often bound together in a mutually reinforcing vicious cycle (Emeka, 2010).

There are global effects of land degradation, but also other important levels of land degradation; at the household/field level, it may result in reduced productivity; at the national level, it may cause flooding, and sedimentation; and, at the global level, it can contribute to climate changes, damaging bio-diversity, and international waters (Pagiola, 1999).

There are other causes of land degradation other than shifting cultivation in Miombo. These include use of agricultural practices that do not maintain soil fertility, lack of sustainable fuel wood and charcoal harvesting mechanisms and of alternative cooking fuels, inadequate land use planning and agreements, low capacity to monitor and enforce

laws and regulations, unclear and insecure land tenure, wild fires and/or overlapping land and resource tenure, overstocking of animals, and some development projects, particularly resettlement schemes (WWF, 2012). A situational approach is therefore needed to generate policies appropriate to local circumstances.

2. 5 Factors for land Degradation in Miombo Woodland

According to Alemneh *et al.* (1997), fertile land is crucial to provide a livelihood for most people in Sub-Saharan Africa (SSA). Agricultural land is under enormous pressure from agents of soil degradation mainly caused by deforestation, inappropriate farming and grazing practices, population growth, fuel wood shortage, land tenure conflicts, lack of effective extension service and local organization, and other institutional and policy shortcomings. The functional capabilities of land deteriorate from activities related to agriculture, forestry, and industry. On the other hand, natural events such as heavy rainfalls and floods cause land loss, and can also deteriorate functional capabilities of land.

Generally, the causes of land degradation can be divided into natural hazards, direct causes, and underlying causes (Doug *et al.*, 2011). Natural hazards are the conditions of the physical environment which lead to the existence of a high degradation hazard, for example steep slopes as a hazard for water erosion. Direct causes are unsuitable land use and inappropriate land management practices, for example the cultivation of steep slopes or in forests without measures for soil conservation. Underlying causes are the reasons why these inappropriate types of land use and management are practised; for example, the slopes may be cultivated because the landless poor need food and conservation measures not adopted because these farmers lack security of tenure (Maiangwa *et al.*, 2007).

alternative sources for energy and construction materials; insufficient number of financial institutions that support farmers in terms of credit to acquire or develop land; insufficient institutions to provide information on land availability for those in need, and guidelines/arrangements on how the landless, especially the youth can acquire land; and rapid population growth (URT, 2013b). Inadequate land use plans at various administrative levels is among the factors causing not only land and resources degradation but also land conflicts (URT, 2013e).

Agriculture is the predominant economic sector in Kigoma region (URT, 2008). Over 85% of the total population of the region depends on agriculture for their livelihood (URT, 2013a). The bulk of agricultural production comes from smallholder farmers who employ very little capital with labour and land as their main input (Gwalema, 2010; URT, 2012a). Due to poor infrastructure there prevail unprofitable prices for agricultural products (including maize cultivated by majority) in Kasulu which do not motivate farmers to invest in improving land resource management in order to increase crop production. At the same time there is insufficiency of extension agricultural services (DALDO, 2012). This situation has in most cases forced farmers in miombo woodlands to repeatedly opening new farms due to decreasing soil fertility (following land degradation) as a consequence of over cultivation on the same piece of land (GEF, 2011).

Given a number of factors discussed, its combined influence on the farming households has been resulting into the cycle of miombo deforestation leading to deterioration of the ecological system with resulting negative impacts on soil fertility, water flows and biological diversity and hence continued shifting cultivation in miombo (Gwalema, 2010; GEF, 2011). Following this farming situation, the maize production in the region has been declining in recent years. Increase in production of maize and other food crops were

observed between 1995 and 2000 (URT, 2007c). There after there has been a declining trend in maize production. For instance in year 2000 maize production in KigomaRegion was 120 000 tones but in 2008 it was 113 051 tones, the yield of maize has decreased from 1.26 tons/ha in 2003 census to 1.99 tons/ha in 2008 despite the recorded rise in planted land to 95 170ha from 83 396ha (URT, 2012a).

2. 6 Land Degradation Mitigation Strategies in Miombo Woodland

Concern with land and water degradation in smallholder agriculture is not a new issue. It has been around for a long time and farmers are involved in a constant struggle to adopt and adapt mitigation and conservation strategies under changing climatic and socio-economic conditions (Shiferaw *et al.*, 2009). Low levels of land productivity and subsequent land and resource degradation has been one of the key challenges facing the rural farmers in Tanzania. The field experience has demonstrated that local land users (smallholder farmers) often have different perceptions and responses against officials to the land degradation problem (Mongi, 2012). This has resulted in conflict with officials in diagnosing and solving the problem and is a major constraint to the successful implementation of policies and projects to address land degradation (Dejene *et al.*, 1997).

Degradation of land and water resources gradually diminishes the capacity of individual farmers and communities to undertake critical investments needed to reverse the situation; that is, they lack sufficient income due to low productivity which would enable them afford the land degradation mitigation measures labour and other field based requirement. This in turn increases vulnerability of household to poor and unsustainable livelihoods (Shiferaw *et al.*, 2009). There are currently different practices and technologies used to mitigate land degradation and they do and vary from one region to another, but include a mix of indigenous and introduced structural (or mechanical) and agronomic practices.

They range from combating soil erosion and nutrient depletion, improving water conservationto enhancing soil and water productivity (World Bank, 2006).

In an effort to redress the problem and improve actual livelihood and environmental outcomes, the approach to land and water conservation has evolved through several phases. In recent years more holistic and landscape-wide approaches that go beyond resource conservation towards improved land husbandry and water management for beneficial conservation have been promoted (Wani *et al.*, 2006).

Rehabilitation is seen as the most viable way of mitigating the effects of land degradation in miombo woodlands. Initiatives in this area have been going on for some time now in Africa, especially in Sub-Saharan Africa (SSA). There exist useful examples of success stories in rehabilitation but also of failures, both of which present opportunities as learning points (Blay *et al.*, 2004).

In order to reverse or mitigate the effects of land degradation in miombo areas a number of techniques are available, depending on: the priorities and objectives of stakeholders, the costs and benefits associated with available rehabilitation techniques, and the economic, social, and environmental values of the land resources in their current and desired future states (Dewees *et al.*, 2011). The major techniques that have been used in miombo woodlands of Sub- Saharan Africa include; natural regeneration, assisted natural regeneration, enrichment planting, plantations establishment, agroforestry, and soil and water conservation (Blay *et al.*, 2004).

In Tanzania miombo areas, as elsewhere in Sub Saharan Africa, a number of mitigation strategies have been implemented and they include facilitation of tree planting, tree

planting campaigns in Tanzania is done national wide. First day of January each year is set aside specifically for planting trees. Secondly a joint efforts to support Community Based Natural Resource Management (CBNRM), thirdly facilitating land use plans development, and promotion of conservation agriculture focusing on soil fertility improvement (Abdalla and Monela, 2007). Participatory Forest Management (PFM) approach specifically CBNRM is contributing to a comprehensive reform of Tanzania's forest administration and management, which places new emphasis on participatory management systems of natural and other forests. In Tanzania, PFM has become the most important approach within the forestry sector following its inclusion in the National Forest Policy of 1998 and the Forest Act of 2002 and Land Acts of 1999.

A combination of these strategies by different departments of the Government is perceived to offer a more promising way to manage natural resources than continued reliance on protection by centralized government technical services and agencies. Through CBNRM approach, smallholder farmers can organize themselves into institutions for learning purposes in accordance with their traditions, commonly held interests, and available information about the condition of the resource base and from this learning they can develop mechanisms and bylaws to guide the sustainable management of the available resource (URT, 2013bc). In combating wildfires there are for example some areas in Tanzania where fire incidences are rare and these apparent local successes in fire control can be scaled up to address the fire problems in the miombo (Sambala, 2013).

2.7 Categories of Land Degradation Mitigation Strategies

According to Shiferaw *et al.* (2009) these different approaches may be grouped into three major types: top-down interventions, populist or farmer-first and neo-liberal approaches. Most of the early (pre-independence era) soil and water conservation approaches focused

on topdown interventions, mainly using structural methods for arresting the physical process of soil erosion (Wani *et al.*, 2006). This approach was also characterized by lack of farmer participation in technology design, and use of command-and-control type policies for implementation of externally developed structural measures.

Based on the experiences gained from the failed command-and-control policies, a new paradigm – referred to as 'populist' – that upturned the process and made the farmer central to programme design and implementation of soil and water conservation activities emerged. This view appeared in the late 1980s and was marked by the publication of *Farmer First* – a book that embodies many of the ideas behind the 'populist' approach (Chambers *et al.*, 1989). This approach stressed small-scale and bottom-up participatory interventions, often using indigenous technologies and largely rejected the traditional transfer of technology model in the process of technology development and extension.

The neo-liberal approach advocates the need to understand the present structure of incentives that prevents resource users from adopting and adapting existing land and water management technologies. This approach recognizes the appropriate roles for farmer innovation but brings to the centre stage the critical role of markets, policies and institutions to stimulate and induce farmer innovation, adoption and adaptation of suitable options (Reij, 1991).

In the last few years, the approach for soil and water conservation in agriculture has also slowly moved towards the concept of sustainable land (and water) management; at both farm and landscape level (de Graaf *et al.*, 2008). There is no single definition for sustainable land (and water) management but Hurni (2000) suggests that it implies a system of technologies and/or planning that aims to integrate ecological and socio-

economic and political principles in the management of land for agricultural and other purposes to achieve intra- and inter-generational equity.

Suggesting on how to improve the management of miombo woodland, there mainly four categories of proposed strategies or management practices. According to Sunderlin *et al.* (2007) and Campbell *et al.* (2010) one major proposed management practice is expanding management opportunities in miombo regions. This strategy specifically advocates for three key interventions starting with devolution of rights and responsibilities for woodland management to the local level (for example PFM in Tanzania), this is more effective when rights of use and access are completely rather than partially devolved. The next intervention is exploiting opportunities for transfer payments to achieve environmental objectives, such as from payment for environment services schemes. The last intervention is increasing the value of woodland production enhancing forest-based markets by. for example, removing restrictive legislation specifically by allowing communities to harvest resources previously harvested by state monopolies (Abdallah and Monela, 2007).

The second major proposed management practice is tackling poverty traps and enhancing safety nets; Miombo has a crucial role in poverty mitigation in spite of the fact that it has low productivity and is not well-endowed with high-value timber resources. This makes miombo less interesting to commercial concerns, but what matters is their high local value to tens of millions of poor households. Miombo woodlands do sustain livelihoods, and act as safety nets in times of emergency (Dewees *et al.*, 2011).

The third major proposed management practice is agroforestry; in fact, when forest land conversion has taken place in miombo regions, the most productive land management approaches are those that continue to integrate some aspect of woodland management into

the farming system, such as the composting and deposition of leaf litter on depleted fields. On balance, the most productive farming in miombo regions requires integration of miombo into the farming landscape in a fractured mosaic, rather than total land clearance (Douge*t al.*, 2011). And lastly, improving policies and incentives for management; improved relevance of forestry institutions, policy and legal reforms, and building capacity in local organizations will be crucial but will take time (Abdallah and Monela, 2007).

Despite the increasing efforts made and the growing policy interest, spontaneous and widespread adoption and adaptation of technologies and innovations for sustainable management of land and water resources by smallholder farmers outside of intensively supported project locations has generally been limited (Fujisakae*t al.*, 1994; Pender and Kerr, 1998; Barrett *et al.*, 2002). Smallholder farmers and resource users continue to face difficulties in adoption and adaptation of soil and water conservation technologies. The diagnosis of these changes and lessons from different examples show that several factors have indeed contributed to the continuing challenges facing smallholder farmers in adoption and adaptation of sustainable land and water management interventions – ranging from the poor performance of the technologies themselves to policy and institutional deficiencies at different levels (Joshi *et al.*, 2005).

The growing understanding and recognition of the public goods characteristics of land and water conservation (from the theory of collective goods), and the non-technical factors that condition individual technology choice and adaptation has also prompted strategies that address institutional and organizational constraints and internalize local externalities to induce proper action at the community and landscape level (Shiferaw *et al.*, 2006).

2.8 Adoption of Land Degradation Mitigation Measuresin Miombo Woodland

Adoption of an innovation is the process by which a particular farmer is exposed to, considers, and finally rejects or practices a particular innovation (Chuma *et al.*, 1998). This process involves changing from current farming practices to more sustainable practices, it is a gradual process. A phased approach can start with the easier changes, to minimise risks and spread investments. It should allow farmers to develop gradually the required skills before tackling the more complex changes. In this transition process, the following phases according to (de Graaff *et al.*, 2008) can be distinguished: Increased efficiency; this involves modification of current practices to reduce consumption of resources and environmental impact and secondly adaptation which involves a substantial adaptation of agricultural technologies and techniques, and lastly redesign whereby there is structured change of the entire farming system to ensure full application of the principles of sustainable agriculture, mimicking the characteristics of natural ecosystems, bearing in mind that each system is unique and that the farmer is the only person fully conversant with that system (Dorina, 2013).

In the course of these three phases, the changes increase in size, impact and complexity. Fine-tuning and readjustment of farming practices may involve some repetition of the phases. Improving land husbandry starts from a thorough understanding of the current situation of which only the farmers themselves have an intimate knowledge (Krishna *et al.*, 2008; Posthumus *et al.*, 2012). That is why they have to be the architects of change from the outset and during the transition process, and even further in order to make sure that the new system is sustainable.

There are a number of opportunities to manage and benefit from miombo woodlands: forests are still a valuable resource; resource rights are shifting to local people; new

approaches to integrating conservation and development are emerging; and forest markets are emerging and expanding (Blay *et al.*, 2004). However, there are a number of barriers to sustainable use and benefit from miombo woodlands specifically that they have low inherent productivity; managing for multiple products; disenabling forest policy; marginalisation of the forestry sector; cash constraints pushing decisions towards high preferences for rapid exploitation; low margins and high management and transaction costs; weak local organisations; and weak national organisations (Campbell *et al.*, 2010).

In Kasulu District where this study was conducted, according to the (DALDO, 2012) smallholder maize farmers are aware of the challenges thay face following decling farm productivity due to declining trends in soil fertility and other endogenous and exogenous factors, they are also aware of the reasons for this and its impact on household food security. To countercheck this situation, smallholder maize farmers in miombo areas have at the minimal level and with limited extension support repeatedly adopted few and simple land degradation mitigation measures including terracing and crop rotations. Unfortunately due to reasons which are not clear smallholder maize farmers have continued practicing traditional farming practices that include shifting cultivation. This practice have perpetuated the land degradation and consequently declining farm productivity problem and hence continued shifting cultivation. Their traditional adoption of the mitigation strategies does not go through the above mentioned chronological order but rather according to (Dorina, 2013) depends on relative preference of one practice against the other, this is mostly affected by the list of both internal and external factors including the relative cost of each practice which varies from one place to another, the socio economic characteristics of the farming unit, the risks involved in adopting that practice and other external factors like market forces.

Improving land husbandry in miombo starts from a thorough understanding of the current situation of which only the farmers themselves have an intimate knowledge. That is why they have to be the architects of change from the outset and during the transition process, and even further in order to make sure that the new system is sustainable.

2. 9 Knowledge Gap

From the reviewed literature, much of the available and documented information have focused on the control of decreasing forest wood resources and biodiversity in miombo forests in various areas in Tanzania and elsewhere. There is limited documented information on other non wood forest products (for example land) deteoration. Specifically, there is limited information on the effect of land degradation on livelihoods, the factors for and extent of shifting cultivation, its effects to maize farming communities, and the socio economic factors influencing land degradation mitigation measures and maize productivity in miombo areas of Kigoma Region and specifically in Kasulu District. The available literature does not provide sufficient information on the relationship between farm productivity, ongoing shifting cultivation due to poor farming practices and decreasing soil fertility in miombo areas of Kasulu and its economic importance on the households' livelihood. The available literature has also limited information on the role of an individual smallholder farmer in mitigating land degaradation side effects. This study targeted to provide some information on barriers to mitigation strategies of land degradation in miombo areas of Kasulu Distric and hence cover part of this information gap.

CHAPTER TIIREE

3.0 METIIODOLOGY

3.1Study Area

Kasulu is one of the 6 districts of Kigoma Region of Western Tanzania (URT, 2013a). It lies between $3^0$45' South and5^0 00' latitudes south of the Equator and longitude between $29^0$50' and 30^0 55' East of Greenwich. The elevation range is between 1000 and1800m above sea level. It is bordered to the North by the country of Burundi, to the East by Kibondo District and to the South by Kigoma Rural District and Kigoma Municipal to the West. The District is administratively divided into 30 wards, 7 Divisions and 91 villages (Fig.2). It has a total land area of 9324 square Km which is equivalent to 25.2 % of the land area of Kigoma Region (URT, 2008).

There are mainly two seasons in Kasulu, the rainy season which starts from October and ends in May and the dry season whichstartsfrom June and ends in September. Rainfall ranges between 800mm and1500mm, and the temperature is from 27^0C – 34^0C (Rachel, 2007).

The District population according to the 2012 National Population Census results was 437 479 and 460 901 males and women respectively that make a total of 888 380 inhabitants (URT, 2013a). Land use is categorized into arable land 606 000 ha, area under cultivation 167 375 ha and the forested area 239 400 ha. The main economic activities include agriculture employing 91% of the population, business operations 3.6%, office work 2.6% and elementary occupations 1.8%. Majority of the population is engaged in subsistence farming of both food and cach crops like maize, cassava, bananas, beans and other traditional cash crops like groundnuts, coffee, cotton and tobacco (URT, 2006).

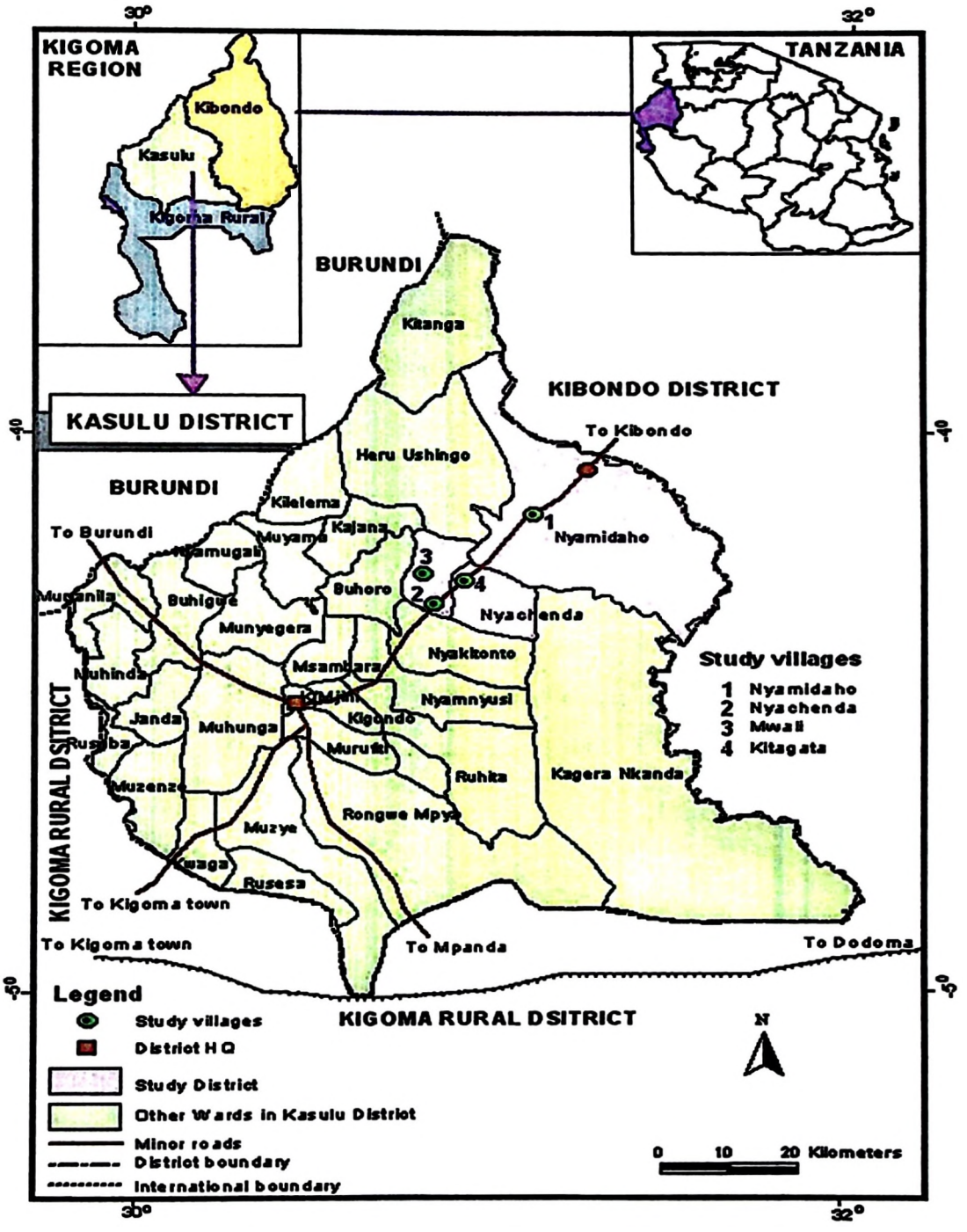

Figure 2: Kasulu District Map showing administrative boundaries: Source; District Planning Office 2013

3.2 Study Area Justification

Kasulu District was purposely chosen for this study based on the fact that the District has potential ecological resources including the two National Forest Reserves (North and South Makere Forest Reserves), Moyowozi Game Reserve and the Malagarasi river catchment (URT, 2008). Conservation and sustainable utilization of land resources available in this area means more benefits and vice versa to a larger population which enjoys a number of ecological goods and services beyond Kasulu District. In addition to this, an area under maize cultivation in Kasulu District represents 53% of the total area planted with maize in Kigoma Region in 2010 (URT, 2012a). Therefore investigation of the reasons as to why there is continued land degradation in maize farms located in miombo woodlands of Kasulu District was also a justification for this study to be conducted in Kasulu.

3.3 Research Design

According to de Vaus (2001), a cross-sectional research design (which was used in this study) refers to collection of data from a sample of individuals (or groups) at a particular point in time as a basis for inferring the characteristics of the population from which the sample comes. This type of study design utilizes different groups of people who differ in the variable of interest, but share other characteristics such as socio-economic status, educational background, and ethnicity. The key characteristics of the cross section study involves taking place at a single point in time, it does not involve manipulating variables, it allows researchers to look at numerous aspects (dependent and independent variables) at once, and it is often used to look at the prevalence of something in a given population (Bhattacherjee, 2012). On the other hand longitudinal research design is used to assess and track the development of the same variable over a long period of time (Ekmeck, 2003). However, this method requires the continuity of the procedures for a long time and thus

requires significant resources support and extended supervision. To countercheck these challenges and fulfil the objectives, this study employed a cross sectional research design.

3.4 Sampling Procedure

According to Natasha *et al.* (2005), sampling can be defined as the process whereby a subset of items is picked from a set, and it is done so using a systematic process. It is concerned with the selection of a subset of individuals from within a population to estimate characteristics of the whole population. According to Kothari (2004), sampling in the context of social science means using any choosing technique to pick respondents from a larger population, and through that biases are avoidable.

During this particular study, to collect the primary data, sampling was done at the District, Division, ward, village, and sub village level. At the District, division and ward level purposive sampling was employed to include the divisions and wards in Kasulu District that have miombo vegetation cover, and have been most affected by land degradation possibly due to poor farming technologies leading to practicing shifting cultivation. Provided most villages in Makere and Buhoro Divisions are located in miombo woodland, the four selected villages were purposively sampled for this study taking into account of them bordering the Makere North and South Forest reserves and also due to their accessibility with respect to time, available financial resources and the rainy season (October to March, 2012) that prevailed in the study area during data collection. Purposive sampling (criterion based sampling) has been explained by Paula and Justo (2001) as the sampling technique whereby the researcher establishes criteria necessary for being included in study and find sample to meet criteria.

Before smpling and data collection, the researcher conducted a day visit to each village government office as part of reconnaissance and further introducing the study objectives and procedures to the Village Executive Officer (VEO) and Village government chairperson. Thereafter in consultation with few randomly selected farmers in each village, and under guidance of the VEO a simple informal participatory discussion on the criteria used to categorize wealth status was conducted (Table 1 and 2). This method was used to explore with few farmers, documenting their understanding of wealth and the criteria (local indicators) by which they judge the wealth rank of a household in their village.The outcome from this discussion has been presented in tabular form under results section of this study.

The list indicating total number of households in each of the four villages was obtained from village register at the Village Executive Office. Thereafter, in collaboration with experienced few elder farmers, in each village stratification was conducted whereby households' wealth sub-groups were assigned to each head of household based on criteria listed by farmers. Specifically, the criteria were size of land owned, number and type of owned assets and the level of food security. Later during sampling, from each wealth sub-group (stratum) individual households were randomly selected in order to get a representative sample (Table 1). Wealth ranking is a method for collecting and analyzing data on perceptions of wealth differences and inequalities in a community and for identifying and understanding local indicators and criteria of wealth, well-being, and poverty (Majule, 2010). On the other hand, simple random sampling means every member of a population has an equal chance of being selected. It is preferred because it has demonstrated least chance of sample bias, and that through this method probability is highest that sample is representative of population than for any other sampling method (Paula and Justo, 2001).

3.5 Sample Size

A sample is a relatively small subset of people, objects, groups, or events that is selected from the population which refers to the total set of individuals, groups, objects, or events that the researcher is studying. In this study the sample size depended on population size, but according to Natasha *et al.* (2005), it's recommended to include 30 cases per group. In this study 35 smallholder farmers (Table 1) involved in maize production from each of the four villages namely Nyachenda, Kitagata, Mwali and Nyamidaho respectively were interviewed for primary data collection giving a total of 140 households.

Table 1: Sample households and wealth ranking per village

Ward	Village	Household wealth ranking categories			Total
		Rich	Moderate poor	Poor	
Kitagata	Kitagata	10	12	13	35
Nyachenda	Nyachenda	9	13	13	35
Nyamidaho	Nyamidaho	12	15	8	35
Nyachenda	Mwali	7	17	11	35
Total		38	57	45	140

Source: Kavumvuli, 2013

The sampled villages were from three wards of Nyachenda, Kitagata, and Nyamidaho and two divisions of Makere and Buhoro in Kasulu District. The focus group discussions included groups of five to ten elders, field extension officers, environmental committee members, and village and ward leaders at the village and ward level. The total of four discussion sessions one in each village was conducted. The key informant discussions included agriculture and natural resources officials at the District level and other key stakeholders specifically World Vision Tanzania and CARE Tanzania.

3.6 Types of Collected Data

3.6.1 Primary data

A structured questionnaire (Appendix 1) with both open and closed end questions was used to collect quantitative data on household charcteristics, farming practices, maize

productivity trend, adopted land degradation mitigation measures and challeges limiting adoption. The Focus Group Discussion (FGD) was employed to collect additional primary data on productivity and challeges to adoption of land degradation mitigation measures. The Key informant interviews involving representatives from different agriculture development stakeholders were also conducted for additional primary data collection on projects and initiatives that supported towards mitigating the land degradation challenges. Simultaneous with administering questionnaire to different head of households, the field condition observation through taking still pictures (photos) was also used to support collected primary information during discussions.

3.6.2 Secondary data

The secondary data were collected through reviewing reports, articles and other relevant documents of the subject matter at the Regional and District level. At the Regional and District level the natural resources and agriculture departments were consulted for reports, articles and other relevant documents with detailed information on the research problem. Further reading materials on the research problem from The Sokoine National Agricultural Library (SNAL), Tumbi Agriculture Research Institute, World Vision Tanzania and CARE International were also referred to.

3.6.3 Data collection

The study used both qualitative and quantitative research methodologies. The key tools used included structured questionnaires (Appendix 1), checklists (Appendices 2 and 3) for Focus Group Discussions (FGD) which was conducted with influential village community members/elders, and a total of four sessions one in each village was conducted. The FGD included also the village/ward government leaders, and the village environmental conservation committees, and farmer groups' represenatives. The semi-structured

interviews (Apendix 4) with key stakeholders (key informant interviews) such as District natural resources and agriculture officials, NGOs/CBOs representatives were also conducted. During these discussions and interviews, recorder was responsible with tracking and records all the discussion points for further analysis. In addition, the research utilized field observations whereby the administration of questionnaires was concurrently carried out while observing the condition of the maize farms and other aspects of a household. The field observation information was recorded through taking various still pictures (Plates 1 to 7) at different maize farms under different farming practices from four different villages under this study and located in miombo areas. The pictures (photos) were taken simultaneous with interviews and used as evidence to the data collected with questionnaires, in interpretation and presentation of facts. The study was divided into two phases, beginning with an initial survey (wealth ranking criteria identification) for one day in each village (Table 2). This exercise targeted to serve as a source of prior information required for identifying the sampling frame within the community and to ensure a mixed/diverse sample taking into account of various household characteristics is chosen. Eventually a final stage of intensive field study was conducted. With trained enumerators, data were collected through asking but not limited to questions as listed on questionnaire; the questions (both open and closed) were asked to the head of households, or any other family member who had as of recent participated in family maize farming activities consecutively. The guiding questionnaire was prepared in English (Appendix 1) but later translated in Kiswahili (Appendix 2) for proper field application.

3.7 Data Processing and Analysis

Data processing including coding and summarization were done using spreadsheets, and then the analysis for descriptive statistics and inferential analysis was conducted. Descriptive statistics were used to describe the group/sample under study. In this study

frequency distributions, mean, mode, median, range, and standard deviation wereused to describe data from the sample for objectives one, two and four. Inferential statistics on the other hand is concerned with making predictions or inferences about a population from observations and analysis of a sample. In this case, the result of an analysis using a sample was used to generalize it to the larger population that the sample represented. In order to do this, however, according to Eckmek (2003) it is imperative that the sample is representative of the group to which it is being generalized.

For this particular study to address this issue of generalization, tests of significance was conducted. A paired sample t-test was used to analyze data for objective three by comparing maize productivity (in $tonha^{-1}$) before and after adopting land degradation mitigation measures. The binary logistics regression analysis (model described below) provided information on the probability that the results of the analysis on the sample are representative of the population that the sample represents (Eckmek, 2003). In other words, this test of significance provided information on the probability that the results of the analysis could have occurred by chance when there had been no relationship at all between the variables studied in the population under study (Long and Freese, 2006). The content analysis specifically discourse analysis was undertaken to determine meaningful patterns out of collected information.

The following Binary logistic regression model was used for inferential analysis of this study:

$$Y= \alpha+ \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e_i \quad \text{..... (1)}$$

Where;

Y= Afarmer has adopted an intervention practice (Yes 1, 0 otherwise)

α= Constant term

X_1= farmer has access to extension services (Yes 1, 0 otherwise)

X_2= the farmer is a male (Yes 1, 0 otherwise)

X_3= the farmer has alternative source of income (Yes 1, 0 otherwise)

X_4= average farm size in hectares

X_5=1 if farmer is aware of the reason for adoption (Yes 1, 0 otherwise)

X_6= Household wealth status (farm size, amount harvested in bags and number of assets owned)

e_i= random error term

β_1 to β_7= Coefficients

The above mentioned variables in the regression model were all determined using different questions in a structured questionnaire. An exception was the household wealth status that was determined from a free discussion held by the researcher with few experienced farmers in each village. From that discussion a number of criteria for specific wealth sub groups were established as indicated in Table 2. The binary logistic regression model is an appropriate statistical tool to determine the influence of independent variables on dependent variables when the dependent variable has only two groups (dichotomous), for example, adopters and non adopters, and the explanatory variables are continuous, categorical and dummy (Long and Freese, 2006; Shiferaw and Holden, 1998).

In the binary logistic model, the coefficients are compared with the probability of an event occurring or not occurring and bounded between 0 and 1 (Bhattacherjee, 2012). The dependent variable becomes the natural logarithm of the odds when a positive choice is made. The odds ratio and predicted probability of the independent variables indicate the influence of these variables on the likelihood of adoption of improved practice if other

variables remain the same (Long and Freese, 2006). Hence, if the estimated values of these variables are positive and significant, it implies that the farmers with higher values for these variables are more likely to adopt improved land conservation practice.

3.8 Study Limitations

i) Dependency syndrome: It was noticed that some of the farmers could purposely give a response that they were not using inorganic fertilizers expecting the study was prior to the government or any other donor support. To resolve this, objectives and scope of the study were shared with each of the farmer before and were referred to during conducting an interview.

ii) Villagers and District Government misunderstanding: This follows the order by the District council at that time (Specifically the District Natural Resources Department) for the small maize farmers to evacuate the Kagerankanda farming area (where majority of maize farming is undertaken). This was following the fact that, over time from the general land, majority of maize farmers had gradually encroached a section of the protected land area (part of South Makere Forest Reserve). As such, while it was the reality, most farmers could not freely acknowledge were cultivating maize in the Kagerankanda miombo forest area. To resolve this, to each farmer who was identified for this study, the objectives and scope of the study were shared with him/her before conducting an interview.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 IIouschold Characteristics

This section presents the household characteristics of the sampled farmers. It is important to understand these characteristics because they may influence adoption rate of soil conservation practices. Key characteristics which were examined in the study were age, sex, alternative income sources, wealth status, education and household size.

4.1.1 Age

Findingsshow that the age of the 140 household heads ranged from 18 to 75 years with a mean of 41years and standard deviation of 10.75. Fig.3 shows that all respondents (140 or 100%) were adults, that is, they were aged over 18 years. Categorically, majority of the respondents (137 or 98%) were in the age category of 18-64 years. Following the fact that the sample of this study was purposively selected, then the findings have contrary indicated that in the study area there are more production active family members to the study by Gwalema (2010) who also identified in the study area that two thirds of heads of the household (63.9%) were in the active age groups between 15-54. This implies that in the study area there is no shortage of labour for agricultural activities which are the main source of liveilihood, and that there is a higher possibility of adoption of land degradation mitigation measures in the study area due to readily availability of active manpower.

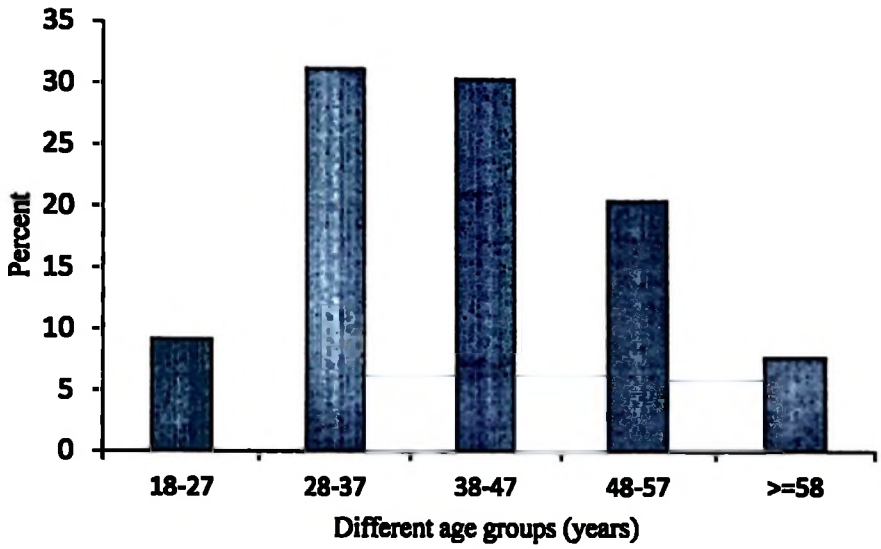

Figure 3: Age of respondents in Years

4.1.2 Level of education

The respondents were of different educational backgrounds. The study findings (Fig.4) have revealed three main groups namely: those who had no formal education, those with primary/elementary education, and those with tertiary education. The findings (Fig. 4) indicate that of the total respondents, 115 (82.1%) had attained primary level of education, followed by 14 (10%) who had no formal education and the rest 11 (7.9%) had attained the secondary and above level of education.

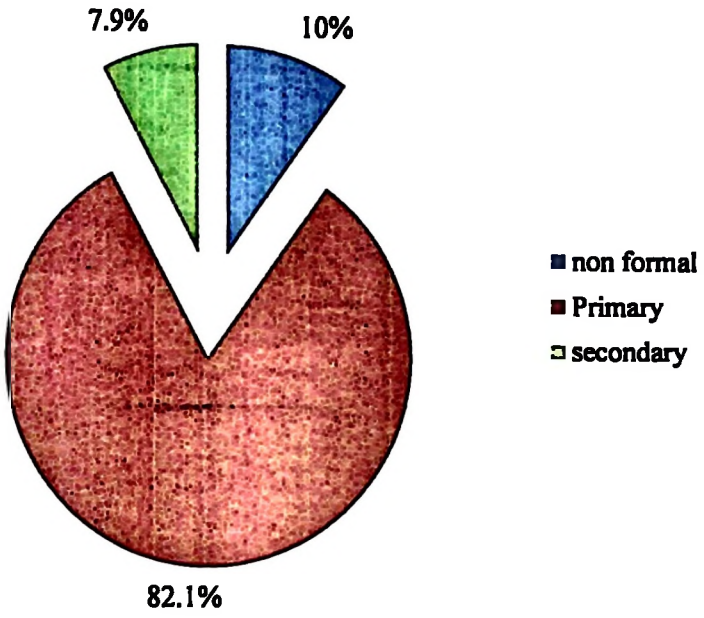

Figure 4: Level of education of respondents (n=140)

With only few (10%) who had no formal education, majority of the respondents had at least attained primary level of education which according to URT (2001b) is universal and compulsory for all children from the age of seven (7) years until they complete this cycle of education. Primary education is intended to equip children with permanent literacy and numeracy; basic life skills and values to enable them function productively in the socio-economic settings of Tanzania and pursue further education and training. The structure of the Formal Education and Training System in Tanzania constitutes 2 years of pre-primary education, 7 years of primary education, 4 years of Junior Secondary (Ordinary Level), 2 years of Senior Secondary (Advanced Level) and up to 3 or more years of Tertiary Education (URT, 2012b).

Comparing Tanzanian Education system to other African countries we note some similarities and differences, for example Primary education in Namibia is split into two phases: five years of lower primary which consists of Grade 0 (pre-primary) to Grade 4,

followed by 3 years of upper primary (Grades 5-7). In other Sub Saharan Africa countries (South Africa, Mozambique, Namibia and Botswana), the target has been that all students should be functionally literate and functionally numerate by the 6th Grade of primary school (approximately 13 years old). That is to say that they should be able to read ashort and simple text and extract meaning from it, as well as be entirely comfortable with arithmetic operations, and be able to use these to make related judgements and interpretations (Nicholas, 2011).

According to URT (2012b), it has also been documented in Tanzania that primary education enables every child to acquire basic skills of literacy, communication, numeracy and problem solving as well as basic learning content of integrated relevant knowledge skills and attitudes needed for survival and development to full capacity. As such majority of the respondents having attained primary level of education are considered educated and, therefore could read and write. These people could be trained to effectively use sustainable land management practices whenever they are available (Ephraim and Nhamo, 2011). However experiences on ground in Tanzania have of recent indicated that while by the time they enter Standard 3, 100% of children should have basic competencies in literacy and numeracy. The reality is that by Standard 3, 7 outof every 10 children cannot read basic Swahili, 9 out of every 10 children cannot read Basic English, and 8 out of every 10 children cannot do basic mathematics (Twaweza, 2010). Consequently during 2013 one of the daily newspapers (Guardian, page 3) reported on 20 February 2013 that:

> *"The National Form IV examinations results released on Monday by the Minister of Education and Vocational training, Dr. Shukuru Kawambwa showed that over 240 000 students out of 397 136 or over 60 per cent of those who sat for the examination scored division zero".*

Ealier, similar argument on level of education to farmers by Oyewo and Fabiyi (2008) was documented that when the level of education is significant, implication is that farmers with more years of formal education tend to sustainably adopt more land conservation practices in maize production, presumably, due to their enhanced ability to acquire technical knowledge.

UNEP (2012) documented the fact that, there are significant social challenges confronting smallholder farmers such as limited formal education and literacy levels that do impair their ability to negotiate equitable commercial contracts with suppliers and customers; apply for governmental support programs; register for land rights and participate in other institutional agreements and entitlements.

If the local people are empowered, they can develop their own initiatives, which may assist in the management of land. Outside assistance should be channelled to develop local people's initiatives so as to build local skills, thereby empowering them to manage the land.

4.1.3 Sex

The study findings indicate that over two thirds (97 or 69.3%) were males while about one third (43 or 30.7%) were females (Fig.5). Provided the sample households were purposively chosen, it cannot be directly concluded that the interviewed respondents were all head of households but rather in absence of the head of household (who are in most cases males) any other family member (wife or older child) responded to the study questions. The available literature including the Tanzania National 2002 Population Census results have however documented that, in the rural areas 32.4 percent of the households and in urban areas 33.6 percent of the households were female-headed

respectively (URT, 2006). The 2012 Census results revealed that, 51 percent of Tanzanians were females and 49 percent were males (URT, 2013a). This is a common pattern in most African Countries.

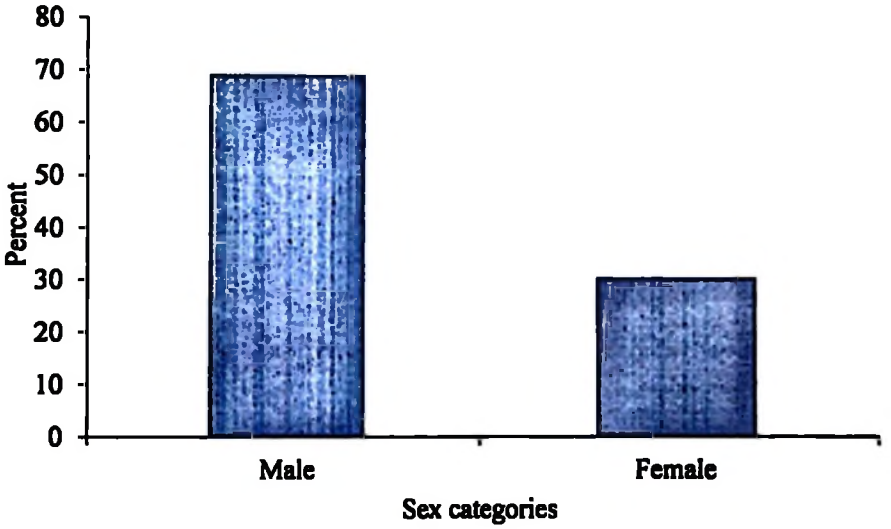

Figure 5: Sex of respondents

From available literature it has been indicated that, approximately 85% of all smallholder farms in the developing world have land areas of less than 2 hectares, and more than half of smallholder farms activities are managed by women (Byerlee *et al.*, 2007). Many of these farms produce subsistence levels of food for the family with little surplus available to sell in local markets for income and hence persistence of poverty (Arumairaj, 2005). Taking into account of other variables (diversity of household assets and the prevailing biophysical, socio-economic environment and the level of policies support) female-headed or male-headed households can have different capacities (resources ownership, knowledge, or social support) in adopting land degradation mitigation measures (Krishna *et al.*, 2008). Thus this variable can take either positive or negative influence.

4.1.4 Size of households

Findings in Fig. 6, indicate that the sampled households had minimum size of 1 person and a maximum of 18 persons with a mean size of 7 persons and a standard deviation of 3.24. This family size mean is higher compared to the Kigoma Region household average size which according to the 2012 census stands at 6 persons while the District's average size is 8 (URT, 2013a). The variation between the regional household size to that of Kasulu District which is higher is due to the fact that during 2012 when the National populationa and housing cencus was conducted, Kasulu Distict population involved included the 63 000 Congolese refugees hosted in nyarugusu camp and 38 000 Burundian refuges hosted in mtabila camp (UNHCR, 2012).

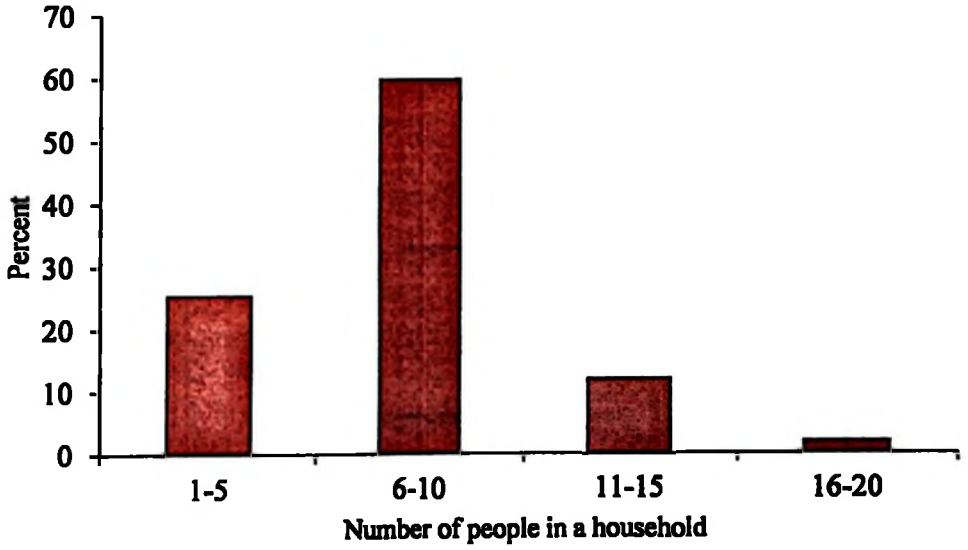

Figure 6: Household size

Based on the findings, it is argued that the effect of family size on the adoption of land conservation practices may be either positive or negative (Demeke, 2003). Larger households will be able to provide the extra labour that might be required during participation in

fertility is very low.Similarly, Dick (2005) argued that households with larger families (higher endowment of family labour) are more likely to adopt land conservation practices of labour-intensive nature.

4.1.5 Distribution of households by wealth categories

The findings from the four villages (Table 2) indicate that two fifth (57 or 40.7%) households were moderately poor, while 45 or 32.1% were poor and 38 or 27.2% were categorized as rich. This classification is based on the criteria mentioned by farmers (food security, level of income, size of owned land and number and quality of owned assets) during the initial study group discussions in each of the four villages. Similar categorization was also adopted by Majule (2010) whose study conducted in Southern Highlands of Tanzania identified three main social groups based on ownership of different assets, size of land resource owned, the number and types of livestock, food and income securities and labour management. This is important because planning of agricultural development interventions must take into account differences in wealth among farmers in order to determine priorities for research and to develop interventions and technical packages that are relevant to and adoptable by majority of the farmers (Shiferaw *et al.*, 2009).

According to URT (2012c, 2013d), it has been documented that, the proportion of the population below the basic needs poverty line declined only slightly from 35.7% in 2000/1 to 33.6% in 2007, and that the poverty headcount rate for the 2011/12 has been estimated at 28.2%. Meanwhile, the incidence of food poverty fell from 18.7% during 2000/01 to 16.6% in 2007 down to 9.7% in 2011/12. With this level of poverty incidence, and given that a large proportion of the population is still engaged in agriculture, it is not surprising that 74 percent of all poor people are primarily dependent on agriculture (Rweyemamu,

2009). Since poverty is predominantly a rural phenomenon, and agriculture is a major economic activity of rural population, it follows that the level of poverty found in rural areas can in no way be disassociated from the over dependence of rural households on subsistence agriculture (Raymond and Emanuel, 2010).

Table 2: Households Wealth Categories

Village name	Poor Indicators	Moderate poor Indicators	Rich Indicators
Nyamidaho	-has insufficient food stock (one meal a day) -owns no assets like radio, livestock , bicycle -sells labor mostly -cant afford children fees to secondary schools -harvests less than 2 bags of maize per season	-has some access to food (two meals a day) -have assets like goats, and bicycle -owns farms -harvests to 5 bags of maize	-has sufficient food (three meals a day) -A plastered burnt brick made and iron sheet roofed house -owns motorcycle or vehicle -afford children fees to private secondary schools -have bank accounts -harvests over 10 bags of maize per year
Kitagata	-harvests 1 bag per season -affords one meal a day -owns no assets like bicycle radio and even chicken - wood and mud made wall house thatched with grasses -has no any cash saving (no purchasing power)	-harvests to 7 bags of maize per season -can afford two meals a day -owns radio and bicycle - bricks made wall house thatched with iron sheets -owns some livestock chicken and goats -have some cash savings (middle purchasing power)	-harvests over 15 bags of maize -affords three meals a day -owns motorcycle or vehicle - a plastered burnt brick made and iron sheet roofed house -owns chicken, goats and cattle -have savings and high purchasing power
Mwali	-owns no assets (radio or bicycle) -has less than 0.5 hectare - wood and mud made wall house thatched with grasses -harvests less than 2 bags of maize per season	-owns 5-6 hectares of farm land - owns radio and bicycle - bricks made wall house thatched with iron sheets - harvests to2-7 bags of maize	-owns over 10 hectares of farm land -owns motorcycle or vehicle -harvests over 7 bags of maize -a plastered burnt brick made and iron sheet roofed house
Nyachenda	-has insufficient food stock (one meal a day) - wood and mud made wall house thatched with grasses -owns no land for production (sold it) -sells labour as has no production	-can afford two meals a day - bricks made wall house thatched with iron sheets -owns 2-3 hectares of land but cant manage them properly (afford weeding and inputs) -food runs out of stock before harvesting season - harvests to 7 bags of maize per season	-affords three meals a day (can sell extra food) -employs poor as labourer - a plastered burnt brick made and iron sheet roofed house -owns means of transport (motorcycle or vehicle) -affords farm inputs -owns over 10 hectares -harvests over 50 bags of maize per season

4.1.6 Alternative sources of household income

Taking into account that maize farming activities was their main source of income and food in the study area, the interviewed farmers also did report that in addition to maize farming they were simultaneously engaged with other microeconomic activities. This information is particulary important to researchers, planners and policy makers as guidance to formulate appropriate policies and programs considering the farmers' interest, socio-economic capacity, and limitation in promoting land degradation mitigation practices for greater acceptance and adoption by the smallholder farmers (Krishna *et al.*, 2008). According to the interviewed farmers, maize farming being their main economic activity contributes to 90% of the household income while the rest is covered by the alternative sources of income as shown in Table 3 whereby each head of household mentioned one main alternative source of income.

Table 3: Other households' sources of income

Alternative income source	Percent
Savings and credit	10.7
Charcoal making/Lumbering	2.9
Petty trading	40.7
livestock keeping	37.1
Beekeeping	2.2
selling labour	3.6
Tobbaco farming	0.7
None (only maize farming)	2.1

4.2 Adoption of Different Land Degradation Mitigation Practices

4.2.1 Adopted land degradation mitigation practices

The study findings show that all 140 interviewed farmers (100%) were engaged in maize farming activities, and only 5 respondents (3.6%) having formal employment in addition to farming activities. The study results have indicated that though at different levels, 79 maize smallholder farmers in miombo areas of Kasulu have adopted different land

degradation mitigation measures and 61 did not adopt any mitigation measure. Specifically, smallholder maize farmers in miombo areas were practicing six different mitigation measures which included construction of terraces, use of inorganic fertilizers, traditional bush fallows, crop rotations and intercropping, combination of different practices and application of cowdung manure.

4.2.2 Adoption rate of different land degradation mitigation practices

The study findings in Fig.7 indicates that 79 farmers (56.4%) out of the 140 sampled farmers had practised at least one or more conservation practices. The rest 61 respondents (43.6%) had not practised any of the land degradation mitigation measures for over three years period consecutively on same piece of land. From the field data, all interviewed farmers mentioned the decline in maize yield due to fertility decline as the key motivation for them to practicing land degaradation mitigation measures. The speficic practiced measures (Fig.7) by the 79 respondents include construction of terraces (42%) that was reported is normally undertaken after the third year since when the new farm is opened in the forest, and thereafter farmers continued with maize farming on the same piece of land (Plate 1).

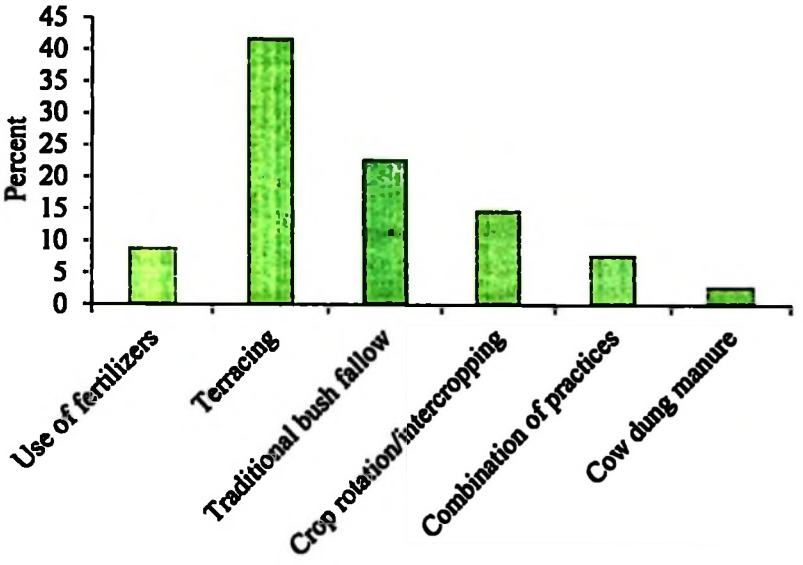

Figure 7: Adoption rate of different land degradation mitigation measures

The study findings also indicate that all interviewed farmers were involved in maize farming as their main food and cash crop for the past two years. Other cultivated crops included a bean that was reported mainly as intercropped with maize. Cassava and groundnuts were also intercropped with maize at small scale. The other crops specifically sorghum, sunflower and *Cajanus cajan* were reported by farmers grown at a very minimal scale.

Plate 1: Terracing (fifth year since farm was opened) for maize growing in miombo forest areas at Nyamidaho village in Kasulu District 2013

Secondly 23% of 79 respondents introduced traditional bush fallow (Plate 2) that include temporary abandoning old farm for about two years following decline in soil fertility (after the fifth year of consecutive maize farming) and opening new farms through clear felling and burning all trees and hence encouraging deforestation (Plate 3).

Plate 2: Traditional bush fallow (six years after farm was opened) in miombo forest at Mwali village Kasulu District 2012

Plate 3: New farm opening in miombo forest at Kitagata village in Kasulu District 2012

Thirdly, 15% of the 79 respondents who adopted conservation measures applied crop rotation (replacing maize with cassava on the same piece of land after the third year of consecutive maize growing) or inter cropping (Plate 4).

Plate 4: Maize intercropped with beans at Nyachenda village, Kasulu District 2012

Crop rotations means introducing sequential cropping patterns to maximize continuity of production (reducing the risk of crop failure). This eventually ensures that if one crop fails, there is still a chance that one or more of the other crops in the system will yield, thus, ensuring greater food security (Anne, 2009). Intercropping on the other hand means a diverse mixture of annual and perennial cash and subsistence food crops grown simultaneously on the same piece of land (Plate 4).

Plate 5: Maize under inorganic fertilizer application at mwali village in Kasulu District 2013

The fourth conservation practice that was mentioned by 9% of 79 respondents was the use of inorganic fertilizers (Plate 5) which due to associated costs most farmers could not afford. The fifth land degradation mitigation practice adopted by (8%) was combination of different land degradation mitigation measures (Plate 6) whereby farmers mentioned were for example practicing terraces construction and intercropping simultaneously.

Plate 6: Maize under combination of land conservation practices (terracing and intercropping) at Nyamidaho village, Kasulu District 2013

Lastly, 3% of the 79 farmers who adopted different land degradation mitigation measures were applying cowdung manure. The field observation also identified some maize farms whereby due to a combination of reasons (possibly fertility decline, late planting, quality of seed or late weeding) the maize were severely stunted (Plate 7).

Plate 7: The stunted maize crop (front) and normal growth (rear) at Kitagata village, Kasulu District 2013

Astudy by Stoorvogel and Smaling (1990) indicated that per-hectare annual nutrient losses (depletion rates) were highest in East Africa, exceeding 40 kg Nitrogen, 15 kg Phosphorus, and 40 kg Potassium. Organic sources alone cannot overcome these nutrient deficits. It has been estimated that two hectares of land planted to leguminous plants are needed to provide nitrogen for one hectare of maize (Michael and Walter, 1997). This signifies the fact that organic land degradation mitigation measures improve the land fertility. However, they require availability of labour,. means of transport and they should always be applied in combination with other conservation measures and not solely on a given piece of land.

Alternatively, it has also been documented that, the more crops produced by increasing output on existing cropland using inorganic fertilizer, the less the pressure to convert forests and other marginal and fragile lands to agricultural uses. Increased fertilizer use will increase crop residues, and a larger portion of them can be left on the soil to increase its organic matter, protect soils from erosion, and improve soil structure (Zoé and Jesús, 2012).

However, to achieve the above mentioned environmental sustainability, there is a need to establish strong extension services for timely communicating relevant technologies to smallholder farmers. Site specific research based fertilizer recommendations and consistent agronomic recommendations and follow ups are few.

Further analysis of resultsin Fig. 8 on farmers' preferences over different mitigation measures indicate that, of the 79 respondents who adopted different land degradation mitigation measures, 45 of them (57%) more frequently practised terracing, and therefore this was the most preferred amongst adopted land degradation mitigation measures.

Second most preferred was crop rotation and intercropping practised by 18 farmers (24%). The rest below 10% preferred applying inorganic fertilizer by (6 or 7%); cow dung manure and those doing combination of the interventions were both preferred by 4 farmers (5%) respectively, and 2 farmers (2%) were opening new farms in the forest.

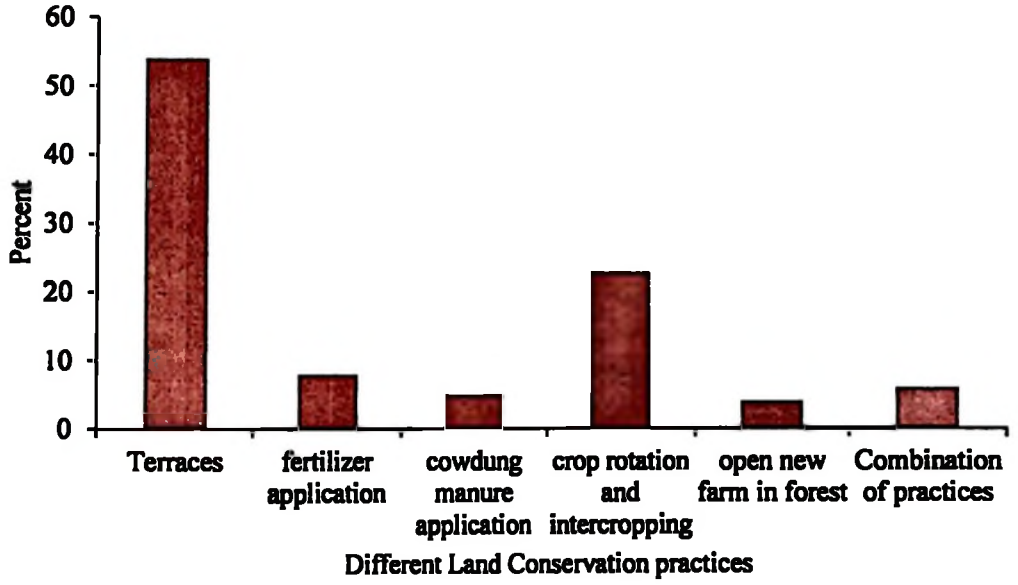

Figure 8: Farmers preference over different land conservation practices

The field data have demonstrated that due to declining soil fertility farmers adopted various mitigation strategies in their maize farms, as indicated in Fig. 8 majority were practicing the construction of terraces and rotation of crops or inter cropping. While it it can not be concluded that all changes in productivity (kg) of maize were due to farming practices alone and specifially terraces or intercropping application, similarly results in Table 4 demonstrates the significant variation on the amount of maize harvested (minimum to maximum) in Kilograms per hectare before and after practicing the land degradation mitigation measures and the average productivity in Kilograms.

Table 4: Maize productivity (Kgs) before and after mitigation mesures

	N	Minimum	Maximum	Mean	Std. Deviation
Productivity before mitigation	140	0.00	1000	334	213.5
Productivity after mitigation	140	100	1500	523	327.9

According to Maitima *et al.* (2009) it has been documented that the decline in soil productivity in most cultivated soils in East Africa leads to yield declines. This decline in yield has been attributed to the loss of plant nutrients through poor farming practices, plant removal, erosion, leaching and deterioration of soil physical conditions.

4.2.3 Factors contributing to adoption of land degradation mitigation measures in Kasulu

In addition to the assessed sample background variables, this study also assessed socio-economic factors contributing to adopting of the mentioned land conservation practices. According to Nkegbe *et al.* (2011) it has been documented that in Northen Ghana farmers' conservation decisions, and the utilization rate of both improved and traditional soil conservation measures, were influenced by a combination of social, economic, institutional, and agroecological factors. These included age, level of formal education in the household, farm size, tenure security, labor availability, number of extension visits, and natural resource management policies.

A number of variables were considered for their contribution towards the adoption of the land degradation mitigation measures. These included the farmers' access to extension services, size of their farms, farmers' awareness on the reasons for adoption, involvement into alternative income generating activities and wealth status of the household.

4.2.3.1 Learning of conservation practises by farmers who adopted land degradation mitigation measures

Findings from the field indicate that of the farmers who had adopted at least one or more of the mitigation practices only 23.6 % had formally learnt the adopted conservation practice. The rest 76.4% were adopting conservation practices, while they had never formally learnt the conservation practices. Correspondingly, the main sources of information and hence learning of the conservation practices were mentioned as either own initiatives (58.2%), from sharing with neighbour farmers (25.3%), from NGOs and CBOs training sessions (8.9%) and lastly from extension officers (7.6%).

4.2.3.2 Access to extension services

From the findings, of interest was how access to extension services related to the adoption of the land degradation mitigation measures. Findings from cross tabulation have indicated that of respondents who had adopted different land degradation mitigation measures (76%) had not accessed extension services but yet had adopted at least one of the land degradation mitigation measures as indicated in Table 5.

Table 5: Relationship between land degradation mitigation measure and access to extension services (n=79)

Adopted land conservation practice	Access to extension services	
	No	Yes
Use of fertilizer (%)	2.5	6.3
Terracing (%)	30.4	11.4
Opening a new farm (shifting cultivation) (%)	21.5	1.2
Crop rotation/intercropping (%)	12.7	3.8
Combination of practices (%)	7.6	0
Cow dung manure (%)	1.4	1.2

Traditional knowledge (the wisdom, knowledge, and practises of the indigenous people) gained over time through the experience and orally passed on from one generation to the other has, over the years, played a significant part in solving problems, including

problems related to land degradation (Ephraim and Nhamo, 2011). The implication of this finding is that farmers have on their own struggled to improve their farming system, and therefore the extension system has a room to further improve farmers' knowledge for sustainable results. The remaining 19 farmers (24%) had accessed extension services at least once and consequently had practised some mitigation measures.

On the contrary, 22.6% of 61 farmers who had not adopted any of the mitigation measures had fortunately accessed the extension services. This demonstrates the conservatism nature of the rural smallholder farmers and that adoption of any land degradation mitigation measure is a process.

4.2.3.3 Farm size and adopted land degradation mitigation measures

The study findings in indicate that the minimum farm size per household which adopted mitigation measures is on hectare, the maximum are 29 hectares with a mean of 4.05 hectares and standard deviation of 3.51. This farm size is above the national average which is estimated at 2.0 hectares per household and the regional average of 0.82 hectares (URT, 2012a). This finding indicates that there are big variations (from the mean) in the size of farms cultivated by maize smallholder farmers who adopted land degradation mitigation measure. In other words majority of the maize farmers who adopted land degradation mitigation measures in the study area owned varied farm sizes compared to the mean farm size.

The relationship between adopted land degradation mitigation practise and the size of the farm was also assessed using cross tabulation as indicated in Table 6. Generally, 85.7% of the 140 sampled households owned farms with size in the range of one to six hectares. The specific groups findings indicate that of the 79 farmers who adopted some degradation

mitigation practises 62 farmers or over three quarters (78%) owned farm sizes above six hectares (moderate poor and rich) as classified in wealth ranking in Table 2. The opposite trend is observed to those 61 farmers who did not adopt any of the landdegaradation mitigationpractises; within this category 51 farmers (84 %) owned the farms of less than five hectares. This group, according to the wealth classification (Table 2) that was conducted by farmers in the four villages under this study was ranked as poor.

Table 6: Relationship between adopted land degradation mitigation measures and owned farm size in hectares (n=140)

Land conservation practices	Average farm size in hectares					
	1-5	6-10	11-15	16-20	21-25	26-30
Use of fertilizers (%)	0	0	2	2.5	2.4	2.4
Terracing (%)	2.5	10.1	29.1	0	0	0
Fallowing (%)	1.2	8.7	6.3	2.8	2.5	1.2
Crop rotation/intercropping (%)	11.4	3.7	0	0	0	0
Seek extension officer support (%)						
Combination of practices (%)	1.2	0	0	0	0	0
Cow dung manure (%)	5	2.5	0	0	0	0
	2.5	0	0	0	0	0

Comparatively, from cross tabulation results in Table 6, results further confirm the effect of wealth status of the households in adopting the land degradation mitigation measures. Following the high costs of fertilizers, majority of farmers who afforded to apply inorganic fertilizers were those owning over 10 hectares of land who according to the farmers classification during wealth sub groups establishment (Table 2) were regarded as rich farmers. Alternatively, majority of poor farmers opted for crop rotations or terracing that relatively required less capital. Similary, (Krishna *et al.*, 2008; Tadese and Belay 2004) documented that the economies of scale influence the adoption of land degaradation mitigation measures, normally the production input and transportation cost of the products decreases gradually as the farm size increases raising the profitability for farmers hence motivating them for further adoption.

4.2.4 The influence of different social economic factors on adoption of different land conservation practises

The Binary Logistic Regression model was applied and the results in Table 7 indicate a number of socio-economic factors have significant influence towards adoption or non adoption of the land degradation mitigation measures.

Table 7: Binary Logistic Regression table (n= 140)

	B	S.E.	Wald	df	p.value	Exp(B)
Access to extension services	2.004	1.919	1.090	1	0.296	7.421
Alternative income source	-2.400	1.319	3.311	1	0.069	0.091
Household wealth	.746	.324	5.292	1	0.021	2.109
Farm size	.842	.387	4.743	1	0.029	2.321
Sex	2.647	1.247	4.503	1	0.034	14.114
Adoption reason	-3.242	1.109	8.551	1	0.003	0.039
Constant	-7.248	3.069	5.578	1	0.018	0.001

Four out of the six variables included in the model were found to influence adoption of land conservation practices at different level of significance. From Table 7, results indicate that the following variables are statistically significant in influencing adoption of mitigation measures. The first variable was household wealth. Results in Table 7 indicate that wealth was also statistically significant (p=0.02). Regression analysis indicates that wealth of households in which respondents belong to have an influence on adoption of land degradation mitigation measure. The coefficient of wealth is positive, which means the houscholds with better wealth status (rich as per. villagers classification) are more likely to adopt mitigation practices.

The average farm size (hectares) was the second variable in regression model. The coefficient for the farm size is being positive implies that increasing in farm size had positive influence on adoption of land conservation farming practices. In other words

farmers who hold large farms are more likely to adopt improved land conservation practises. The Wald statistics showed that there was significant influence (p=0.029) on adoption of land degradation mitigation measures. This is similar to the findings by Amsalu and Graaff (2007), who found that large farmers are more likely to invest in soil conservation measures. Farmers with more land can take more risks, including relatively high investment, if required and survive crop failure due to pests, drought and or excess rainfall. This indicates that the bigger the landholding size, the higher the probability of adoption of improved land degradation mitigation measures.

Understanding of the reasons for adoption of the conservation practices by farmers constitutes the third factor that influences adoption of land degradation mitigation measures. Results from regression analysis in Table 7 indicate the coefficient is negative implying farmers who were much aware of the reasons for adoption of the mitigation measures were less likely to adopt the land degradation mitigation measures. The reasons for adoption of conservation practices had significant (p=0.003) influence. However, it is argued that awareness on land conservation outcome is an important tool and component of any land conservation program that intends to ensure wide spread acceptance and adoption of land conservation measures by smallholder farmers (Tadesse and Belay, 2004; Shiferaw, 2009).

The other two variables particularly whether the farmer had an alternative source of income or not was not significant (p= 0.069) and the regression coefficient was positive. According to available literature there are in rural Nepal, nuclear and joint family systems, off-farm employment (alternative income generating activities) of family members in a joint family system employed in the local area, for example, as school teachers or extension workers, significantly influenced the adoption of improved land conservation

practice or technology. The rate of adoption was found to be higher in those households whose family members are employed in off-farm occupation (Krishna *et al.*, 2008).

Interestingly, the access to extension services was found to be not statistically significant (p= 0.296), this was possibly because only 34 farmers or less than a quarter (24.2%) of sampled farmers reported to have accessed the extension services as indicated in Table 5. However, according to Ligonja and Shrestha (2013), access to extension services may provide knowledge on conservation measures and make farmers increase adoption of mitigation measures. The issue of access to extension services was as well raised by most of the interviewed farmers as a key barrier for them to sustainably adopt land degradation mitigation measures.

4.2.5 Other factors contributing to improved maize production

Land degradation in miombo woodland is more than an environmental problem alone and should be considered holistically, taking into account different ecosystem goods and services, biophysical as well as socio-economic factors (Giliba *et al.*, 2011). Although the maize yield decline through time cannot be attributed to land degradation problem alone, farmers felt it and repeatedly mentioned that poor farming practices had played a significant role to land degradation and hence decreasing maize productivity. From the sample households, 90.7% mentioned land degradation related reasons as the underlying cause for productivity deterioration of their maize farmland as shown in Table 8.

Table 8: Factors for decreasing maize productivity

Factors	Percent
Soil infertility	37.7
Increased weeds and farming costs	23.7
Soil pests and climatic condition	5.0
All the above	29.3
None	4.3

Accorring to Dewees (2011), a number of limitations have restricted sustainable management of miombo woodland resulting into its degradation. Specifically they include biophysical factors which are limits posed by ecology for improving productivity; policy barriers preventing better management of the miombo; economic barriers that limit incentintives for improving management and organizational and institutional barriers.

The study findings also identified other maize productivity influencing factors which included the amount of rainfall per season, planting date, soil type, and the type of the seed planted (local or improved variety) of which interviewed farmers reported were mostly uniform and its influence towards maize yield was very minimal in the study area during the study period.

4.3 Land Degradation Mitigation Measures Effectiveness

This section discusses the difference observed in the maize productivity ($Kgha^{-1}$) under two different farming practices, which are when a farmer has adopted any land degradation mitigation measure while growing maize and when he/she has not practised any mitigation measure. Each farmer within the two respective groups was asked to mention size of his farm (in hectares) and the amount of maize (in bags) he/she had harvested during the recent harvesting season (August, 2012). These were later converted into Kilograms per hectare (Table 9).

Table 9: Average maize productivity (kilograms per hectare)

Maize productivity	Mean	n	Std. Deviation	Std. Error Mean
Productivity on adopting mitigation (Kgs/ha)	334	61	213.5	±18.05
Productivity while not practising mitigationmeasures(Kgs/ha)	523	79	327.9	±27.72

The recorded mean maize productivity by farmers not practising mitigation measures was recorded at 334kgha^{-1} or 0.334 tha^{-1}, while by those farmers practising at least one or more of the mitigation measures improved to 523kgha^{-1} or 0.523 tha^{-1}. This amount of harvested maize (by farmers practising mitigation measures) is by 60% less than the Kigoma Region average maize productivity of 1.3tha^{-1} which tallies with the national productivity average of 1.3tha^{-1} (URT, 2011a). The similar yield is 58% of the current recorded District mean productivity of 0.9 tha^{-1} (DALDO, 2012). Arguing on the same, Msuya *et al.* (2008) documented that the maize smallholder productivity in Tanzania is very low and highly variable, ranging form 0.01tha^{-1} to 6.77tha^{-1}, averaging 1.19tha^{-1}.

Similarly, when a paired t-test was applied to compare the means, results in Table 10 indicated there was statistically significant difference ($p<0.001$) in productivity under the two different maize farming practices. These research findings in Tables 9 and 10 reveal a mixed success when a variety of land degradation coping strategies are applied, the effect of land degradation on maize yields is evident, which suggests that the amount of maize harvested by smallholder farmers in the study area have significantly been affected by the land degradation.

Table 10: Difference in productivity for farmersadopting varied land degradation mitigation measures and those not adopting (n=140)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Productivity while mitigating– Productivity while not mitigating	-189	169.6	±14.3	-217.3	-160.7	-13.2	139	<.0001

The findings indicate that practising mitigation measures have significantly improved maize productivity compared to when a farmer is not practising mitigation measures. At the same time, these findings as indicated in Table 9 means that even those farmers who are investing in the land conservation practices as a measure against land degradation are at the same time harvesting very low maize per unit area. This may be due to the fact that by the time (mostly after third year of consecutive farming on same piece of land) farmers decide to apply some mitigation measures the land is significantly degraded. Irrespective of the fact that majority (91%) of the sampled maize farmers head of households reported weed their farms not less than twice in one growing season as indicated in Fig. 9, and that there was no shortage of rain in the study area for the past two years, still the level of maize productivity after the adoption of the land degradation mitigation measures was far less than the recorded national, regional and District's average maize productivity.

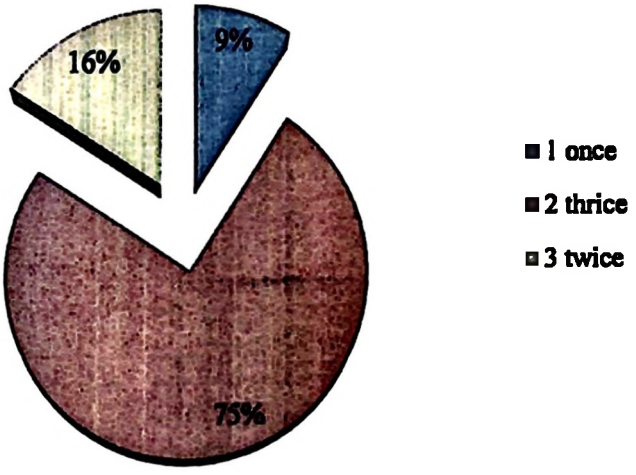

Figure 9: The maize farms weeding frequency in miombo forests in Kasulu

From the study findings, majority of the farmers reported that one of the common indicators for significant decrease in soil fertility due to land degradation in the study area was massive growth of various weeds in their maize farms. According to Hein*et al.* (2008), it has been documented that due to increasing population pressure, it has been noted in the miombo woodland that the long periods of fallow with short periods of farming have been replaced by long periods of farming with short fallow periods. This practice does not allow sufficient time for revegetation and recovery of soil fertility. As a result, large tracts of land have lost their vegetation cover and are exposed to further degradation through soil erosion, or infestation by weeds, pests, and diseases. Arguing on the same Gandhiv (2011), documented that when the fallow period goes below 3 to 4 years, soil fertility is not renewed, and erosion and weed competition increase dramatically.

Irrespective of these efforts by individual farmers and given that the amount of rainfall received was also reported to be average, and that majority of the smallholder maize farmers planted local maize variety, these findings signify the fact that land degradation is the key reason for the reduced maize harvests in miombo areas of Kasulu District.

The above findings demonstrate the effect of land degradation following poor farming practices on the amount of maize harvested per unit area in the miombo woodlands of Kasulu District. Similar results have also been documented by Hein *et al.* (2008) that the key factors of the low maize yields in miombo areas include an extensive nature of farming, a weak technological base, and poor agricultural extension support services. Explaining solution on the same subject Ephraim and Nhamo (2011) noted that when there is partial success after the use of traditional knowledge in coping with land degradation,

this calls for a healthy relationship between scientific knowledge and traditional or indigenous knowledge, which both have limitations.

4.4 Challenges Facing Adoption of Mitigation Measures

Land degradation is clearly a cause for concern. It puts the productive potential and general well being of communities at risk because it results in a significant reduction in economic, social and ecological benefits of land for crop, livestock and tree production purposes. Irrespective of the fact that farmers who adopted the land conservation practices have recorded improved maize productivity as the results indicate, at the same time farmers have been experiencing some challenges that limit them to sustainably adopt the land degradation mitigation measures. Generally, out of the total 140 respondents, 128 (91.4%) mentioned to have experienced challenges as they practise land degradation mitigation measures, these include both who had adopted none of the mitigation measures and those practiced some measures.

These findings imply that even those who are practising the landdegradation mitigation measures were at the same time experiencing some challenges as well. This is possibly the reason as to why the level of maize productivity even after the adoption of the mitigation measures was far less than the recorded national, regional and district's average maize productivity. Further analysis of the results in Table 11 also indicates that 55 respondents or about two fifth (39.3%) of all respondents mentioned lack of technical know how as their first main limitation to adopt land degradation mitigation measures. These include training and practical demonstrations from extension officers on improved farming practices. This corresponds to what was observed in Ghana by Edwin *et al.* (2011) who emphasized the importance of educating farmers to minimize illiteracy and conservatism which limit the ability to adopt innovative land conservation practices, and as his

suggestion he mentioned that a solution lies in education. It is a recognized fact that the diffusion of information on improved land conservation practices is an important element that contributes positively for thea doption and sustained use of a given practice (Posthumus, 2012).

Unless there is an adequate mechanism for transmitting information, the adoption of any land degradation mitigation measure would not be successful. Lack of relevant and timely information can prevent a widespread adoption of conservation practice. In the study area, the most important sources of information cited were own experiences, through communication with relatives and neighbours, NGOs and CBOs and the government's agricultural extension system. From the results, the other (35 or 25 %.) mentioned increased time and costs in farm activities as their main limitation.

Table 11: Challenges for adopting land conservation practices (n=140)

	Percent
Fertilizers areexpensive and late delivered	15.0
No training on improved farming practices	39.3
More time/cost in farm activities	25.0
All the above	12.1
None	8.6

The second challenge that had been mentioned by 21 farmers (15%) was the cost of farm inputs specifically inorganic fertilizers which were mentioned to be expensive for smallholder maize farmers to afford, and at times when subsidized fertilizers are supplied by the government, they always arrive in the respective villages very late. The issue of farm inputs cost is as well reflected in the 2007 Poverty and Human Development Report (URT, 2007a) which showed that 87 percent of Tanzanian farmers interviewed by the research and analysis group under Tanzania's NSGRP said that they were not using chemical fertilizers; 77 percent said that they were not using improved seeds; 72 percent

said that they were not using pesticides, herbicides or insecticides (agrochemicals), due to the high costs of agricultural inputs and services.

As an example, during focus group discussions, farmers in Nyamidaho and Mwali villages reported that subsidized farm inputs (improved seeds and fertilizers) under the voucher system for 2012/13 maize crop planting season were received by the respective village governments in December 2012, while the planting season was from September to October 2012. According to FAO (2012a), the voucher systems have the additional advantage of bringing greater flexibility in the implementation of the farm input subsidy and greater transparency (tracking of delivery and use). On the negative side, they involve higher financial and administrative costs (linked to the production and to the distribution and allocation of vouchers and finally to the reimbursement of suppliers) and are prone to fraud (counterfeit vouchers) or to the creation of secondary markets.

According to Mohamed *et al.* (2012), this system has become highly politicized and, as such, unsustainable in the long term. While there is a clear consensus about input vouchers being a preferable delivery mechanism to direct distribution, proper implementation, monitoring and close evaluation is necessary in order to reap their potential benefits (Zoéand Jesús, 2012). According to URT (2007b), the current arrangement scheme (vouchers) benefits the middle business persons as opposed to the targeted smallholder farmers.

The third challenge that had been mentioned by 35 respondents (25%) was the increased time and cost in farm activities (Table 11). This was the case when there is land degradation and farmers can either construct terraces or establish the traditional bush fallow and required to cultivate new maize farms in the miombo woodlands. This activity

requires much more labour which in case a farmer can not afford, he/she uses fire to burn all trees cleared. Explaining on the same, Kabamba and Muimba (2009) documented that farmers in Zambia kept on adopting the land conservation practices despite the hard work associated with land conservation practices especially when a farmer adopts the practice for the first time. The findings also indicate that 12% of the respondents had experienced a combination of challenges simultaneously, and 8.6% experienced none the challenges.

Irrespective of the mentioned limitations, still maize production in Kasulu District has greater chance of contributing towards poverty reduction efforts, given the fact that there is fertile land availabile, conducive climate for maize cultivation, existence of the newly established Mubondo Agricultural Training College, and the potential existing maize markets in Burundi, Rwanda, and the Eastern part of Democratic Republic of Congo due strategic location of the study area. It is also worth mentioning that amidst all the problems mentioned by the farmers, there were opportunities. Perhaps, the most outstanding one was the sheer enthusiasm of farmers to adopt land degradation mitigation measures.

4. 5 Reasons for Adoption of Land Degradation Mitigation Measures

The study findings in Fig. 10 indicate that, the interviewed farmers were aware of the reasons and consequences that would face their households following maize yield decline due to fertility decrease following land degradation. Of the 61 respondents who had not adopted any land degradation mitigation measure, 47 of them (77.1%) mentioned lack of sufficient knowledge to adopt improved farming practices being the key reason.This reason mentioned by farmers closely matches with the previously mentioned main challenge of insufficient extension services support to both groups. This was regardless of the fact that, the same farmers acknowledged were aware of the consequences they had ever experienced following land degradation in their maize farms, of which they

specifically mentioned a decrease in maize yield, food shortage, decreasing income and consequently persisting poverty. According to Shiferaw *et al.* (2009) farmers also find themselves highly constrained to adopt and adapt otherwise profitable (or economically attractive) interventions due to poverty, imperfect information, market, policy, institutional and other limiting factors. These factors can be broadly categorized into incentive and market factors, poverty and capacity factors, policy and institutional factors, participation and information factors, and environmental factors. This is similar to what Imoke (2012) found out in Nigeria that as land becomes less productive, food security is compromised and competition for dwindling resources increases (poverty), the seeds of famine and potential conflict are sown.

The other 10 farmers (17.1%) mentioned increased farming activities costs particularly additional costs for land preparation and weeding frequency as the key reason for them not mitigating land degradation. The same argument has been mentioned previously as part of the challenges facing adoption and practising of the mitigation measures. The rest 4 farmers (5.8%) who did not adopt mitigation measures mentioned no any specific reason. The last reason is due to the economic characteristics of natural resources like land, water, forests, and biodiversity, which are generally regarded as public goods (to which access is nonrival and nonexcludable) or common pool goods as pertheory of collective goods (World bank 2006; Watcher 1992).

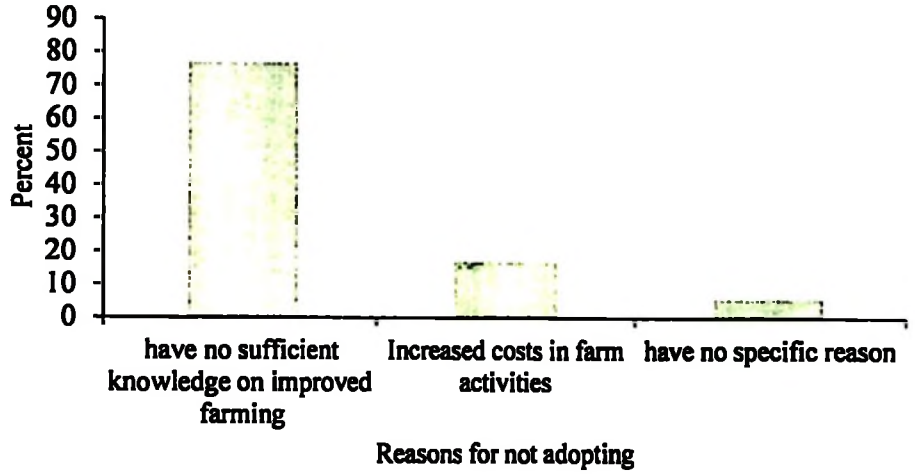

Figure 10: Key reasons for not adopting degradation mitigation measures

Alternatively, findings in Fig.11 indicate that the key reasons (motivation) mentioned by 46 farmers (59.3%) of the 79 farmers who adopted the land degradation mitigation measures were mainly the decreased yield and income. Other19 (23.6%) mentioned that with limited resources they had, they did adopt land degradation mitigation measures to avoid the tedious and extra labour demanding weeding frequencies and clearing miombo forests activities during fallow periods when they had to establish new farms in the forest.

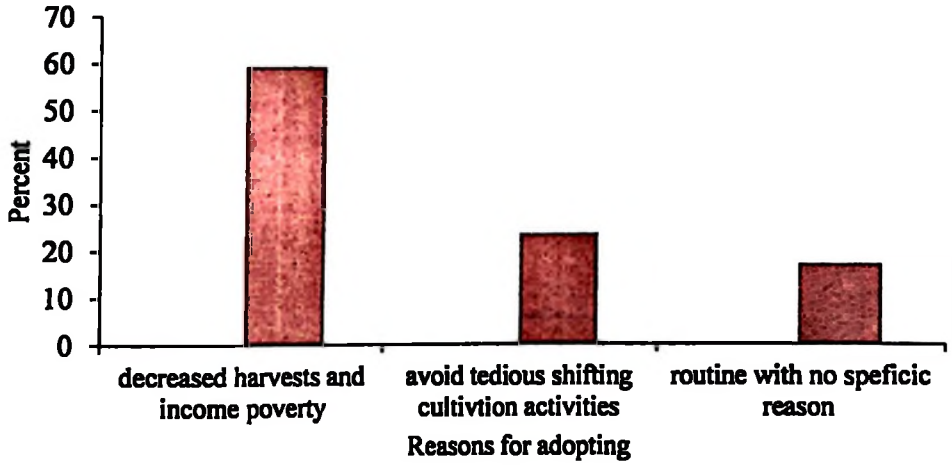

Figure 11: Key reasons for adopting degradation mitigation measures

The study findings in Fig. 11 indicate 14 farmers (17.1%) practised mitigation measures as their routine with no specific reason (conservatism), which is due to old behavior of cultivation practices embedded in farmers for long period (Tadese and Belay, 2004). This is due to the fact that farmers' decision to adopt new technologies at any time is influenced by the combined effect of socioeconomic, demographic, institutional and biophysical factors, which are related to their objectives and constraints.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study attempted to identify barriers which influence adoption of land degradation mitigation measures in Kasulu District. From the study findings all farmers in the study area cultivate maize in miombo woodlands and therefore to them land degradation results in diminished land based livelihood opportunities. This is because overall production per unit area for maize is low, due to deteriorating soil fertility while maize is their main food and cash crop.

Findings indicate that, maize smallholder farmers in Kasulu District are aware and concerned with the ongoing land degradation due to poor farming practices. Findings further indicated some land degrading practices including farm preparations using fire, repeated mono cropping and clear felling of trees are practised. Due to experiencing some land degradation consequences, over half of the sampled households have invested efforts in minimizing its effects through practicing terracing, crop rotation and intercropping, cow dung manure application, inorganic fertilizers application as well as traditional bush fallow for the periods of not less than two years.

The findings show that major factors influencing adoption of land degradation mitigation measures in the study area are: farmers' understanding on reason for adoption; farm size and wealth status of the household. An important implication of the factors assessed in this study is that any intervention against land degradation should recognize the heterogeneity in household characteristics. This study results has indicated that the difference in the maize yield per unit area between those farmers practising land degradation mitigation

measures and those who are not was statistically significant. However comparatively, it has also been identified that the outcome following the adoption of different land degradation mitigation measures has remained unimpressive, as the average maize harvested per hectare remained far below the Global, National and District's records.

The key challenges mentioned by farmers are specifically lack of supportive extension services, high costs of the farm inputs, conservatism and the increased labour costs in adopting the land degradation mitigation practices (as majority of farmers are poor).

The fact that farmers acknowledged did adopt the land degradation mitigation measures against threats posed by land degradation to their livelihood has positive implications for sustainability of any land conservation initiatives in future. This is particularly an opportunity for those initiatives which would target to minimize land degradation, enhance ecosystem functioning, improve agricultural productivity and, through these, it will help to improve the generally poor rural living conditions of maize farmers in Kasulu District.

5.2 Recommendations

Given the significant role, that farmer's knowledge plays on practising land degradation mitigation measures in maize production in the study area (as this was the key challenge mentioned by most maize farmers), from this study the following recommendations are made:

(i) To improve the continued sharing of technical information with smallholder maize farmers, the District government should strengthen the existing agricultural extension services in terms of improving the human, financial and material resources including demonstration plots establishment in the study area.

(ii) Given the significance on livelihood of the land degradation problem, the District should practically support farmers to learn from projects providing the long term solutions to the threats affecting biodiversity and livelihoods in the Miombo woodlands. The threats include deforestation and land degradation resulting from poor farming practices, land clearance and burning for agriculture (Tabora Region is starting from 2013 implementing such project).

(iii) In collaboration with farmers, efforts should be made (by different development stakeholders) to identify, introduce and support new cash crops to minimize the dominance of one crop as both cash and food crop.

(iv) Support development and smooth implementation of by-laws (that will be developed by farmers themselves) to control and minimize extensive farming system, and encourage trees plantingby smallholder farmers including land use plans development.

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APPENDICES

Appendix 1: IIouschold questionnaire

CIIALLENGES ON LAND DEGRADATION MITIGATION STRATEGIES

Questionnaire No. ☐

Date of interview:_____Name ofenumerator_____

Name of person doing qualitycheck_____

Sub-village:_____Village:_____

Ward:_____Division:_____

District:_____Region:_____

Household wealth status (established through wealth ranking exercise at village level)

1=Rich; 2=Normal/average 3=poor (tick off what is appropriate)

Section 1: Basic Information

1. Name of household head_____
2. Name of respondent_____
3. Age of respondent_____years
4. Sex of respondent (1) male_____ (2) Female
5. Education: years of education of respondent
6. Marital status: (1) Single____(2) Married____(3)Widow_____(4)Divorced
7. Household size _____members
8. Household structure (1) Children_____(2) adults_____
9. Household main economic activity (1) Farming (2) Livestock keeping (3) beekeeping (4) petty business (5) charcoal making 6) formal employment
10. What are the household alternative income generating activities

a)_____b)_____

Section 2: Interventions for Land Degradation

11. Has your household been involved in maize farming during the last 2 years?
    1) Yes
    2) No
12. If the answer is yes, what has been the location of your cultivated maize farm?
    1) in the forest
    2) around the homestead
13. What has been the size of your farm?
    a) last season_____(acre)
    b) this season_____(acre)
14. Did you plant maize with other crops
    a) Yes
    b) No
15. If yes what crops a)_____b)_____c)_____
16. What has been the source of labour for your maize farm activities?
    a) family members
    b) neighbor support
    c) hired labour (local)
    d) hired labour (refugee)
17. How many family members did participate in the farming activities during the last two seasons?
    a) last season_____(persons)
    b) this season_____(persons)
18. In case there are no family members, how much does it cost to pay for the labour to cultivate one acre? _____Tsh for Tanzanaia laborer and Tsh_____ for refugee labourer
19. Have you ever expericnced any land related constraint in your maize crop production?
    1) Yes
    2) No
20. If yes mention them
    a)_____
    b)_____
    c)_____

21. What have you been doing to avoid/minimize the above experienced problems?

a) using inorganic fertilizers

b) terracing

c) shifting to new farming site in the forest

d) introduce new crop in the same farm

e) consult the extension officer for advice

f)Other_____

22. How do the above mentioned consequences affect the welfare of your household?

a)_____

b)_____

c)_____

Section 3: Adoption of the Land Conservation Mitigation

23. Have you ever learnt any land conservation mitigation practice?

a) Yes

b) No

24. Have you ever adopted any land conservation mitigation practice?

a) Yes

b) No

25. If YES, what have you been doing to mitigate/minimize the effects of the problems mentioned in QN 20 above?? (If No go to QN 28)

a)_____

b)_____

c)_____

26. For how long have you been practicing that?

a) 1 year

b) 2 years

c) Above 3 years

27. Where did you learn the interventions to mitigate land degradation from?

a) Government extension Officer

b) From a neighbor farmer

c) Own initiative (Indigenous knowledge)

d) NGO/CBO

28. What have been the key reasons for you to adopt or not adopt the land degradation mitigation Practices?

a)_____

b)_____

Section 4: Effectiveness of the Mitigation Strategy

29. Specifically what land conservation practice have you mostly been applying?

a)_____

30. What has been your maize production under two different farming prctice?

a) After practicing the land conservation practice_____bags per_____acre

b) Before practicing the land conservation practice _____bags per_____acre

31. How was the amount of rainfall during the last two seasons?

a) Above normal

b) Normal

c) Below normal

32. Did you access any extension services within the last two years?

a) Yes

b) No

33 How often do you access extension services per annum?

a) weekly

b) monthly

c) Quarterly

d) bi annually

e) Annually

34. Have you applied any inorganic fertilizer in your maize farm during the last two seasons?

a) Yes, mention the amount of fertilizers_____kgs per _____acre

b) No

35. In the last two seasons what category of maize seeds did you plant?

a) Local variety

b) improved variety

36 For the last two seasons how many times did you weed your maize farm?

a) Last season did weed _____ times

b) This season did weed _____times

37. What has been the additional cost of implementing the above mentioned land conservation practices? _____Tsh per acre

38. What has been the additional time of implementing the above mentioned land conservation practices? _____Days per acre

39. How do you link the relationship between application of the mitigation practices and maize productivity?

a) Positively correlated

b) no correlation

c) negatively correlated

Section 5: Farmers Experience on Adopting the Interventions

40. What opportunities can you mention as your experience while learning and adopting the land degradation mitigation Practices?

a)_____

b)_____

c)_____

41. Are you aware of any policy, Act or bylaw addressing land degradation issues?

a) Yes , Mention_____

b) No

42. What challenges can you mention as your experience while learning and adopting the land degradation mitigation Practices?

a)_____

b)_____

c)_____

43. What are your overall comments over the ongoing shifting cultivation around your village?

a) Does not have any negative effects

b) Have some negative effects example_____

c) I don't know anything on that

44. Following the challenges/successes you experienced while practicing interventions against land degradation Practices, what can you mention as your way forward?

a) Its beneficial I will continue adopting the practices

b) Undecided

c) There are no benefits of adopting the practices

THANK YOU VERY MUCH FOR ANSWERING OUR QUESTIONS!!!

Do you have any questions to us or additional statements that you would like to make?

Appendix 2: A Guide for Focus Group Discussion with elders, committees and other stakeholders

1. What are Major economic activities performed in the village?
2. What is employing majority of the household in the village?
3. Which crop is contributing much on household income?
4. Which crop is contributing much on household food?
5. What are the challenges facing production of the above mentioned crop?
6. Are you aware of the ongoing land degradation situation in farms?
7. How was the situation 15 years ago compared to now?
8. How do you relate the land degradation with ongoing shifting cultivation?
9. Does farmers in this village use fire as part of land preparation practice for maize production?
10. How do you estimate the extent of shifting cultivation in this village per year? (in acres)
11. What factors do you consider contribute to the ongoing shifting cultivation?
12. What programs have ever been implemented in this village to mitigate land degradation?
13. Do you access extension services in this village? Which ones specifically?
14. Do farmer groups exist in this village? How many? Of which composition?
15. What positive outcomes have been recorded by farmers by engaging in farmer groups?
16. What are individual farmers doing to curb ongoing land degradation?
17. What have village government been doing to mitigate the degradation?
18. What has been the outcome?
19. What are the factors influencing one farmer to adopt land degradation mitigation strategies and the other not?
20. How do you perceive the land degradation mitigation strategies? (Mention both positive and negative experiences)
21. What do you suggest should be done to rectify this situation? (mention each suggestion to be done by whom)
22. What challenges are facing the land degradation mitigation strategies in this village?
23. How has climate change affected the maize productivity in this village?
24. What are your overall comments on land degradation situation in your village?

Appendix 3: A Checklist of Items for Key Informant Interviews with various stakeholders

1. What are the main crops grown in Kasulu lowland?
2. Which crop is cultivated by majority of the smallholder farmer in lowland Kasulu?
3. What has been the average maize production in lowland Kasulu in Miombo woodland (Bags/acre) or (Tons/Ha)
4. What are the main challenges facing the land conservation initiatives in Kasulu?
5. What are the opportunities for the maize production in Kasulu ?
6. How does land degradation affect the maize productivity in the area?
7. What projects /programs have been implemented in the area to address the land degradation challenge?
8. What has been the community participation in these programs?
9. How is land degradation problem addressed at the district level?
10. How do you estimate the effect of shifting cultivation (area) in deforested hectares per annum?
11. How are the policies addressing land degradation implemented?
12. How do you relate the presence of refugees and the existing pace of shifting cultivation and land degradation?
13. Has the district developed any by law to countercheck land degradation problem?
14. What are the current ongoing land degradation mitigation strategies currently promoted by smallholderfarmers in Kasulu District?
15. How is land degradation problem addressed under Kilimo Kwanza initiative?
16. Does livestock keeping (due to migrating pastoralists) have an influence on land degradation?
17. What can you mention as challenges facing the strategies towards land degradation mitigation efforts?

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