ASSESSMENT OF CHANGE IN SMALLHOLDER FARMERS' LIVELIHOODS DUE TO LAND DEGRADATION IN LUDEWA DISTRICT, TANZANIA

BY

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ABSTRACT

Cross sectional survey was conducted to investigate change in smallholder farmersô livelihoods as a result of land degradation from stratified sample of 240 households in four villages in Ludewa District, Tanzania. Survey was complemented by remote sensing, documentations, Focus Group Discussions (FGDs), transect walks, and in-depth interview with key informants. Data were analyzed by Geographical Information System (GIS), chi-square and logistic regression and qualitatively by content analysis. The results showed that between 1979 and 2002, area covered by open woodland dropped from 30 percent to five percent. In contrast, settlement with mixed cropping increased from 15 percent to 22 percent, bushland with scattered cropping from four percent to 16 percent, and woodland with scattered cropping increased from 10 percent to 22 percent in the same period. The increase in settlement with mixed cropping and woodland with scattered cropping implied increased continuous cultivation, shortened fallow periods, invasion of marginal lands, drying of natural springs, change in water sources, and increased migration. In absence of land management plans and none enforcement of conservation bylaws, weak and/or uncoordinated institutions, the change in state of land increased encroachment of marginal lands. Furthermore, the study revealed that smallholder farmers responded to decline in soil fertility by increasing use of new crop varieties and animal manure, limiting field size and increasing land fragmentation. In addition, there was limited agricultural development, especially agricultural mechanization apart from spraying machines for cashew nut and small irrigation scheme in Lifua village. Moreover, 99.4 percent of farmers in the study area got new cassava varieties

from their neighbours. Logistic regression showed that influence of socio-economic factors on smallholder farmersô livelihoods was not uniform. Young and single households dominated in fish selling and those with high incomes were leading cattle keepers. The major conclusion is that the extent and magnitude of change in smallholder farmersô livelihoods differed between villages and households. In order to improve smallholder farmersô livelihoods, this study recommend Ludewa District Council to train farmers in improved livestock keeping, beekeeping, fish farming, and commercial tree planting which are viable activities to support livelihoods of financial constrained households in degraded lands.

DECLARATION

I, Cosmas Benedict Mabalika Haule, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work, and it has neither been submitted nor being concurrently submitted to any other university.

_____ _____

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The above declaration is confirmed.

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ABBREVIATIONS

ASPS	Agricultural Sector Programme Support
ASDP	Agricultural Sector Development Programme
BSP	The Biodiversity Support Program
CARITAS	International Confederation of Catholic Organization for Charitable and Social Action
CDTF	Community Development Trust Fund
CMT	Council Management Team
CMB	Cassava Mealy Bug
CTA	The Technical Centre for Agriculture and Rural Development
DALDO	District Agricultural and Livestock Development Officer
DARE	Deagrarianisation and Rural Employment
DFID	Department for International Development
EC	European Community
EEC	European Economic Community
ETM+	Enhanced Thematic Mapper plus
EWB-SFP	Engineers Without Borders San Francisco Professionals
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FGDs	Focused Group Discussions
GEF	Global Environmental Facility
GIS	Geographical Information Systems
HIMA	Hifadhi Mazingira

ICRISAT	The International Crop Research Institute for the Semi-Arid Tropics
IWMI	International Wetland Management Initiative
LDC	Ludewa District Council
-2LL	Likelihood Ratio
MDGs	Millennium Development Goals
MSS	Multi-spectral Scanner Systems
MWARP	Miombo Woodland Agro-Ecological Research Project
NEMC	National Environmental Management Council
NGEDEA	Ngelenge Development Association
NGOs	Nonï Governmental Organizations
NLUPC	National Land Use Planning Commission
NSS	National Soil Services
PANTIL	Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods
R&AWG	Research and Analysis Working Group
SADC	Southern African Development Community
SCSRD	SUA Centre for Sustainable Rural Development
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forestry Research Institute
TDV	Tanzania Development Vision
TM	Thematic Mapper

TMV	Tanzania Maize Varieties
UMADEP	Uluguru Mountains Agricultural Development Project
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
URT	United Republic of Tanzania
USGS	United States Geological Society
VEOs	Village Executive Officers
WASSAN	Watershed Support Services and Activities Network
WEOs	Ward Extension Officers

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Problem

In many parts of the world, land degradation is one of the phenomena that affect the smallholder farmersô livelihoods. Livelihood is defined as the means of gaining a living for an individual or a household, including livelihood capabilities, tangible assets (land, water, vegetation) and intangible assets (knowledge, skills, social relations) (Chambers and Conway, 1992). The livelihoods of over 75 percent of the population in rural areas in Tanzania depend on direct and/or transformation of local natural resources (Research and Analysis Working Group-R&AWG, 2004). In that case, the livelihoods of land-users, especially smallholder farmers tend to worsen as conditions of natural resources, particularly land continue to degrade.

It is acknowledged that land degradation has occurred and continues to occur, in both developed and developing countries (Jacks, 1935; Barrow, 1991; Stocking and Murnaghan, 2001). A study by Jacks (1935) found evidence of ancient land degradation in North China, Persia, Mesopotamia and North Africa associated with deforestation, soil exhaustion, crop failures, land abandonment, and ultimately desertification. Similar evidences of land degradation in Midwest in United States of America in 1930s as manifested by dustbowls are reported by Barrow (1991). The global nature of land degradation has also been reported in Germany (Moldenhauer, 1980; Riquier, 1980). In the colonial era, land degradation was perceived to be due to mismanagement by ill-informed farmers exacerbated by population growth and poverty (Blench *et al*., 2002). Relating land degradation to mismanagement by ill-

informed farmers was a professional ignorance which made some scholars denies its existence in Western Europe (Jacks, 1935). For instance, it was thought that Sahara desert is moving to the south, the attitude that made for many years wage a futile war against desertification while in actual fact desertification is a process going on over large areas (Christiansson *et al*., 1993).

Apart from lack of knowledge on suitable agricultural techniques, other factors responsible for land degradation as reported in France include settlement expansion and natural forces (Belpomme, 1980). In France, it is estimated that about 35 000 hectares (ha) of wooded areas are degraded by man and natural forces every year and another 11 000 ha of agricultural land is lost due to town expansion. The harmful effects of soil erosion have made the French government set aside about 560 000 ha (5 percent of the mountain area) for special mountain study and restoration. The French government response in provision of support on how to maintain land quality correspond to FAO (2000) observation in Asia that information on status of land resources are instrumental in building capacity of land users to plan and monitor the use of natural resources.

It is estimated that about 40 percent of the world land resources have been converted to crop land and/or permanent pasture and about two thirds of the agricultural land is affected by land degradation (Enger and Smith, 2000). In Africa, the conversion of land to agriculture has made about 43 percent of its land into moderate to severe risk from human induced land degradation (UNDP/GEF, 2004). In sub-Saharan Africa (SSA), about six million hectares of productive land are lost each year (UNDP/GEF,

2004). Despite increasing evidences of effects of land degradation on livelihoods of land users, most of the studies on land degradation have put emphasis on the physical processes and visible evidence of land resources depletion (Barrow, 1991; Stocking and Murnaghan, 2001). Even though land degradation is a biophysical process, its spatial and temporal distribution is the product of human decisions and actions (Helleiner, 1968; Tegene, 2000). The nature of human activities and therefore, the extent of land degradation are determined by socio-economic factors such as land tenure, demographic trends, access to markets, institutional support and human health that influence the use and access to assets (Tegene, 2000; Lal, 2005).

Evidence from Ethiopia shows that more marginal and fragile lands are incorporated into farming in the absence of technologies for intensification and opportunities for off-farm employment (Tegene, 2000). Also, inadequate intensification makes more smallholder farmers go back to shifting cultivation in the nearby areas (Bryceson, 1990). The use of marginal lands further reduces the capacities of smallholder farmers to support their livelihoods. As the degraded land resources could no longer be used for further crop production rural people either migrated to more productive areas or diversified their means of living (R&AWG, 2004). It follows then that the magnitudes of land degradation in rural context depend on how farmers use and manage the resources, and their ability and willingness to control land degradation. For instances, the decline in soil fertility status when combined with socio-economic factors such as increase in population, lack of application of external inputs, laxity in enforcement of laws and regulations, and absence of land use plans can lead to the change in land use like conversion of forest into farming area (Avralioglu, 1988).

A study in Southern African countries by Loubser (2005) found increasing migration and creation of environmental refugees in rural areas as a consequence of loss of more than 25 percent of its soil fertility. The creation of environmental refugees come from the fact that migration as reported in Mali is taken to be an exit from difficult food security and/or disadvantageous tenure conditions (Batterbury and Baro, 2005). However, another study in West Africa found that existence of free migration among smallholder farmers in rural areas has potential to increase and spread the negative impact of land degradation on peopleôs livelihoods (Blench *et al.*, 2002).

In Tanzania, land degradation was mentioned in the National Environmental Policy, as one of the six major environmental problems (URT, 1997a). Other major environmental problems in Tanzania include deforestation, deterioration of aquatic system, loss of wildlife and biodiversity, environmental pollution, and lack of accessible good quality water. In Tanzania, land is estimated to have permanently lost more than 20 percent of its production potential due to human induced erosion in the past 100 years (Dregne, 1990). The human induced erosion result in reduced soil organic matter content reduced biological activity, reduced water holding capacity and decline in soil fertility. All these processes lead to reduced peoplesô capacity to sustain life as viability of their livelihoods strategies they undertake depend on the conditions of the natural resources (R&AWG, 2004). Low productivity of degraded lands increase field abandonment and promote continuous cultivation in marginal lands. Field abandonment not only increases the problem of land shortage for agriculture, but also accelerates the deterioration of smallholder

farmersô life and promotes out-migration (Glantz, 1987). Out-migration as manifested by creation of new sub-villages in Ludewa District is reported by CONCERN (2000). The establishment of new settlements and its associated increase in unplanned conversions of land make farmers more vulnerable to impact of land degradation. In this study, investigations are made on areas and category of people prone to migration in order to establish status of migration and avoid further land degradation.

It is, therefore, apparent that increased land degradation not only affects the existing livelihood strategies such as agricultural production but also changes the status of livelihoods among smallholder farmers (Lestrelin and Giordano, 2007). The changes in importance of land due to its degradation affect smallholder farmersô activities and outcomes of those activities (Lestrelin and Giordano, 2007). For instance, in Bukoba District, Tanzania, studies (Rugalema *et al*., 1994; Rugalema, 1999) found change in land value which led to decline in importance of *kibanja* (homegarden) and increasing use of less fertile *rweya* for annual crop production among smallholder farmers. The change in land value was associated with introduction of maize and beans in marginal lands (*rweya*) that replaced coffee and banana in homegarden (*kibanja*). Similar impact of land degradation upon production as manifested by total abandonment of exhausted land, reduced crop yields, increased need of external inputs to compensate the lost nutrients, and greater costs of production, reduced response to inputs, created greater risk and diversion of resources to reclamation as reported in South Asia (FAO, 1994). The resulting consequences of land degradation on people increase landlessness, food insecurity,

labour requirements, lower incomes, and destroy means of livelihoods to an extent of dependency on famine relief programmes, migration, and employment to other farmers and engaging on non-agricultural activities.

Masasi Division in Ludewa District is one of the areas most affected by land degradation in Tanzania (URT, 1999b). In Ludewa District, agriculture is a land based activity which sustains the livelihoods of over 90 percent of people. Reducing the impact of land degradation in the study area is essential for ensured improvement of peopleôs livelihoods. This is in line with the goals stipulated in the Tanzania Development Vision 2025 (TDV2025) and United Nations Millennium Development Goals (MDGs) that call for the eradication of poverty and hunger while ensuring environmental sustainability (URT, 1999a; URT, 2006a). Despite the good motives of national and international community goals for the improvement of smallholder farmersô livelihoods, cautions are more than often made that the intentions are not sufficient in themselves (Duda, 2007). Experiences from all over Africa show that for the intentions set by different development partners to yield the expected fruits they depend on the context in which smallholder farmers operate (Duda, 2007). The prevailing circumstances like policies and institutions either support and/or limit activities that could improve the livelihoods of smallholder farmers (Amede, 2003; Duda, 2007).

The susceptibility of smallholder farmerôs livelihoods to land degradation in the study area was exacerbated by the villagization programme of mid 1970s (Friis-Hansen, 1987). The villagization programme abruptly increased population pressure

on land found in rural areas that formerly was sparsely populated (Friis-Hansen, 1987). In most cases, the induced population pressure tended to alter the existing land use patterns and made availability of crop land insufficient to support livelihoods of smallholder farmers (Lestrelin and Giordano, 2007). As a result of the villagization programme, fallow periods in the study area were reduced and replaced with continuous cultivation. However, the increased annual cropping due to population growth and induced land shortage without improvement in soil fertility exacerbated land use crisis and threatened livelihoods of the smallholder farmers. Unlike the case of Machakos District in Kenya (Tiffen *et al*., 1994), population growth and land degradation in Ludewa District did not stimulate agricultural intensification but increased utilization of marginal lands that are unsuitable for shifting cultivation (Burbridge *et al*., 1988; Haule, *et al*., 2009). The remoteness of Masasi Division make it invisible to the eyes of policy-makers and little attention was paid to its conservation, so it becomes more vulnerable to land degradation (World Bank, 2003). On that ground, this study treats Masasi Division as an area requiring urgent attention by both decision-makers and researchers (Mahler, 2003 cited by FAO, 2003).

Despite this long recognition of the effects of land degradation on people, most studies in developing world including Tanzania have concentrated on the effects of land degradation upon production (Kikula *et al*., 1991; UNDP/GEF, 2004). For instance, in Rukwa region, it was found that agricultural land use is a function of land physical conditions especially soil fertility, agricultural systems and settlement patterns (Mohamed, 1985). Besides, the changes in livelihood strategies such as

migration and extension of farming in marginal lands in Ludewa District are among the neglected aspects that have not been quantified. But, the impact of land degradation on livelihoods of farmers as manifested by the frequency of food insecurity and widespread migration in the study area has reached a point that could no longer be ignored (Nyangôali *et al.*, 2001; EWB-SFP and NGEDEA, 2005). It was on this background that investigation on change in livelihoods due to land degradation was considered necessary in selected villages of Ludewa District.

1.2 Statement of the Problem and Justification

The change in livelihoods is one of the consequences of land degradation upon people (Sah, 2002; Lestrelin and Giordano, 2007). Land degradation undermines the structure and function of ecological systems critical for human survival (GEF, 2003). The deterioration in land qualities affects the way in which smallholder farmers make a living (R&AWG, 2004). Studies (Roose, 1996; Scoones, 1998; R&AWG, 2004) show that when faced with land degradation some farmers may decide to intensify and/or extensify their agricultural production while others will migrate and/or diversify their activities. However, farmersô decisions depend on both ecological and socio-economic conditions (i.e. economic status, resource owned/available, policies, laws, conservation by-laws, technology, knowledge base, institutions). The ecological and socio-economic conditions enhance the potential of available resources in the creation of viable livelihoods strategy. Unfortunately, many of the activities (such as tobacco cultivation and deforestation) carried out by smallholder farmers to create livelihoods also tend to accelerate land degradation (Sajad, 2007).

Even though the importance of socio-economic conditions in the change in livelihoods is recognized, most studies have given emphasis to understanding of ecological aspects such as deforestation and loss of biodiversity, drought, climate change, soil erosion, and resulting desertification (ICRSAT, 1995). This is due to long held view that ecological aspects are core indicators of land degradation (ICRSAT, 1995). A study in Mediterranean Europe showed that ecological aspects are better in development of physical models suitable for identification of potential hazard zones (Hill, 2002). But, physical models in themselves cannot be used for monitoring of changes of livelihoods that are driven by socio-economic conditions. Socio-economic factors determine the resources available, the way they are allocated, accessed and used by smallholder farmers to achieve their livelihoods (Mascarenhas, 2000). In this case, the kind of livelihoods secured depends on understanding of the dynamic nature of smallholder farmersô activities given the socio-economic conditions in place. In most cases, impacts of the socio-economic factors on livelihoods taken are not the same to all (Carney, 2002). It follows that the prevailing socio-economic conditions are behind smallholder farmers increased cultivation of marginal lands in the disguise of increasing agricultural production (Shisanya, 2005). Despite knowledge on negative impacts of cultivating marginal lands, in most cases policy-makers and land users ignore the anticipated consequences of their decisions and activities as shown by Starkloff (1998) study in Sri Lanka.

In order redress the past weaknesses in the study of land degradation in sub-Saharan Africa, Manyong (2002) argue that there is a need to integrate policies, institutions, infrastructure, and technology that enhance contributions of particular activity to improvement of smallholder farmersô livelihoods. The national policies and institutions have potential to improve environmental governance as they control what happens to given resources. Policies and institutions specify roles and responsibilities of various actors in natural resource management through allocation and enforcement of rights of use, access, tenure and transfer (Kallonga *et al*., 2003). The clarity in responsibilities creates incentive structures such as commitment for technology adoption, agribusiness development, and marketing of inputs and products which are essential for agricultural intensification, commercialization, and enterprise diversification (Manyong, 2002).

Even though there are many studies (Ponte, 2002; Ellis and Mdoe, 2003) on impact of policies on livelihoods of smallholder farmers in Tanzania, there are gaps in knowledge on how specific policies are implemented at district level. The understanding of policies related to natural resource management has potential to accommodate the diversity of smallholder farmers by bringing interventions designed at national level to local situations (Ellis and Mdoe, 2003). Besides, the knowledge to decision-makers on how institutions at district and village levels operate enhances law enforcement and ensures better use of the available land resources (Kisanga, 2002). The knowledge among policy-makers on functioning of local institutions responsible for land allocation is essential in organizing smallholder farmers in conservation of the land resources especially where rural

migration associated with forest clearing are rampant (Sajad, 2007). This has potential to reduce smallholder farmersô degree of exposure to negative consequences of land degradation.

Above all, the findings on smallholder farmersô livelihoods would significantly shed light on the progress made by Tanzania towards achievement of the global Millennium Development Goals (MDGs) particularly on increasing income, ensuring food security and environmental sustainability (URT, 2006a). This understanding has an advantage of finding the best pathway to follow in different localities. As the understanding of socio-economic factors influencing smallholder farmersô activities would pave the ways for decision-makers gain knowledge on the opportunities and constraints of various livelihood strategies. This would provide entry points on how to support different categories of smallholder farmers. The knowledge is vital especially in remote and low potential areas like those of southern parts of Ludewa District (NEMC, 1995), where increased uses of ecological sensitive areas are going unnoticed among decision-makers. This threatens the land resources and livelihoods of its people.

In addition, the understanding gained on how the socio-economic factors affect smallholder farmersô activities and livelihoods would contribute to creation of preparedness among policy-makers on how to support smallholder farmers. Such an understanding will bring changes required for advisory services interventions in the natural resource to be effective and will establish links between macro policies devised by government and micro processes as manifested by smallholder farmersô

activities. For instance, knowing how smallholder farmers interact, in the acquisition of planting materials, fertilizer, and pesticides is essential in priority setting, targeting and avoidance of blanket recommendations in agriculture/livestock extension programmes.

1.3 Objectives of the Study

1.3.1 General objectives

The general objective of this study was to investigate the changes in livelihoods among smallholder farmers as a result of land degradation in Ludewa District.

1.3.2 Specific objectives

The specific objectives of this study were:

(i) To assess changes in land resources (in terms of land use/cover, soil fertility status, water level) in selected villages of Ludewa District.

(ii) To identify the potential of government policies related to natural resource management in reducing land degradation in Ludewa District.

(iii) To examine the institutional effectiveness in reducing land degradation in Ludewa District.

(iv) To determine the influence of socio-economic factors in changes of smallholder farmersô livelihoods in selected villages in Ludewa District.

(v) To explore livelihood strategies taken by smallholder farmers as a result of land degradation in selected villages of Ludewa District.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

This chapter presents a literature review on land degradation and change in smallholder farmersô livelihoods. It starts with highlighting how land degradation manifests itself by looking at the changes in land conditions that create context of smallholder farmersô livelihood strategies. Then, it reviews the potential of policies related to natural resource management and effectiveness of institutions in reducing land degradation. This is followed by a discussion on the changes of farmersô livelihood strategies and how socio-economic factors influence the livelihoods. The chapter ends with review of theoretical frameworks that provide explanations on the relations of variables used in the study.

2.2 Change of Land Conditions due to Land Degradation

Land degradation is the processes which result into temporary or permanent lowering of the productive capacity of land (FAO, 1994). Land degradation negatively affects the quality of land as manifested in various forms that express the poor condition of the land resources such as soil erosion by water and wind, soil fertility decline, water logging, salinization, lowering of water table and deforestation (FAO, 2003). In most cases, changes in quality and quantity of land due to land degradation are site specific and tend to vary with variations in human activities that exert pressure on the land resources (Dumanski and Pieri, 2000). However, most studies on change in productive capacity of land concentrate on global indicators of land degradation like ozone layer depletion (Abrahamson, 1989;

Weart, 2005), climate change (Ellis, 2007), and desertification (Darkoh, 1998; Mainguet and Da Silva, 1998) and neglect indicators that reflect worsening conditions of resources at local level (GEF, 2003, Selvaraju *et al*., 2006). In this study, three major biophysical indicators, namely, change in land use/cover, decline in status of soil fertility, and fall in water level (Dumanski and Pieri, 2000) were considered. The knowledge on the change in land use/cover, decline in status of soil fertility, and fall in water level in the study area is essential to understand ways that people use natural resources for agriculture to sustain their livelihoods.

Change in land use/cover is one of the major indicators that reflect the patterns and magnitude of land degradation (Dumanski and Pieri, 2000). Land use and land cover are two related terms that describe the state of natural resources, as the former is the way in which, and the purpose for which land user utilize the land and its associated resources such as soil, topography, vegetation, water bodies, and man made infrastructures (Meyer, 1995). In contrast, land covers describe the biophysical state of the earthôs surface, originally applied only to vegetation, but currently include the land uses. Further, this work embraces Unruh and Lefebvre (1995) position who treat land use/cover as a single category where land cover is influenced by land use or lack thereof. In that case, land use establishes a direct link between land cover and the actions of people in their environment (Di Gregorio, 2005). The differences in area of a given land use/cover imply either increase or decrease in land degradation over time. The change in land cover as influenced by land degradation, negatively affect the quality of available land, as it degrades physical, chemical, and biological properties (Brinkman, 1997; Neefjes, 2000; Di Gregorio, 2005). In that case, the

distribution of land use/cover over time provides impression of changes in productive capacity of land resources.

Kiage *et al*. (2007) study in East Africa found dramatic changes in land use/land cover at a variety of spatial and temporal scales. Although land use/cover is greatly affected by natural events (flooding, vegetation successions, fire), the character and magnitude of change in land use/cover are greatly influenced by human activities (Meyer, 1995). Ehui (1993) study in developing countries found that decline in soil fertility and crop failure are behind changes in land use/land cover in rural areas. The wide variation in yields of different plots in the same farming systems as reported by Meindertsma (1997) and Larsson (2005) in Asia and Africa imply differences in importance of each land use/cover type to smallholder farmers.

In Tanzania, it is reported that shifting cultivation without soil fertility restoring practices leads to deforestation of about 190 000 to 500 000 hectares of land annually (Amani, 2006). In addition to shifting cultivation, deforestation in Tanzania was promoted by colonial government campaigns to eradicate tsetse flies in the early 1920s and 1940s and expansion of cotton farming in 1940s to 1950s as happened in Shinyanga region (Mlenge, 2004). Mlenge (2004) further reports that campaigns to eradicate tsetse flies and expand cotton farming in Shinyanga region increased bushes and forests clearing. The campaigns led to deforestation, increased livestock population, loss of plant biodiversity, and drying of springs and shallow wells (Mlenge, 2004). The overgrazing of cattle and over cultivation of cotton led to increased soil erosion and loss in soil fertility (Mlenge, 2004). Similar studies

(Rugalema *et al*., 1994; Mohamed, 1996; Rugalema, 1999) in the Kondoa Eroded Area and Bukoba District in Tanzania assert that further decline in soil fertility lead to change in the value of a particular land use/cover. The change in value of a particular land use/cover force change in location of farms, type of farming practices, crops grown, inputs used and outputs gained (Mohamed, 1996). For instance, the loss of soil fertility of former productive homegarden (*Kibanja*) in Bukoba District not only increased use of marginal lands (*Rweya*) but also elevated importance of new crops such as maize and beans (Rugalema *et al*., 1994; Rugalema, 1999).

In addition, the change in value of land as manifested by increased farm abandonment, use of marginal lands, and/or migration are indication of increased land degradation (Rugalema, 1999). Such changes in land uses occur when land is not a limiting factor of production and/or there is lack of land use planning. In the late 1950s to early 1980s, Shinyanga region experienced massive out-migration of Sukuma in search of both pastures and new land for crop production (Meertens *et al*., 1995; Mpiri, 1995; Kajembe *et al*., 2003 cited by Kisoza, 2007). The massive migrations of pastoralists saw the Sukuma and Maasai people invade the southwestern highlands and eastern parts of Tanzania as far as Ihefu wetlands in Mbeya region, Kilombero Valley in Morogoro region and Rukwa basin in Rukwa region (Mpiri, 1995). However, information on farm abandonment, use of marginal lands, and migration are not part of most of the agricultural development interventions including Agricultural Sector Development Programme (ASDP) (URT, 2003).

Cases of fast and disorganized ways in which marginal lands are incorporated into agriculture are many and spread all over the world (Glantz, 1994; Garces and Mora, 2002). Evidences of increased area affected by land degradation due to increased agriculture and settlements in marginal lands are illustrated by satellite data and field surveys in Nguru Mountains in Morogoro, Tanzania (Monela and Solberg, 1998). The study show that between 1949 and 1993 continuous rainforest outside the forest reserve has declined by 37 percent (i.e. 1.3% per year). But, the trends and dynamics of land use/cover changes are not uniform over time and space. A study by Kummer, 1992) in the Philippines showed that between 1940 and 1980 agricultural intensification in mountainous areas led to more deforested land than cultivated land, i.e. 68 000 km^2 and 25 000km^2, respectively. In contrast, from 1980 to 1987, there was increase in rate of conversion of land to agricultural lands by 229 000 hectares a year compared to 157 000 hectares per year lost by deforestation. The shift in land use/cover in Philippines is attributed to spread of agricultural lands into non-forested areas such as grassland, shrubland, and open land (Kummer, 1992). The use of marginal lands among smallholder farmers is associated with decline in soil fertility in the main production area (Friis-Hansen, 1987). Similarly, Glantz (1994) reported use of marginal lands in West Africa for smallholder farmers who were reluctant to migrate to other areas. As observed by Rugalema *et al*. (1994) in Kagera Region, Tanzania the continuing utilization of marginal lands is attributed to absence of land use plans and/or lack of enforcement of regulations.

Several studies (Friis-Hansen, 1987; Misana, 1992; Kikula, 1997; Mbilinyi, 2000; Birch-Thomsen *et al*., 2001; Rugenga, 2002; Abdallah, 2006) have reported changes

in land use/cover due to land degradation in Iringa region. The studies (Friis-Hansen, 1987; Misana, 1992; Kikula, 1997; Mbilinyi, 2000; Birch-Thomsen *et al*., 2001; Rugenga, 2002; Abdallah, 2006) show that changes in land use/cover are attributed to physical (climate, soil, topography, hydrology, biota) and socio-economic (population growth, land tenure, farming practices, settlements) factors. For instance, the increase in population in Ruaha Mbuyuni area had reduced the area covered by riverine vegetation from 5 042 hectares in 1955 to just 1 870 hectares in 1999 (Rugenga, 2002). This came as area covered by irrigated fields and settlements in Ruaha Mbuyuni for the same period increased from 480 and 363 to 4 073.4 and 1 463.3 hectares, respectively (Rugenga, 2002). The evidences of change in land use/cover in Iringa region underscore the need to regulate use of natural resources through management plans. Besides, changing land values call for provision of early warning of possible threats to smallholder farmers to safeguard their livelihoods.

However, not all land use/cover changes imply land degradation (Meyer, 1995; Mbilinyi, 2000). In Mediterranean Europe, Houéruo (1993) reported expansion of forest and scrubland areas and shrinking of farmland as more marginal lands were abandoned from cultivation for about twenty five years. Similarly, in semi-arid West Africa, Leach and Mearns (1996) associate the emergence of forest patches in open Savanna with human efforts to overcome the process of land degradation. Corresponding to above findings, Mbilinyi (2000) based on satellite data between 1978 and 1995 found that area covered by *miombo* woodland in Isimani Division, Iringa District, Tanzania increased by 19 percent due to community conservation efforts. This is contrary to evidences from aerial photographs between 1963 and

1978 that showed loss of about 2 620 hectares of *miombo* woodland due to villagization programme of mid 1970s in Isimani Division, Iringa District, Tanzania. Another positive land use/cover change in Tanzania has occurred on the slope of Uluguru Mountains. Prior to establishment of a squatter settlement called Falkland (with about 200 people) within Morogoro Municipality in mid 1980s, the area was seriously deforested and bare. In late 1980s, people established settlements and started planting trees. Come 2009, the area had more tree species than most parts in the municipality (Mlozi, personal communication, Feb. 2009).

Despite the growing number of case studies on change in land use/cover due to land degradation in developing countries, Nyathi and Campbell (1993) in Zimbabwe assert that there is insufficient land use/cover data at district, agro-ecological and ward levels. Besides, each of the case studies on land use/cover tend to produce quantitative data which are site specific and that cannot be extrapolated to any large geographical area. Studies in sub-Saharan Africa (Unruh and Lefebvre, 1995; Wiesmann, 1998; Isabirye *et al*., 2001) reported that data on patterns and magnitude of land use/cover change help determine constraints and opportunities of specific land use/cover. Also, information on land degradation and its associated changes in land use/cover affect specific populations that react to the impact of changes in different ways.

Utilization of in-place land use/cover data have potential to ensure quick and successful technology transfer that sustain internal coping and risk reduction strategies essential for conservation of resources and improvement of livelihoods at

local level (Unruh and Lefebvre, 1995). The importance of link between rural livelihoods, land use/cover change, and socio-economic development has also been reported in South Africa (Giannecchin *et al*., 2007). The knowledge on how the farmers use specific pieces of land, determine the kind of support needed to improve their ability to increase productivity of labour and reduce pressure on shrinking arable land, which can provide basis for planning conservation of available land resources, thus be in a position to control the impact of land degradation (Avralioglu, 1988; Mudimu, 1999).

Changes in land use/cover in rural areas in developing countries are prompted by decline in soil fertility which is manifested by loss of soil nutrients, decline in crop yields, and outbreak of pests and diseases (Amede, 2003). The depletion of soil fertility affects the capability of the soil to supply nutrients essential to enhance plant growth (Follet and Wilkison, 1985 cited by Follet *et al.*, 1987). Apart from reducing the capacity of soil to supply nutrients, the decline in soil fertility lead to regular decline in crop yields and increased incidence of pests and diseases (Greenland, 1997; Amede, 2003). This come as decline in soil fertility results in poor plant growth that cannot withstand the pests and diseases as reduced fallow period, absence of crop rotations and continuous cultivation favour build up of pests and diseases in both the soil and host plants (Meindertsma, 1997). For example, the outbreak of Cassava Mealy Bug (CMB) in Sukumaland and in the study area in 1987, and banana weevil in Bukoba in mid 1970s were attributed to gradual decline in soil fertility (Rugalema *et al*., 1994; Meertens *et al*., 1995; CONCERN, 1995; EWB-SFP and NGEDEA, 2005). The decline in cassava production due to CMB has

also been reported by Charman (2006) in Malawi. The outbreak of CMB in 1985/86 growing season in Malawi plummeted cassava yields from an average of 12 t/ha to 3.5 t/ha (Charman, 2006). Similarly, the localized famine in the study areas in the late 1980s is attributed to outbreak of CMB (CONCERN, 2000).

The causes of fall in soil fertility include continuous cultivation, insufficient use of inorganic fertilizers, erratic and unreliable rainfall, and drought (Ley *et al*., 2002). Continuous cultivation causes loss of about 20 to 60 kg N per hectare (Smalling, 1993 cited by Mohamed, 2004). In contrast, the average use of inorganic fertilizer in sub-Sahara Africa is below 9 kg N per hectare that cannot compensate for the loss in essential nutrients (Bumb and Baanante, 1996 cited by Baijukya, 2004). In the absence or with limited use of fertilizers, continuous cultivation has increased the loss in nutrients and organic matter, and reduced yields (NSS, 1988). The quantity of organic inputs continue to decline as both population increase and short fallow periods limit the amount of crop residues that is accumulated (Hilhorst *et al*., 2000). Besides, the potential of animal manure to replenish soil fertility in sub-Saharan Africa is limited by little amount and poor quality of organic manure available (Amede, 2003; Gachene and Kimaru, 2003; Seiter and Horwath, 2004).

Many studies on the changes in land conditions in Asia and Africa have paid attention on use of soil analysis in determination of variations in soil fertility due to land degradation (Mowo *et al*., 1993; Nindi, 1999; Rushomesa, 1999). Even though the use of local peopleôs perceptions in assessment of land conditions is among the neglected aspects in various land improvement programmes, its potential has been

acknowledged by a numbers of other studies (Magayane, 1995; Pearson *et al*., 1995; Kikula, 1997; Murage *et al*., 2000; Ovwigho *et al*., 2006). Studies in Tororo District in eastern Uganda found that farmersô perceptions on the conditions of land resources, affect the way farmers receive new technologies promoted to replenish the soils (Miiro *et al*., 1998). Similarly, a study in Iringa region, Tanzania found that the use of farmersô views raises awareness amongst the people towards the natural resources and ensure effective planning of strategies for land rehabilitation (Kikula, 1997). Seeley (2002) study in India found that increased participation in conservation programmes not only raised awareness among smallholder farmers but also was part of human and social capital development. The development of human and social capital as manifested by increased self-reliance and confidence, positive attitudes and capacity to implement various strategies is prerequisite for the success of natural capital improvement such as replenishment of soil fertility (Seeley, 2002). Given this background, it was rational to assess how smallholder farmers in the study villages of Ludewa District rated the status of soil fertility of their land resources.

The unattended changes in land conditions as manifested by changes in land use/cover and soil fertility decline lead to decrease in both ground and river water levels (Starkloff, 1998). Evidence from Sir Lanka show that human land use changes such as increased vegetable cultivation around water sources and within watershed threatened both water level and livelihood strategies (Starkloff, 1998). Similar observations are reported in South Central Rift Valley Region of Ethiopia (Kleman, 2007) and in Nara semi-arid zone of Mali (Dembélé, 2006). Increased cultivation

reduce vegetation cover and organic matter content resulting in reduced infiltration rate, reduced dry season flow, change of permanent rivers into seasonal rivers, extinction of ponds, shrinkage of swamp areas, drying of natural springs, wells, and wetlands (Lundgren and Taylor, 1993; FAO, 1994; Minja and East, 1996; Yanda, 1996; Starkloff, 1998). Other reasons for change in water level have been identified to be change in rainfall amounts, water use patterns, and evaporation patterns (FBD, 2005a).

Threat of land use/cover change on water level tends to vary depending on the force behind it. Evidence from participatory assessment of household surveys in Tanzania and Zambia showed that ill-conceived development policies result in environmental degradation with negative consequences on peopleôs livelihoods (McCartney and Van Koppen, 2004; Masiyandima *et al*., 2004). For instance, the forced villagization programmes and flue-cured tobacco production of the mid 1970s were responsible for change in land use/cover and water level in the study villages of Ludewa District in Tanzania. The villagization programmes increased the conversion of farm area into settlements that led to fragmentation of the remaining arable land. In addition, villagization programme interrupted the cropping patterns, reduced fallow periods, and increased cultivation of marginal lands. This came as tobacco cultivation in developing countries is dependent on clearing of lands and continued supply of fuel wood as energy for curing tobacco, so increasing the problem of deforestation (Mbilinyi *et al.*, 2004; Paulo and Shemwetta, 2007).

It is accepted wisdom that tobacco planted on new cleared land not only requires less agro-chemical inputs, but also is of superior grade (Geist, 1997 cited by Abdallah, 2006). Consequently, most tobacco farms were abandoned after about three years of cultivation as expressed by increase in bushlands from 0 ha in 1959 to 2 749.9 ha in 1978 and 3 558.8 ha in 1999 in Iringa District (Abdallah, 2006). The study also reported drop in area covered by woodland from 9 661.5 ha in 1959 to 3 280.9 ha in 1978 and further to 2 085.5 ha in 1999. The drop in area covered by woodland comes from the fact that to cure tobacco from a 1.0 hectare field requires 2.0 hectares of *miombo* forest (Otsyina *et al*., 1997 cited by Mbilinyi *et al*., 2004). Unfortunately, in many areas, the cultivation of tobacco is not associated with tree planting campaigns. In Iringa District, Abdallah (2006) reported that area covered by tobacco fields increased from 108.5 ha in 1959 to 3 860.7 ha in 1978 and up to 3 482.8 ha in 1999, hence increase in tobacco grown area imply increased rate of land degradation.

On the other hand, flue-cured tobacco demands large amount of water in the first two days of curing. Water is spread in the barn to improve humidity required for the yellowing of leaves (Simon, 1998). In the absence of reliable water supply systems in rural area, most of the new farms are located close to river banks and/or water sources. Cultivation in catchments increased depletion of water sources. Studies in Sir Lanka (Finlayson, 1998), Burkina Faso (Sourabie, 1999) and in the southern parts of Ludewa District, Tanzania (EWB-SFP and NGEDEA, 2005) also report the insufficient water quantity available due to deforestation. Although there are a number of studies on impact of deforestation on river flow regimes in Tanzania,

most of them have concentrated on aspects of water resources and biodiversity changes (FBD, 2005a; Kashaigili, 2006; Nindi, 2007; Kasthala *et al*., 2008). Little attention has been given to the aspects of change in water level such as change in water sources and distance covered to collect drinking water that has direct impact on farmersô livelihood strategies and outcomes. The understanding of change in water levels will shed light on the immediate consequences of land degradation on the smallholder farmersô livelihoods and highlight areas that need immediate attention in conservation (BSP, 1995).

2.3 Potential of Policies for Reducing Land Degradation

A policy in the context of this study is taken to be an explicit statement of government priorities as interpreted in action and reflected in laws, operational directives, and regulations that define rights and responsibilities on the use and management of natural resources (Tyler and Mallee, 2006). Policies reflect the individual, households, and groups of people rights and responsibilities on the use and management of natural resources. The rights and responsibilities as stipulated in laws, management plans, and land tenure identify the stakeholders, status of access or ownership of resources, institutions involved in planning and decision making on use of the resources. Neefjes (2000) argues that by influencing the conditions under which the resources are used and managed policies related to natural resource management reduce magnitude of land degradation.

For instance, the National Land Policy of 1995 in Tanzania, among others encourage users to acquire title deeds in the forms of rights of occupancy in order to increase

the value of land and reduce land use conflict (URT, 1997c). The land policy aim at ensuring that land is put to its most productive use in order to promote rapid social and economic development. Similar calls of prevention and control of degradation of all life support systems (land, water, vegetation) and improvement of productivity of degraded areas are also made by the Environmental Policy of 1997. Furthermore, the Forestry Policy of 1998 spells out the right of all stakeholders in management of forests. The policy propagates the Participatory Forestry Management (PFM), decentralization, and privatization so that community could gain knowledge on opportunities and constraints offered by forest sector. The understanding has potential to develop livelihood strategies that enhance conservation and management of natural resources. Similarly, the Water Policy of 2002 calls for cross-sectoral interests in water and watershed management and the need for integrated and participatory approaches in dealing with natural resources (URT, 2002a). Besides, the water policy acknowledges the changing role of government from service provider to that of coordination, regulations and guidelines formulation.

Unfortunately, most of the government policies in Tanzania as outlined above are sector-based, and not integrated (Pretzsch, 1998; Songorwa, 2004). Besides, the policies are not in harmony with one another. For instance, the Agricultural and Livestock Policy of 1997 calls for bush clearing of unused land to create rangelands and resettlement of livestock owners from overgrazed areas to sparsely populated areas (URT, 1997b). The mobilizations of bush clearing and resettlement of livestock keepers forget the fact that the two processes are likely to cause deforestation, soil erosion, and general widespread land degradation. Since the use

of one resource to achieve human needs tend to affect the others and can lead to land degradation (Poore and Sayer, 1991).

Apart from lack of intersectoral coordination and cooperation, some policies deny local people control of the natural resources. A livelihood study in India suggests that the lack of political will among decision-makers to involve local people come from the very nature of command and control approach to natural resource management (Seeley, 2002). The approach assumes that rural people and smallholder farmers in particular can not sustainably manage natural resources. Assumptions by decision-makers that they know what is best for smallholder farmers, reduce the interests and commitment of local people in natural resource conservation, and create local peopleôs dependence on state (Pretzsch, 1998; Barrow *et al*., 2000).

On the other hand, study in the Eastern Arc Mountain Forest in Tanzania found that large proportion (70%) of the Eastern Arc community representatives were not aware of the Eastern Arc Mountain Forest programmes in their areas. The findings reveal that state and its agencies take little efforts to inform and/or educate people in rural areas in Tanzania on policies that affect their living (Russell, 2001; R&AWG, 2004; FBD, 2006a). In that case, it is more likely that the uninformed farmers are not only marginalized but also used in the programme they donôt know its mission so posing the resource to more degradation. Smallholder farmersô understanding of policies and their instruments for implementation would offer incentives that encourage effective participation and adoption of livelihood strategies that conserve

the environment (Pearson *et al*., 1995; Manyong, 2002; Kallonga *et al*., 2003). The provision of education, public awareness and information create a context into which the strategy to conserve natural resources should fit.

To implement policies for sustainable use and management of natural resources, the policies are backed by a number of laws. The laws enable or constrain behaviour of natural resource users (McEvoy *et al.*, 2008). The major laws on use and management of natural resources currently in force include the Water Utilization (Control and Regulation) Act No. 42 of 1974, the Land Act No. 4 of 1999, Village Land Act No. 5 of 1999, the Forest Act No. 14 of 2002, and the Environmental Management Act No. 20 of 2004. These laws, among other things, prohibit human activities in certain areas which are considered to be hazardous land. The fragile land is one whose development poses a danger to life and can lead to environmental degradation. The hazardous land as outlined in the acts include wetlands, swamps, coral reefs, land within sixty metres of a river banks, water catchment areas, slopes in mountain areas prone to erosion. The Environmental Management Act No. 20 of 2004 demand the Minister responsible for environment protection to declare any area that is ecologically fragile or sensitive to be an environmental protected area. But in most cases, the location, boundaries, and extents of hazardous lands, the fragile areas in rural areas are not gazetted so they are subject to land degradation.

Experiences with the Green Campaign in Ethiopia have shown that it is impossible to tackle the problem of land degradation at village level in the absence of bylaws (Amede, 2003). The bylaws tend to guarantee effective participation of people in

natural resource management by legitimizing and empowering the local authorities. In Tanzania, bylaws have been used to protect and conserve the natural resources. For instance in Mtanza-Msona village in Rufiji District, the bylaws enabled the establishment and gazettement of village forest reserve in attempt to conserve fresh water biodiversity and avoid degradation of habitat (Kasthala *et al*., 2008). In line with national efforts to conserve the natural resources, Ludewa District Council has enacted bylaws on environmental conservation. The bylaws prohibit setting of bush fires, put restrictions on cutting of trees, emphasise on the need to conserve water sources, land use planning, need to plant trees, set aside pasture land, and regulations on farming and livestock keeping (URT, 2002b). As argued elsewhere, for the environmental conservation bylaws to have potential in the use and protection of natural resources they are supposed to be known to all stakeholders in order to avoid resource misuse (Munishi *et al*., 2007). However, a study (Roxburgh *et al*., 2002) in marine resources in Tanzania shows that few people are aware of regulations protecting the natural resources in their surroundings. In most cases, it is taken for granted that people will implement the bylaws. However, Escobal (2003) study in Latin America and the Caribbean revealed lack of compliance towards regulations on the use of land resources in the absence of operating mechanisms to monitor individual or group actions. The observation in Latin America and the Caribbean is confirmed by findings from urban agriculture in Tanzania, where bylaws guiding natural resources utilization existed and penalties for infringement are stipulated, but lax in enforcement of bylaws increased the risk of land degradation (Foeken *et al*., 2004).

Apart from declaration of hazardous lands and existence of bylaws, natural resource policies and laws demand the development of natural resource management plans. Natural resource management plans can promote public awareness on the value of land resources. The Environmental Management Act No. 20 of 2004 instructs preparation of Environmental Action Plans at national, regional, district, and village levels. Management plans in protected areas are in the form of zoning, access restrictions, use restrictions, and benefit sharing, entrance fees and permits. The management plans can reduce land degradation as they provide framework for monitoring the changes in land use over time. Besides, management plans set boundaries of protected areas, provide explanation on resources to be conserved and/or used, and procedures on their utilization (Lerise, 2005, Kasthala *et al*., 2008). Evidences from wildlife management in Africa have shown that participatory land use planning establish local responsibility for the management of wildlife resources and reduce the costs of law enforcement (Barrow and Murphree, 2001).

In developing countries as reported by Orlandini (2003) in Thailand, projects and programmes are supposed to be the building blocks of a management plan. In the forestry sub-sector in Tanzania, several programmes and projects such as the Tanzania Forest Conservation and Management Project, Sustainable Wetland Management Programme, and Eastern Arc Mountain Conservation strategy are in operation at different stages (URT, 2008). In all these programmes emphasis is placed on the community based forest management that seek participatory of local people. The participation of local people in natural resource management is taken to be a panacea to degradation of natural resources. Based on good governance

experiences in Thailand, it is argued that for participation of local people to be effective there is a need for executing organizations to be reorganized, improved and strengthened (Orlandini, 2003). The transformation of institutions is essential for them to understand the context of local people. The understandings of local social and cultural contexts of projects and programmes beneficiaries initiate the process of policy negotiation and bargaining. The process of policy negotiation and bargaining enable local people to make informed and better land management choices, commit resources to conservation programmes, have opportunities to negotiate conflicts resolutions, and raise awareness. Awareness on the underlying cause of resource degradation offer an opportunity to develop appropriate management plans (Roxburgh *et al.*, 2002).

Experiences from Thailand show that there are more ideas on resources use and management than are good practices in natural resource management (Orlandini, 2003). In this case, the study argues that non-existence of land use management plans are due to wish for standardization rather than lack of skilled manpower and funds. The general thinking among decision-makers is that what is good for developed countries is good for the world. Regardless of its socio-economic conditions most of the developing countries consume policies developed by donors and international organizations (Orlandini, 2003). However, evidences from Lung Vai community in Vietnam show contextualization of policies where detailed topographic surveys required for allocation of land-use certificates were replaced by sketch-maps produced based on information provided by farmers (Neefjes, 2000). In doing so the Lung Vai community saved the forest resources from illegal logging

and farming in steep slopes. On that ground, this study examine if preparation of village land use plans in Tanzania could emulate the Oxfamôs projects in Lung Vai, instead of sticking to recommended land suitability assessments, which are absent for most of the villages in Tanzania (URT, 2006b). Despite the recognition of the importance of local people participation and long existence of national guidelines for participatory village land use management in Tanzania, most villages do not have land use plans or the existing plans are not being implemented (NLUPC, 1998; URT, 2000). The absence of land use management plans is also reported by FBD (2005b) study in 26 forest reserves in 13 Districts in the Eastern Arc Mountains of Tanzania. This means that most activities in the forest reserves were happening at irregular and/or on ad hoc basis. In this case, land use management plans can no longer be an effective yardstick to gauge performance of conservation programme.

In addition to land laws and management plans, another important aspect of natural resource policies that has potential to reduce land degradation is existence of secure land tenure. Land tenures are terms, conditions, and rights that a person may possess with respect to a piece of land (Adams *et al*., 2000). The importance of land tenure in protecting resources from land degradation come from the fact that it influence how people use the land (Mohamed *et al*., 1993). The land tenure ensures protection of land by the existence of use rights, transfer rights, exclusion and inclusion rights, and enforcement rights in its content (Boesen and Rukuni, 2000). The land policy in Tanzania through titling and registration aims to ensure secure land tenure systems for all people (URT, 1997c; Songorwa, 2004). But, a study by Isinika and Ashimogo (1999) has shown that the security of land tenure depend on the adequacy to which

property rights are defined, duration of time over which the rights are valid, assurance in exerting those rights, and the costs of enforcing the rights.

According to the Land Act of 1999 and the Village Land Act of 1999 all land in Tanzania is public owned and vested on the President as trustee on behalf of all the citizens. Under Village Land Act of 1999, the village council has been given the mandate to manage the village land, and allocate it to its people who have user rights. However, in practice apart from land found in urban centres, state in Tanzania remain to be the formal owner of land while customary land tenure define and determine the way land is held and used (Shivji, 1998 cited by Kisoza, 2007). This is in line with empirical evidences in other parts of Africa, which indicate that most people in rural areas hold their land based on the customary land tenure (Boesen and Rukuni, 2000), which recognize three forms of rights, namely individual land, communal land, and open access land which express the levels of labour investment. Under customary land tenure, land is not only passed from one generation to the next by inheritance, but also verbal agreements between neighbours, forest clearing and/or planting, cultivation, and marking of agreed boundaries are enough to ensure a personôs claim on land (Shepherd, 1992). Monela *et al*. (2000) reported that forest clearance of general land in miombo woodland attributed to about 32 to 45 percent of farm land acquired by smallholder farmers. The prevalence of forest clearance as a means to land acquisition imply increased shifting cultivation and use of marginal lands, and hence land degradation.

A study among the Chagga in Kilimanjaro by Lerise (2005) found that increased land shortage as a result of population growth demanded more guided land occupation other than tenurial claims based on forest clearing. Under customary land tenure, through special arrangements for protecting fragile lands, society have managed to protect forest in hill tops, water points, and watershed found in communal and open access lands from degradation. For instance, the Fipa in Mtimbwa village in Sumbawanga district, Tanzania have managed to protect the Kamenje bushes as sacred areas. The Kamenje bushes have been left intact and protected for ritual purposes as it is strictly forbidden to cut trees without the permission of its custodian (Mohamed *et al*., 1993). The effectiveness of customary land tenure in land conservation has also been reported by Mlenge (2004) among the Sukuma people in Shinyanga region, Tanzania. Under the Hifadhi Ardhi Shinyanga (HASHI) project the Sukuma have managed restore *ngitili* (fodder bank) and conserve woodlands after years of overgrazing and deforestation. Of interest in customary tenure in that study is the restoration of *ngitili,* that is, the traditional method of closing an area to livestock to create fodder bank.

Despite the provision of mechanisms to protect and manage communal lands, customary land tenure is blamed to be insecure and inefficient. Most studies (Mohamed *et al*., 1993; Msumali *et al*., 2007) equate it to an open access system. For that matter, emphasis by the government is placed on individual land rights and registration (Shepherd, 1992; URT, 1997c). In its development assistance, the World Bank promotes land titling and registration. Land registration is taken as a means to improve security of tenure, build sense of ownership and increase willingness to

invest on land for long term benefits and ensure sustainable use of resources as land pressure is increasing in rural areas (Zeleke, 2003 cited by Amede, 2003). However, a study in Kigezi District (Boesen and Rukuni, 2000), in south western Uganda, found low demand for land title among smallholder farmers. Only 1 800 titles out of 6 400 land parcels surveyed were paid and collected. Similarly, only 11 percent of title holders in Kenya used land titles to access credit. More evidences from Kenya and Zimbabwe show that land registration did not increase the use of improved techniques necessary to reduce land degradation. The inefficiency of land registration to ensure land tenure security and increase investment on land improvement was also reported by Hebo (2006) in Ethiopia and Mattee and Shemu (2006) among the pastoralists in Tanzania. In this case, policies that continue vesting vast area of rural land on the government control without enforcement capacity risk its land to increased degradation.

2.4 Institutional Arrangements for Reducing Land Degradation

Institutional effectiveness in reducing land degradation illustrates the extent to which the outcomes of human impact on environment differ from what would have occurred in the absence of these arrangements (Kisoza, 2007). In that case, institutional effectiveness depend on type of land degradation, scale of the problem in terms of area and people affected, distance between where the problem is produced to area affected, enforcement costs, and the position of the institution to address the problem (Cistulli, 2002; Kallonga *et al*., 2003). These factors determine how the institutions control what happen to a given resource.

In the context of natural resource management institutions are arrangements available in a society to tackle problems and deal with issues related to natural resources (Lang and Armour, 1980). Institutions governing the use of natural resources are made of two major components, namely set of rules and organizations (Prathapar, 2001). The set of rules define practices, norms, behaviours, or relationships underlying use of a particular resource. The rules defining the use and management of natural resources constitute formal rules (constitutions, laws, regulations, contracts) or informal rules (taboos, customs, traditions, trust, implicit codes of conduct) and/or their enforcement mechanisms (Eggertsson, 1994). The effectiveness of formal rules such as laws discussed in section 2.3 in reducing land degradation depends on the available enforcement mechanisms. The enforcement mechanisms comprise of the process used in decision making that monitor actions of land users by rewarding desired or penalizing undesired behaviour (Russell, 2001). Some of the enforcement mechanisms in use include sending notices of violations, levying, administrative penalties, obtaining criminal indictments for individuals deemed responsible for violations. However, it has been found that giving local institutions responsibilities without power to enforce the laws and regulations could be the source of this laxity. The importance of power to enforce laws is better illustrated by strict observation of laws that establish protected areas such as national parks and forest reserves in Tanzania (Pelkey *et al.*, 2000). Pelkey *et al*. (2000) observed that in a period of thirteen years there was an increase in vegetative cover in woodlands and forests of the protected areas. In contrast, for the same period there was a marked decline in vegetative cover in swamp areas that were not

protected though village councils were mandated to ensure their protection (URT, 2005b; URT, 2006c).

On the other hand, organizations are groups of individuals bound by some common purposes to achieve objectives (North, 1990 cited by Ellis, 2000a). Organizations include government agencies (ministries, extension services), private companies, NGOs, associations, committees, and user groups. Organizations dealing with natural resource management are supposed to develop, issue, and implement the sectoral laws, regulations and guidelines that prevent land degradation. In that case, organizations are supposed to ensure that there is coordination, consultation, and cooperation among stakeholders. In our case, organizations have to ensure joint decision making among smallholder farmers in the area affected by land degradation while at the same time link agricultural sector and other sectors. In most cases, agricultural sector that interact with other sectors in the allocation of resources (legal power, money, staff, information) to various functions, manage and conserve the natural resources according to set rules so as to reduce land degradation (Lang and Armour, 1980; Prathapar, 2001).

The existing policies and laws on natural resource management in Tanzania stipulate a number of institutions responsible for protection and control of land degradation. The institutions at different level of operations control land degradation by regulating human activities, enforcing laws and regulations. Besides, the institutions are supposed to administer the state of natural resources and manage their use through training of human resources and raise of public awareness on resources

value and conservation, and research best way to use and manage the resource in sustainable manner. To achieve the above objectives, various sector ministries such as Ministry of Natural Resources and Tourism, Ministry of Land and Human Settlement Development, Ministry of Agriculture, Food and Cooperative, and Ministry of Water and Irrigation have departments dealing with natural resource management. In addition to departments in sector ministries, the laws have established advisory committees at national level such as National Environmental Advisory committee, National Land Advisory Committee, National Forestry Advisory committee, National Environmental Management Council (NEMC), and the National Land Use Planning Commission (NLUPC). Apart from NEMC, each advisory committee and department operate on sectoral basis without necessary consultation with other sectors. The multiplicity of institutions on sectoral basis has led to duplication of efforts contrary to the endeavors of natural resources policies in Tanzania that call for integrated and multi-sectoral linkages in the use and management of resources (Kisanga, 2002; URT, 2002a).

NEMC came into being in 1983 and was operational in 1986 following the enactment of National Environmental Management Act No. 19 of 1983. NEMC was established to oversee environmental management issues and implement the resolution of the Stockholm Conference of 1972 that called nations to establish and strengthen national environmental councils to advice governments and international communities on environmental issues. The Environmental Management Act No. 20 of 2004, give NEMC mandate to undertake enforcement, compliance, review and monitoring of Environmental Impact Assessments (EIAs). In order to combat land

degradation, NEMC consults with relevant ministries, institutions and link with other organizations at local levels. Currently, there are no NEMC representatives at regional, district, catchment, and village levels to link with lower organs. Absence of representatives at lower levels implies that NEMC fails to pickup signals about needs and problems of the users of resources, hence limiting its performance in control of land degradation. The importance of institutions at local level as a mechanism to coordinate actions and achieve desired goals set by the policies have also been reported in South Africa (Villeval, 2008).

However, a study by Eyzaguirre (1996) in developing countries with less than five million people reported lack of institutions capable of addressing natural resource management most countries. The main reasons for institutions failure to monitor the use and management of the natural resources are many and diverse. In eastern and southern Africa, EC/CTA (1999) study identified lack of understanding on the needs of smallholder farmers, lack of resources (skills, equipment, working procedures, meagre budgets) to serve the smallholder farmers, lack of mechanisms for collaboration and coordination of programmes, and neglect of local peopleôs participation in decision making as the main reason for institutional weakness. Even the local organizations such as district environmental management committees, land allocation committees, catchment water committees, and village councils, water users associations/groups, non-governmental organizations (NGOs), and extension services are in direct contact with farmers they are among the ignored aspects in resource management by high decision making bodies. Kisanga (2002) underscore the role of local organizations in support smallholder farmers in the use of natural

resources. The neglect of local participation in resources management not only denies them responsibility, but also limits the opportunity of costs reduction in law enforcement. Cases of cost reduction in wildlife conservation in Africa are illustrated by Barrow and Murphree (2001) based on experiences with outreach programmes, collaborative management, and community based conservation.

In developing countries, neglecting of local institutions is compounded by frequent changes in responsibilities and structures of various sector ministries without change in legal framework of their operations (Brinkman, 1997). The absence of institutional legal framework of operations leads to failure to guarantee proper use and management of natural resources (Brinkman, 1997). According to Msuya (1999) experiences in nutrition improvement projects in Tanzania, presence of local rooted institutions influence the degree of support needed by farmers from outside. In most cases, disconnection and/or lack of coordinating bodies at district levels to plan and manage programmes that have impact on smallholder farmersô livelihoods create leadership gaps when external support is withdrawn and/or project phased out (Msuya, 1999; Tjonneland, 1996 cited by Duda, 2007).

Apart from national and local institutions, training and research institutions have the role to play in effort to reduce land degradation. According to Mhache (2007) research and training institutions are supposed to be sources of innovations and appropriate technologies that will improve smallholder farmerôs agricultural practices. Research and training institutions strategic role in generation and dissemination of agricultural technologies are instruments in prevention and control

land degradation. In Tanzania, agricultural research is organized by the sector ministries and universities. For instance, the Ministry of Agriculture Food Security and Cooperatives has seven zones, namely Southern Highlands (Agricultural Research Centre-Uyole, Mbeya), Eastern (Agricultural Research Institute-Ilonga, Kilosa), Northern (Agricultural Research Institute-Selian, Arusha), Lake (Agricultural Research Institute-Ukiruguru, Mwanza), Western (Agricultural Research Institute-Tumbi, Tabora), and Central (Livestock Research Institute-Mpwapwa) Research Zone (Mowo *et al.*, 1993). The centres in bracket coordinate a number of institutions in each Research Zones. On the other hand, the Tanzania Forestry Research Institute (TAFORI) under the Ministry of Natural Resources and Tourism has the duty to conduct research on land conservation, water sources, conservation of forests and bees, agro-forestry, conservation of biodiversity, forest management, and development of technologies for acquisition of quality tree seeds.

In addition to research institutions, training institutions like Sokoine University of Agriculture (SUA) train people to deal with prevention and control of resources degradation. Besides, SUA produces technologies and through its various research and outreach programmes such as Miombo Woodland Agro-Ecological Research Project (MWARP), Uluguru Mountains Agricultural Development Project (UMADEP), Soil and Water Management Research Group (SWMRG), and Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods (PANTIL) disseminate knowledge, skills, and demonstrate good governance responsible for management of natural resources. In this case, education becomes a tool for achieving sustainable development as it raises public awareness

on sustainable use of natural resources. Despite larger numbers of research and outreach programmes in Tanzania, the effectiveness of universities and other research and training institutions in reducing land degradation is questionable as the operation of research and training institutions are either concentrated in few areas and/or dependent on donor support. Donor dependency is found in most of the conservation programmes in the country, where donors initiate, own, and manage resource conservation projects. For instance, the Hifadhi Mazingira (HIMA) programme in Iringa Region, where the operation and coverage of the programme was limited by amount of donorôs support to an extent that its expansion has been limited even with the pull out of donor support (Minja and East, 1996; Kamuzora, 2003). The major weaknesses of donor driven programmes are that they are guided by available resources and not priorities given in policies of the host nation for particular area and sector (Eyzaguirre, 1996; Klingebiel, 1999). In addition, the external induced conservation programmes creates dependency among participating farmers. In such cases, most of the programmes on natural resource management aim at fighting land degradation, and village land use plans are abandoned once donor support is terminated.

The lack of coordinating body create environment for continued mismanagement of natural resources that lead to further land degradation and deterioration of smallholder farmers livelihoods. To enhance the contribution of institutions in control of land degradation, EC/CTA (1999) suggested that capacity building, attitude change, reward systems, information sharing and implementation coordination must be in place. The measures ensure institutional responsiveness,

legitimacy, coordination, leadership, integration, conflict resolution, and enforcement of laws that are needed in fighting against land degradation (Bartlett, 1994). The kind of relationships developed in the course of programme planning and implementation determine the level of success in achievement of the set objectives. Performance of an institution depends on how it organizes its mission and links with other organizations in the process of resource management (Villeval, 2008). Nyangito (2007) based on the experiences with coffee farmers in Kenya, reported increased performance of organizations due to existence of co-ordination mechanisms that provide link between decisions and actions of different actors.

2.5 Livelihood Strategies Change due to Land Degradation

Studies in sub-Saharan Africa (Toulmin and Quan, 2000; Foahom and Jonkers, 2005), point out that ineffective policies and institutions responsible for natural resource management have adverse effects on the ability of households to support their livelihoods. As a general tendency smallholder farmers respond to loss in productivity of land by changing their livelihood strategies (Scoones, 1998; Stocking and Murnagham, 2001). In developing countries, studies show that farmers respond to land degradation by intensifying production on smaller areas, extensifying production onto marginal lands, change in crop types, migrating to other areas and/or diversifying their sources of income (Roose, 1996; Scoones, 1998; Stocking and Murnagham, 2001; FAO, 2005). Livelihood strategies taken by farmers are ever changing in response to change in conditions of the land resources in use and/or in access that create opportunities or limit chance of making a living. The understanding of prevailing livelihood strategies has potential to develop land

management interventions that may contribute to limiting impact of land degradation and enhanced smallholder farmersô livelihoods.

In their attempts to increase agricultural productivity and sustain life when their lands degrade, smallholder farmers intensified production in small areas (Dumanski and Pieri, 2000; Kangalawe *et al*., 2001). The use of smaller areas come as a matter of necessities as land degradation induces land shortage which lead to reduced fallow periods and increased pressure on the immediate accessible land. The initiated continuous cultivation if not associated with improved land management practices exerts pressure and degrades the land resources. The degraded land demand more application of external inputs to either increase productivity or maintain an absolute yield level to compensate for the loss (Johnson, 1997). The most common external inputs and technologies adopted to counter adverse impact of land degradation is the use of inorganic and organic fertilizers, pesticides, irrigation, high yielding varieties, increased pests and diseases resistant varieties, agro forestry, and land and water conservation measures. The importance of improved technologies in crop and animal production among smallholder farmers is well known and documented. Studies (Rasmussen, 1986; Mwangi *et al.*, 1999; URT, 2004; Mwaseba *et al*., 2005) about agricultural intensification in developing countries have identified and discussed farmersô technological needs, response to new technologies and the extent to which these technologies had been adopted.

Despite the efforts made by the governments to introduce new technologies especially new crop varieties, the ways sources of seeds and planting materials

among smallholder farmers are kept on changing across space and time have not been adequately addressed. Besides, most studies (Maxwell, 2001; Sanders and Shapiro, 2005) on investment in technologies are in agreement that efforts to develop agricultural sector are concentrated in the main export crops and grain staple crops particularly maize found in high potential areas. The lag behind of poorly served areas and neglected crops in technology investment have been associated with underdevelopment of supporting institutions to smallholder farmers (Glantz, 1994). A study by Ödegaard (1985) in Tanzania has underlined the importance of knowledge on change in crop varieties and sources of seeds and planting materials among decision-makers so as gauge the extent of change in the types of resources used in production. In this case, this study explores resources used in production by smallholder farmers in remote areas of Iringa Region (NEMC, 1995).

In addition to intensifying production, another production strategy opted by smallholder farmers in attempt to redress the decline in productivity brought by land degradation was agricultural extensification. Under extensification strategy, more land in terms of size, number and locations of farms is put under production to compensate for loss in productivity brought by land degradation (Glantz, 1987). The establishment of new farms involves extensive clearing of forests that exposes the land to impact of wind and water erosion and increases land degradation. As little or no external inputs are applied to replenish the soil, after few growing seasons new established farms fail to support the increasing demand of smallholder farmers for food and income. A study in Iringa District showed that smallholder farmers will

prefer to expand their farms rather than engage in other activities (Sano, 1999). Smallholder farmers prefer land expansion as it provides source of independence and food security and is less risky compared to trade. The smallholder farmersô option is supported by evidences from Ileje and Rungwe districts, Mbeya region, in south-western Tanzania that show that the costs of operating off-farm activities is five times higher than that required for farming (Kihiyo *et al*., 1999).

Sometime, in low populated area field expansion persists because of long held view that there is abundant unused arable land in rural areas. Such thinking is also shared by the current agricultural development strategies in Tanzania (URT, 2003). The availability of unused natural resources is one of the seven conditions identified by the Agricultural Sector Development Strategy (ASDS) for Agricultural Sector Development Programme (ASDP) to succeed (URT, 2003). Other conditions identified by ASDS for agricultural development include development of comparative advantage for export and food commodities, involvement in agriculture for large population base, occurrence of domestic and international trading opportunities, facilitated partnership between agri-business and smallholder farmers, continued political commitment in policy and incentives investments and maintained political commitment in local institutions development (URT, 2003). These conditions are consistent with Batterbury and Baro (2005) findings in West Africa that although understanding of rural livelihoods begin with households, most of the household activities are made possible by social arrangements and institutions.

In Ludewa District, it was reported that only 28 399 (7%) hectares of the 383 676 hectares of arable land are under crop production (LDC, 2003). The argument of abundance of land forgets the fact that agriculture is not the only use of land. In most cases, the more accessible arable land to smallholder farmers is always subjected to many competing uses so vulnerable to land degradation (Kikula *et al.*, 1991). Also, the argument put forward does not take into consideration the nature of technology, especially hand hoe used by most of the smallholder farmers which favour cultivation of small fields. The existence of small fields spread over the various agro-ecological conditions has the potential to minimize the risk of crop failure as shown by increased valley bottom cultivation in Matengo highlands in Mbinga district, Tanzania (SCSRD, 2004). However, the scattered nature of fields increase the amount of time spends in travelling from one field to another, thus reducing its management and productivity. In addition, large numbers of small and scattered fields make it difficult for large scale cultivation and mechanization in particular (Ovwigho *et al.*, 2006). This study put forward the argument that there is need for decision-maker to have a new look on what is happening in the field in terms of land use in order to avoid land degradation and improve smallholder farmers livelihoods.

Apart from intensifying use of marginal lands, some farmers when faced with land degradation opt to migrate. According to Hilbert and Lawson (1997) migration is defined as a long term relocation of an individual, household, or group to a new location outside the community of origin. The individual or all household members together move and establish new settlements elsewhere either temporally or permanently (R&AWG, 2004). Migration is not a new phenomenon in the world as

people all over the world have long been migrating from one place to another in attempt to improve their livelihoods. Global studies show dramatic increase in out-migration in recent decades (FAO, 1995; Mollett, 1991 cited by de Haan, 1999). In the Southern and Western highlands of Tanzania, it is estimated that about 50 percent of the migration in the 1990s was attributed to attempts to find new arable lands as former agricultural lands kept on degrading (Narayan, 1997). This was better illustrated by the massive migration of Matengo people from the highlands to the less populated and underutilized lowlands in Mbinga District, Tanzania in the 1990s (Mattee *et al*., 1996; Mhina, 2001). In most cases, farmers relocate in order to reduce their exposure to land degradation and find new bases for their livelihoods. In this case, migration among smallholder farmers is taken to be an exit from difficulties caused by land degradation which induces food insecurity.

With increasing impact of land degradation on smallholder farmers, out-migration can be used as a mechanism to reduce the pressure on land at the point of origin. For instance, in mountain areas of Europe and America, out-migration led to disintensification of land use in marginal lands and land abandonment, which stimulated land recovery, improved watershed and biodiversity protection (Grau and Aide, 2007; Soliva, 2007). However, most studies on migration in Tanzania have paid attention to negative aspects of migration at destination points such as deforestation, poor farming methods, unemployment, and unplanned settlements and rarely have considered the opportunities offered by out-migration at the point of origin (Mbonile, 1995). Similarly studies (CONCERN, 1997; CONCERN, 2000) of migration in Masasi Division in Ludewa District address aspects of rural-urban

migration, but rarely cover on rural-rural migration. This is due to the fact that migration is viewed as a process of urbanization rather than of origin and destination (FAO, 1995). Knowledge on migration as a matter of area of origin and destination is needed in order to understand the conditions more likely causing future migration, identify agro-ecological areas susceptible to migration, and type of households likely to migrate (Ezra, 2001). Evidences from elsewhere show, migration options are not open to all (Hilbert and Lawson, 1997; Warren *et al*., 2001 cited by Batterbury and Baro, 2005), but peopleôs networks preceding migrations and social institutions, determine who migrates and from which areas (Roberts, 1997 cited by de Haan, 1999). This study attempts to establish the categories of people who migrate and areas they come from in the context of land degradation. The information is vital in determining future trends of both population dynamics and land use.

As other people opt to migrate, some tend to diversify their sources of income. Various studies acknowledge the fact that smallholder farmers sustain their lives in diversity of ways in their struggle for survival and in order to improve their livelihoods (Ellis, 1998; Akinyele, 2002). Livelihood diversification is a strategy taken by smallholder farmers to reduce the negative impacts prompted by the decline in natural resource conditions such as loss in soil fertility. Studies (Ellis, 2000b; Davis *et al.,* 2002; Ambrose-Oji, 2004) show that livelihood diversification is neither new nor confined to rural areas of developing countries, as the practice is widespread in all regions and across farm sizes, ranges of income, and wealth. The importance of off-farm activities among farmers in rural areas in Asia (Mooij, 2000) and Africa (Swift and Hamilton, 2001; Bryceson, 2004) is known. Similarly,

evidences from Deagrarianisation and Rural Employment (DARE) studies in Africa (Ethiopia, Nigeria, Tanzania, Malawi, Zimbabwe and South Africa) show that most households had one or more off-farm income sources, which contributed between 60 and 80 percent of their incomes (Bryceson, 2004). As illustrated by the case of Zambia, promotion of off-farm activities is one of the essential elements in rebuilding peopleôs livelihoods and reducing land degradation (Chiwele and Sikananu, 2006).

According to Ellis (2000b), the ranges of diversified activities undertaken by household depend on the access to resources needed to purse a strategy, structure of the household, and ability or willingness to take risks. Others include socio-cultural constraints (such as jealousy, fear of witchcraft, conflict between individual interests, interest of the group, level of household income, agro-ecological and social differences (Tellegen, 1997). Seasonality of activities, labour markets, credit market failures, and coping behaviour and adaptation has also been identified as the factors influencing engagement in off-farm activities. Besides, the growth of rural off-farm activities depends on the surplus generated from agriculture and its commercialization, investments in the rural off-farm activities, and availability of employment opportunities in nearby areas (Da Silva, 2003).

The increasing diversity of smallholder farmersô activities implies the change in sources of incomes. Experiences from Zarma in Niger show that diversification of sources of income is associated with business activities that require frequent travelling (Batterbury and Baro, 2005). In this case, other groups of people with

limited mobility such as women tend to dominate in the local market trading as shown by increased importance of local beer brewing among women in Malawi (Tellegen, 1997). The change in sources of income influences resources allocation among different categories of land users and livelihood strategies and has implications on both the future conditions of land and livelihood outcomes to be achieved. Despite its potential in income generation and sustainable resource use increased old women specialization of in making mats and baskets from local grasses go unnoticed by policy-makers. This study explores how smallholder farmers with no access to creditsô facilities use off-farm activities to overcome the negative outcomes of land degradation.

The livelihood strategies undertaken by smallholder farmers discussed above have both biophysical and socio-economic outcomes. The biophysical outcomes of smallholder farmersô livelihood strategies are changes in state of land which are manifested as loss in soil fertility, reduced water level, and deforestation. On the other hand, the socio-economic impacts of smallholder farmersô livelihood strategies include increased and/or decreased food security and incomes. Food insecurity is one of the visible manifestations of livelihood deterioration prevalent all over the world, but more worse in developing countries like Tanzania. In most cases, land degradation affect smallholder farmers livelihood strategies through reduced area or reduced yields, resulting in food insecurity (Wiebe, 2003). Alemu *et al*. (2008) study in Ethiopia identified anthropometrical measurement, food consumption (calorie intake), coping strategies, and perceptions about the level of food security as methods used to assess householdôs status of food security. In Bangladesh, Webb *et*

al. (2003) developed, tested and used eleven item factors to reveal household perceptions of food insecurity. The eleven item factors were adopted and used to assess the variations in household perceptions of food security status in this study. The items were scientific, quick to administer and analyse, and could be incorporated into ongoing surveys (Kennedy, 2003). The increase in food insecurity threatens the achievement of development goals stipulated in both the Tanzania Development Vision 2025 and the Millennium Development Goals of 2015. Since the 1990s, incidence of food insecurity and reports of food shortage in Iringa Region and Ludewa District have become rampant (URT, 1997d; CONCERN, 1997; Msowoya, 2006). The government and international organizations, especially CONCERN worked hard to achieve food security among smallholder farmers in southern parts of Ludewa district (Nyangôali *et al*., 2001). This study explores the extent of food insecurity problem and its variability among smallholder farmers in the study area.

2.6 Socio-economic Factors Influences on Farmers' Livelihoods

In Africa and Tanzania, gender, age, level of education, level of income, size and number of farm and size of household have been identified as socio-economic factors influencing the livelihood strategies and outcomes (Mwangi *et al*., 1999; Adesina, 2000; Kisusu, 2003; Mwaseba *et al*., 2005). As for biophysical factors which determine the kind of land based activities (Osgood and Lipper, 2001), the socio-economic factors influence the priority and capacities of a household in its efforts to fight land degradation and improve livelihoods (Webb, 2001; Messer and Townsley, 2003). The ability of smallholder farmers to access and use the available

resources tend to vary with location, time, and individual characteristics, and hence, the differences in their activities (Fisher, 2002). In most cases, the socio-economic conditions facing smallholder farmers have been neglected by decision-makers in most of the development strategies to reverse the deterioration of the land quality (Bindraban *et al.*, 2000; Duda, 2007). The study of the socio-economic factors improves the understanding of conditions that shape the patterns of smallholder farmerôs livelihoods. Studies (Magayane, 1995; Assmo, 1999; Stocking and Murnaghan, 2001) show that the capacity of smallholder farmers to undertake a particular livelihood strategy and restore the land resource in use depends on the level of various socio-economic factors. In that case, its understanding is essential in efforts to restoration of the degraded land.

Household composition is one of the socio-economic factors influencing livelihoods of smallholder farmers. A study in Turkey showed that the household composition (size, age, gender) put limits to and determined the nature of work carried out by farmers (Aydin, 2002). Gender of the household head is one of the components of household composition that determines the nature of work carried out by farmers as gender influence the social positioning of household within the society and hence their access to resources (Ellis, 2000). Given the historical and cultural background, most of the female headed households have limited access to resources, either based on inheritance or institutional framework that exclude them from development projects or decision making bodies. The low participation of women limits their capacity to acquire technology to sustain their land resources and become more vulnerable to land degradation. For instance, in Tanzania women are legally entitled

to own land, but legal systems such as the Village Land Act, 1999 in Tanzania subject women especially in rural areas to the customary land laws that in most cases have been found to deny women rights to land (URT, 1999c URT, 1999d).

Experiences from Arsii Oromo in Ethiopia show that women have different rights to land access under different circumstances (Hebo, 2006). For instance, unmarried women are given temporary land use rights but, they have no right to maintain its ownership upon marriage. However, among Arsii Oromo in Ethiopia, widows have complete control of family property including rights to land following their husbandsô deaths. But, similar rights are denied to divorcees. In most cases, the unequal access and lack of control to land used by women is shaped by prevailing policies, laws, and institutions. The circumstances facing women in accessing land would influence their resource management. In this study, a difference in gender is one of the central socio-economic factors considered to influence the likelihood of undertaking various livelihood strategies (Carney, 2002).

Apart from gender of the household head, the household size is another important socioeconomic factor that influences smallholder farmersô engagement in a particular livelihood strategy. As far as smallholder farmerôs production depends on family labour, the size of household determines the activities to be carried out. In some cases, farmers tend to increase the size of their fields in order to meet food and other needs as the household size increases (Yamazaki and van Ni, 1998). The increase in field size involves extensive clearing of land for new fields and the processes potentially lead to increased land degradation. In smaller household size,

fields are left fallow longer and there is reduced pressure on natural resources that offer chance for replenishment of soil fertility. Peopleôs livelihoods to be achieved by a household are also closely related to the age of the household head, which influence the amount of assets available to and/or accessed by a household. For instance, younger household heads have more capability to labour. In the context of limited level of mechanization and poor transport infrastructures, younger household heads are more likely to expand their fields and engage in long distance travel as they have energy to do so compare to older ones. In contrast, older household heads have more accumulated assets, thus are unlikely to undertake migration strategy. In addition to gender and age of the household head, education is an important human capital that enables farmers to participate in a range of activities. The level of education of the household head determines the kind of activities to be carried out under various circumstances. Education raises awareness and develops smallholder farmers understanding on the value and potentials of various technological options available (Sourabie, 1999). Experiences from resettlement projects in the humid tropics show that use of new skills and knowledge increase the ability of smallholder farmers to adapt to the changed land conditions like drop in soil fertility (Burbridge *et al*., 1988). It is unfortunate that despite ample evidences of alternative technologies known to improve soil fertility, little efforts are made by farmers to improve the soil fertility and eliminate impacts of shifting cultivation. Experiences from Niger show that targeting of land enhancing technologies in areas with large percentage of degraded land tend to raise productivity (Baidu-Forsen, 1999).

Level of income is another important socio-economic factor that can complement the role of education in influencing the kind of activities undertaken by smallholder farmers. The income status determines the purchasing power and ability of smallholder farmers to meet the costs of inputs required in production, and the kind of technology to be adopted. In absence of appropriate and affordable technologies, lack of access to credit facilities, make smallholder farmers escape the risk of crop failures by abandoning exhausted farms and migrating to other areas. Extensive cultivation adopted by smallholder farmers in new areas increases their vulnerability to land degradation as cultivation in new areas is not associated with application of improved farming techniques.

2.7 Impacts of Land Degradation on Smallholder Farmers' Livelihoods

2.7.1 Overview

Impacts of land degradation have been defined as the ultimate effects of change in land conditions brought by natural processes and/or human activities (Neefjes, 2000; Woodhouse *et al*., 2000). The effects of change in land resources are expressed in terms of changes in resources used/accessed and/or accumulated by a particular livelihood strategy, change in livelihood strategies themselves, and livelihood outcomes of a particular livelihood strategy. First part of this section reviews theoretical frameworks used in assessment of impacts of land degradation. The second part of this section outlines relations among variables used in this study as summarised in the conceptual framework.

2.7.2 Theoretical frameworks on impact of land degradation

Impacts of land degradation have been assessed in different ways by different individuals and organizations. The use of different theoretical frameworks reflects the fact that the processes of knowledge generation are guided by a purpose (FAO, 2003). Since, the purposes differ among individual researches, to achieve a purpose; a theoretical framework must meet a number of criteria. Wiesmann (1998) study in Kenya identified important criteria for components included in the theoretical frameworks. Wiesmann (1998) asserts that components should allow consideration of empirically observable phenomena, enable formulation of new questions and empirical indicators, and find acceptance within the scientific community. Besides, the components included should be used to develop recommendations for action, allow interpretation that focus on political goals, and which are based on important aspects to the societies and the actors. In this study, four theoretical approaches, namely, ecological, political ecology, environmental accounting, and livelihood approaches are reviewed to examine the impacts of land degradation on smallholder farmersô livelihoods.

The ecological approaches investigate the consequences of human-induced land degradation on resources based on biophysical factors in order to ensure that land remain productive into the future (Tengö and Belfrage, 2004). The focus on biophysical factors made most studies on land degradation pay attention to establishment of the cause-effect relationships of the observed and measurable variables. The understandings of cause-effect relationships are associated with development of various methodologies to control land degradation, map the extent

of the problem, and to predict the likelihoods of their occurrences (BSP, 1995). Land capability classification, land evaluation, agronomic experiments, erosion hazard assessment and productivity modelling are some of the methods used to monitor changes in biophysical factors and its effects on the resources (Stocking, 1998; FAO, 2003; Wiebe, 2003). For instance, Lu *et al.* (2007) used remote sensing images to map and monitor land degradation risks in the western Brazilian Amazon. Similarly, several researches based on biophysical factors have investigated the consequences of human-induced land degradation on resources in Tanzania (Mulengera, 1996; Monela and Solberg, 1998; Rushomesa, 1999; Haule, 2000; Kangalawe, 2001; Tengö and Belfrage, 2004). However, the ecological studies such as the long-term agronomic experiments are time consuming in data generation required for simulation, and demands complex set of data that are not readily available in less studied area like Ludewa District. In addition, the ecological studies are pre-occupied with measurements of observable phenomena (i.e. what, how) to an extent that they do not bother to understand why people degrade their land resources (Röling, 1994; Stocking, 1998). People as an element in the ecosystem can destroy the habitat, create and modifies the ecosystems, consumes and controls depletion of natural resources. In most cases, resource users and their socio-economic and political aspects of land degradation are neglected due to over emphasis given on understanding changes in state of the natural resources (Bindraban *et al.*, 2000).

Apart from ecological frameworks, another theoretical framework used to assess the impacts of land degradation is a political ecology (Blaikie, 1995). The political ecology approach assesses the impacts of land degradation by linking political

economy and ecological analysis. The political ecology is based on notion that changes brought by land degradation are generated by environmental contexts, social structures, and power relations that produce a particular livelihood strategy. In this case, the framework assumes that land degradation is a social construct brought by differences in power relations that define the way resource is controlled and used. As for the ecological frameworks, the political ecology is criticized for the fact that the social contexts of land degradation are diverse in spatial and temporal dimensions that it is difficulty to explain their local variations (Blaikie and Brookfield, 1987 cited by Lestrelin and Giordano, 2007). Besides, the legitimacy and future of political ecology framework is also questionable having in recent years drifted its concentration from biophysical issues to more socially centred concerns (Walker, 2005 cited by Lestrelin and Giordano, 2007).

In addition to ecological and political ecology frameworks, some scholars assess the impacts of land degradation based on environmental accounting. The environmental accounting assumes that natural resources have an economic value, that is, the natural capital (FAO, 1994; Stocking and Murnnaghan, 2001; Hella, 2003; Maiangwa *et al*., 2007). In the environmental accounting framework, impacts of land degradation are assessed based on a change in natural capital value using cost and benefit analysis techniques. The approach asserts that the impact of land degradation depend on assumed costs of preventing land degradation by conservation, costs of lost production, replacement costs, costs needed to reinvest in other sectors, and restoration costs. In this framework, it is argued that land degradation is likely to continue if land users do not bear the full costs of their

actions especially off-site costs. In addition, little efforts are made by land users to combat land degradation when they can exploit scarce resources without contributing to their maintenance, and when property rights to natural resources are poorly defined, unclear, unspecified, and non-existent (Stocking and Murnaghan, 2001; Maiangwa *et al.*, 2007). Several problems and weaknesses are associated with the use of environmental accounting approaches. First it is argued that it is difficulty using the approach to estimate the extent and severity of land degradation. Second problem in the use of the environmental accounting approach is difficulty in conversion of physical effects into economic terms. Last as for the ecological and political ecology approaches, environmental accounting approach put more emphasis on effects of change in resource productivity as it only consider impact of land degradation in terms of the loss in exploitative value of the resources (FAO, 1997).

The last theoretical framework considered in this study was the sustainable livelihood approaches (SLAs). Unlike the ecological and political ecology theoretical frameworks, sustainable livelihood approaches shift the focus in assessment of impacts of land degradation from the resources to the people who use and manage the resources (Ellis, 2000a; Neefjes, 2000; Akinyele, 2002; Bradbear, 2002). Sustainable livelihood approaches seek to improve our understanding of how people use the resources at their disposal to construct livelihoods in the face of land degradation (Swift and Hamilton, 2001). The sustainable livelihood approaches emphasise on individuals, households, and communitiesô ability to manage changes that affect their lives. Depending on differences in access to natural and other

resources brought by vulnerability context a group of smallholder farmers may or may not be affected by land degradation (Neefjes, 2000; Akinyele, 2002; Bradbear, 2002). The emphasis given on individual ability represent a shift in focus of knowledge generation from resources to people, which is vital for identification of livelihood strategies open to smallholder farmers and knowing extent to which farmers are exposed to impact of land degradation. Furthermore, SLAs acknowledge the role of external conditions like policies, institutions and socio-economic factors in enabling or constraining the change in livelihoods (Lestrelin and Giordano, 2007). In this case, the SLAs have been widely used in the study of impacts of land degradation in developing countries (Woodhouse *et al*., 2000; FAO, 2003). SLAs provides a linkage between the pressure exerted on land by human activities, the change in quality of the resource, and the response to these changes as society attempt to release the pressure or to rehabilitate land that has been degraded (Fig. 1).

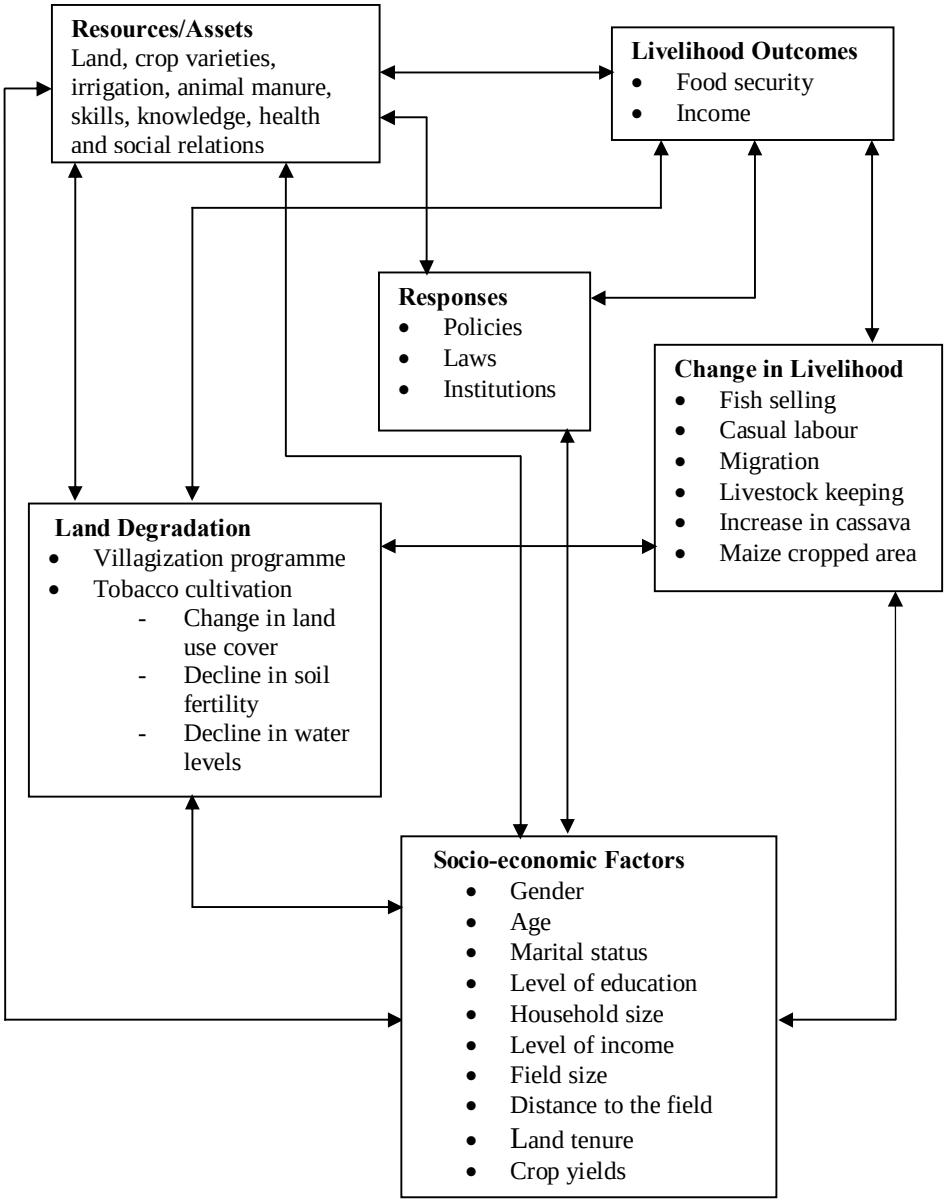

Figure 1: Conceptual Framework for Impact of Land Degradation on Livelihoods

Adopted and modified from Carney (1998)

Unlike the ecological studies, SLAs establish relationships between livelihood strategies and change in state of the resources without assumption of causality that suggest a linear relationship in the human activity-environment interaction (Woodhouse *et al*., 2000). Based on the five assets (natural, physical, financial, human, social capital), SLAs provides disaggregated analysis of changes in livelihoods of farmers and land conditions. By linking agriculture and other aspects of smallholder farmersô livelihoods, SLAs analysis provide an understanding of how the resource became what it is, and whether there are potentials for further change (Leach *et al*., 1997 cited by Neefjes, 2000). However, Swift and Hamilton (2001) found a number of weaknesses related with the use of SLAs in explaining the link between land degradation and change in livelihoods. They suggested that SLAs say little on resources distributional issues thus reducing its empowering goals. Besides, by being holistic in nature SLAs is unlikely to achieve some of its objectives in developing countries. For instance, efforts to achieve food security and ensure sustainable natural resources management are contradictory given the uncoordinated sectoral organization of development programmes.

Despite its weaknesses, various studies used sustainable livelihood frameworks to assess impacts of land degradation on livelihoods in developing countries (Woodhouse *et al*., 2000; Stocking and Murnaghan, 2001; Whitehead, 2002; FAO, 2003; Lestrelin and Giordano, 2007, Resurrecôcion and Elmhirst, 2008; Wood and Halsema, 2008). For instance, in India, a study was made of nine aspects of peoples livelihoods namely, physical base, knowledge and activity base, emotional base, socio-economic space, family base, inner human space, collective orientations,

family orientation, and individual orientation based on the Rural Livelihood Systems (RLS) commonly known as Nine Square Mandala (WASSAN, 2001; Högger, 2003 cited by SAMUHA, 2004). The Mandala framework focuses on understanding the livelihood at personal level and at specific context of that livelihood.

Application of sustainable livelihood frameworks in Africa is illustrated in North-East Ghana where longitudinal survey and panel case studies of three households were used to track changes in livelihood from 1975 to 1989 (Whitehead, 2002). Similarly in semi-arid zone of Nara in Mali, a study by Dembélé (2006) identified low land productivity, famine, malnutrition, and poor health as key impacts of land degradation on livelihoods. Likewise in Tanzania, based on remote sensing data, hydrological records and participatory rural appraisal (PRA) methods, livelihood changes in lowland areas due to land degradation in Matengo highlands was reported in Mbinga district (Nindi, 2007). Despite increased volume of researches, most of the studies on livelihood changes are concentrated on the change in assets status (Woodhouse *et al.*, 2000; Runyoro, 2007; Kasthala *et al*., 2008, Vyamana *et al.*, 2009). This study examines the influence of socio-economic factors in change of livelihoods. The socio-economic factors indicate the extent to which specific household has been affected by impacts of land degradation and how they are capable to mitigate the negative impact of land degradation as illustrated in a conceptual framework of this study (Fig. 1).

2.7.3 Conceptual framework on change in livelihoods due to land degradation

The foregoing review of literature on change in smallholder farmersô livelihoods due to land degradation is summarized and synthesized in the model depicted in Figure 1. The conceptual model is a modification of Carney (1998) sustainable rural livelihood framework. The new model include aspects that are basic in understanding the context of this study such as trends in land degradation and socio-economic factors which were implicit stated in Carney (1998) model. The conceptual model for assessment of impact of land degradation on livelihood (ILADEL) has six components (Fig. 1). The first component illustrates that smallholder farmers vulnerability to land degradation in a study area was driven by government settlement policies (villagization programme) and global market forces particularly introduction of flue-cured tobacco. The combined effects of drivers led among other things to change in land use/cover, depletion of soil fertility and decline in water levels. The changes in land use/cover were triggered by change in quality of upland fields, particularly decline in soil fertility. The decline in soil fertility in upland fields led to field abandonment and forced farmers to encroach marginal lands particularly wetlands, river banks, and river valley bottoms.

As the problem of land degradation is wide spread, the second component shows how the community and government responded to land degradation by formulation of policies, enactment of laws, and establishment of institutions to govern the use and management of natural resources. Among the policies include the National Land Policy of 1995, the Environmental Policy of 1997, The National Forestry Policy of 1998, and the National Water Policy of 2002. Besides, a number of laws and bylaws

have been established particularly the Land Act No. 4 of 1999, the Village Land Act No. 5 of 1999, the Forest Act No. 14 of 2002, the Environmental Management Act No. 20 of 2004, and Environmental Conservation bylaws of Ludewa District Council of 2005. Moreover, various institutions at different levels have been established to oversee the use and management of natural resources and control land degradation. The institutions include the National Environmental Management Council (NEMC), land allocation committees, catchment water committees, village councils, water user associations, non-governmental organizations just to mention a few.

The third component of the conceptual framework is made up of various resources. The resources, sometimes known as livelihood assets or capitals are the building blocks that can be combined or substituted to manage the negative consequence of land degradation and make a living (Ellis, 2000a; Messer and Townsley, 2003). In the study area, smallholder farmers had land, water bodies (Lake Nyasa, Ruhuhu River, Mchuchuma River), minerals, forests, new crop varieties and planting materials, irrigation facilities, animal manure, skills on various vocations, knowledge on agro ecological conditions, health, and social relations. The resources enabled them to engage in a number of activities. However, the accesses to available resources were mediated by prevailing policies, institutions and socio-economic factors. In rural settings, policies, laws, institutions, and socio-economic factors could constrain or enhance smallholder farmersô access to assets and influence the livelihood outcomes. This come as reported by Dumanski and Pieri (1997) that differences in access to assets have potentials to degrade natural resources.

The fourth component of the conceptual framework of this study is made of socio-economic factors. The socio-economic factors such as gender, age, marital status, level of education, household size, level of income, field size, yields, distance to the fields, and land tenure were responsible for shaping the decisions made by smallholder farmers at local level on use and management of natural resources. The kind of socio-economic factor facing a farmer determined the resources accessed, kind of activities to be undertaken and the intensity of impact the activities have on state of the land resources.

The fifth component of the model composes of changes in livelihood strategies taken by smallholder farmers in order to earn a living and mitigate impact of land degradation. In the study area, smallholder farmers increased cassava and maize cropped area, engagement in fish selling and casual labour, migrated to new areas, and kept livestock. The livelihood strategies taken had potential to reduce or increase impact of land degradation and determined the kind of outcomes to be achieved depending on the prevailing socio-economic conditions.

The last component in the model is the livelihood outcomes. Livelihood outcomes represent the socio-economic impact of the livelihood strategies taken by smallholder farmers in the context of land degradation. The major outcomes considered in this study were food security and income. The nature of livelihood outcomes achieved by smallholder farmers depended resources available and/or accessed as influenced by socio-economic factors, policies, laws and institutions. Depending on the effectiveness of available policies and institutions, livelihood

outcomes achieved such as food insecurity and need for income could promote further encroachment of marginal lands. Hence, in order to improve smallholder farmersô livelihoods and reduce impact of land degradation there is a need to consider link between various components of the model.

2.8 Summary

It is evident from the reviewed literature that changes in smallholder farmerôs livelihoods are caused by many factors including land degradation. Land degradation affects quantity and quality of land available to and used by smallholder farmers. However, reviewed literature and theories on impact of land degradation have shown that most of the existing studies dwell on revealing a cause-effect relationship as if land degradation is a linear departure from the ideal and neglect the inherent diversity of many ecosystems (Leach and Mearns, 1996). In most cases, local indicators of worsening land conditions such as change in land use/cover, decline in soil fertility, and decline in water levels which are site specific are neglected. It has been acknowledged in this review that the state of these indicators change the value of land and influence kind of smallholder farmersô activities and ultimately their livelihoods. Besides, the review has revealed that the amount and nature of available and/or accessed land by a household is a function of socio-economic factors, policies and effectiveness of institutions that enhance and/or limit smallholder farmersô activities and capacity to combat land degradation.

The review further suggests that ecological, political ecology and environmental accounting theories neglect the resource users. In so doing no institutionalised

support is given to smallholder farmers faced with land degradation and land continue to degrade. This study in chapter four and five has addressed the identified knowledge gaps by investigating the implications of intensive use of marginal lands due to change in land use/cover and decline in soil fertility as manifested by migration and encroachment of catchment areas. Besides, the study has explored efforts made by farmers (improved farming techniques and new crop varieties adoption, and engagement in off-farm activities) to overcome impact of land degradation. In addition, this study through the adopted and modified conceptual framework has established a link between biophysical factors expressed by change in land use/cover and soil fertility status and its impacts on peopleôs livelihoods in Ludewa District. The link is mediated by policies, institutions and socio-economic factors that determine the resources accessed and used in different livelihood strategies. The link breaks the established causal-effect relationships between state of land resources and livelihood outcomes as resource users decisions are dynamics and influenced diverse factors. That why not all people in the villages that had experienced soil fertility depletion had out-migrated.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Overview

This chapter presents materials and procedures used in collection and analysis of data. The first part provides the description of the study area, while part two explains the research design and sampling procedures. This part is followed by data collection methods and finally data analysis procedures are outlined.

3.2 Description of the Study Area

3.2.1 Location

This study was conducted in three wards namely, Luilo, Masasi, and Nkomang'ombe in Masasi Division (Fig. 2). Other wards in Masasi Division are Manda and Iwela. Prior to 1988, all the villages in the three wards were in one ward of Luilo. Masasi Division is found in the southern part of Ludewa District and Iringa region, in the Southern Highlands of Tanzania. Masasi Division is situated between latitudes 10°15' and 10°30' South and longitudes 34°30' and 34°52' East. Lake Nyasa in the west makes a border of Masasi Division with Malawi. On the south and east, Masasi Division borders Ruvuma region and on its north are Makete and Njombe Districts, and Mbeya Region.

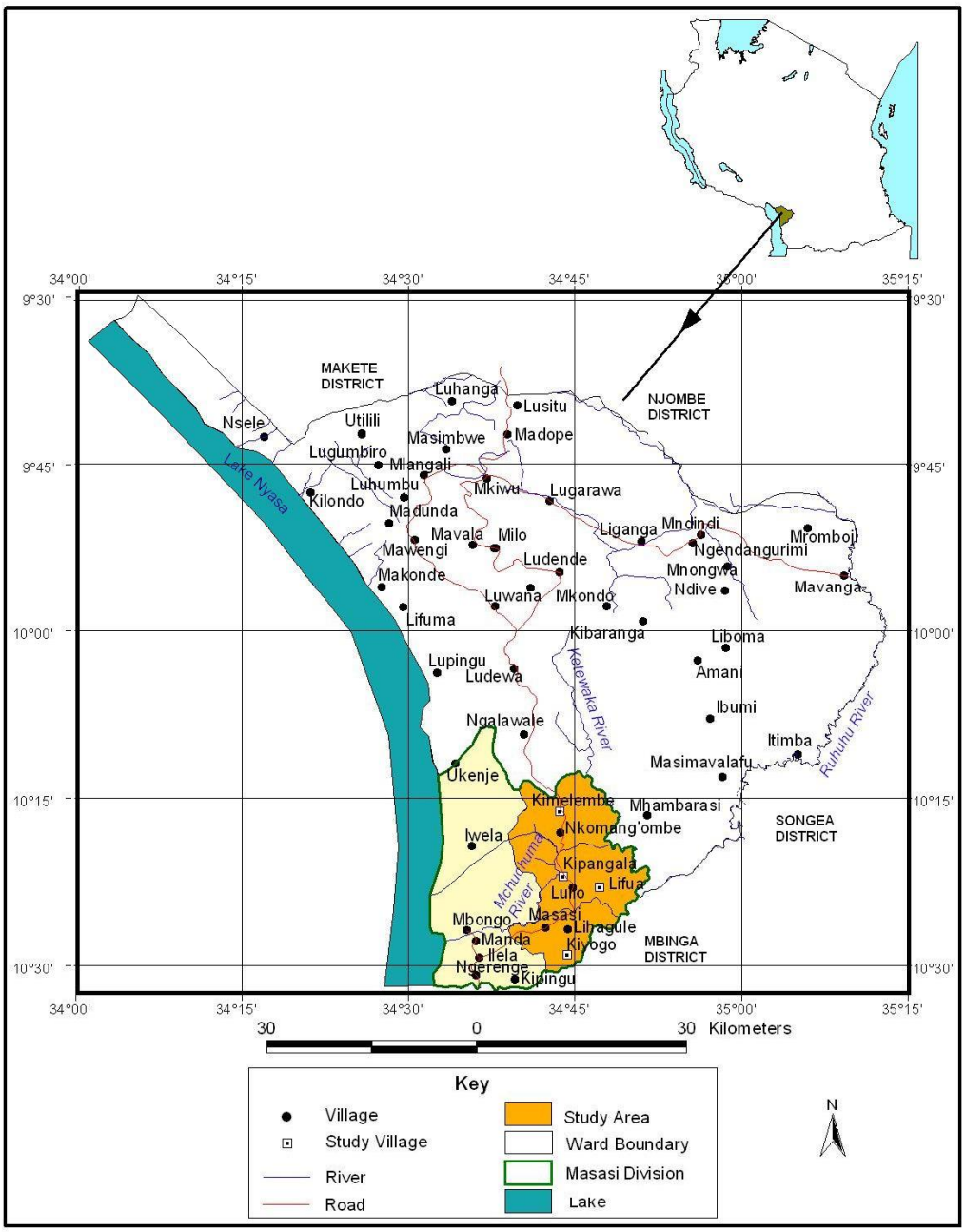

Figure 2: Map of Ludewa District and Tanzania showing study wards and villages

3.2.2 Agro-ecological conditions of the study area

Large parts of Masasi Division are found in the lowlands area that is characterized as medium dry intermediate agro-ecological zone, commonly referred to as the Ruhuhu Basin which covers an area of 1 077 square kilometres and seventeen percent of the total land area in Ludewa District (UNDP/FAO, 1976). The landscape in this agro-ecological zone is undulating with some rocky hills and steep ridges with elevation ranging from 500 m to 1 100 m above mean sea level from Lake Nyasa shore to the Ruhuhu escarpment. The northern parts of Masasi Division is dominated by deep dark sandy loams on rolling hills and shallow sandy clay on steeper slopes and hills (EEC, 1987). According to De Pauw (1984) the southern part of Masasi Division is dominated by yellow sandy soils of very low fertility.

The eastern parts of Masasi Division are made up of loamy sands and alluvial soils along the Ketewaka and Ruhuhu river banks (UNDP/FAO, 1976). In most cases, areas close to the main rivers and along the lake shore in Masasi Division have shallow soils, stony and rocky outcrops (UNDP/FAO, 1976). In Kiyogo village, stony and rocky outcrops cover over 50 percent of the village area. The study area is drained by a number of rivers including Mchuchuma in the western parts, Ketewaka in the north east and Ruhuhu in the east (EEC, 1987). The dominant vegetation in Masasi Division is *Miombo* woodland in hilly and upland areas, wooded or bushed grassland on undulating landscape, and scattered *Commiphora*, acacia scrubs, baobabs and *Combretum spp* on plains and floodplains along the main rivers.

The study area experience warm and dry climatic conditions. The average annual total rainfalls vary from 800 to 1 200 mm and rainy seasons start in mid December and continue until April (DANIDA, 1982 cited by EWB-SFP and NGEDEA, 2005). The northern parts get more rain than the southern and eastern parts of the Masasi Division. The low rainfall in southern and eastern parts of Masasi Division is attributed to rain shadow effects of the Namswea Mountains in the neighbouring Mbinga District. Annual evapotranspiration of 1 450 mm exceed the mean annual rainfall of 900 mm, and the mean annual temperature is 22°C (EEC, 1987).

3.2.3 Demographic and socio-economic conditions of people in Masasi Division

Despite the increasing population since 1967 census (6 600 persons in 1967, 7 690 persons in 1975, 15 258 persons in 1988, and 17 970 persons in 2002) Masasi Division has remained the lowest populated area in Ludewa District. The population density of Masasi Division had increased from 6.1 persons per square kilometre in 1967 census, 14.2 persons per square kilometre in 1988 census to 16.7 persons per square kilometre in 2002 census. Based on ward area and population as per 2002 census, population density of study area was 19 people per square kilometre for Luilo and Nkomangôombe wards and 21 people per square kilometre for Masasi ward. Compared to other divisions in the district, Masasi Division is sparsely populated. For instance, population densities of Mwambao Division along Lake Nyasa shore and Mlangali Division (central and northern part of the district) in 2002 were 36.5 and 24.8 persons per square kilometre, respectively (URT, 1988; URT, 2005b). The total population during survey period varied from one village to another. There were 1 158 and 1 240 people in Lifua and Kipangala villages,

respectively. In contrast the total number of people in Kimelembe was 771 while that at Kiyogo was only 504 people. In general, the number of people in the villages that had experienced out-migration was large than to those that had experienced in-migration.

Apart from demographic features of the Masasi Division, the village names provide some clues on the origin, trend and importance of the settlements in the study areas. Settlements in Kimelembe existed prior to 1960s but with less than fifty households. During the mid 1970s resettlement programme, the residents of this village were moved to Nkomangôombe village. The settlements were re-established in 1981 following floods in Lituhi village and remained part of Nkomangôombe village. The name of the village comes from one of its earlier residents. In the past, the village area was an ethnic boundary of Manda and Pangwa tribes. But, currently, the village is composed of Pangwa and Kinga in the northern Igunga sub-village. Manda and Kisi ethnic groups are dominant in the southern Kimelembe, Nkavirondo, and Ndilima sub-villages. The differences in ethnic groups among the sub-villages express the direction and patterns of migrations in the village. Most of the migrants in northern part of the village came from other divisions in the district and are of recent phenomenon. In the southern part, most of the residents came from other villages in either Masasi Division or moved by government from Lituhi in Mbinga District.

On the other hand, Kiyogo village is named after the bathing area that was safe and free from crocodile threat along the Ruhuhu River. *Kiyogo* is the Manda term

literally meaning bathing area either in the river or lake. Traditionally, people apart from having bath at homestead, they used to set separate bathing area based on gender either along the lake or a river. In the past, large numbers of crocodiles were threatening peoplesô lives in the Ruhuhu River and only that portion currently occupied by the village was safe. The main ethnic group at Kiyogo is the Manda. During villagization programme of mid 1970s, residents of Kiyogo were moved to neighbouring villages of Lifua, Masasi, Lihagule, and Ngingama. Kiyogo by then was a sub-village of Masasi. In mid 1980s people started coming back and became part of Lihagule village before achieving full registration as independent village.

On its side, the settlements in Lifua village started prior to Maji Maji war by migrating groups of people of Ngoni, Matengo, Pangwa, and Ndendeule ethnic groups. Despite their differences in origin, all people in Lifua identify themselves to be the Manda, a language they speak. The origin of the name Lifua comes from a Manda word*, wifuwa* literally meaning you will be dazzled. This was the praise given to residents of the village by people from the neighbouring areas (mainly from Luilo) who appreciated their life styles. People from Luilo and other villages used to visit Lifua and take a bamboo wine locally known as *lasi*. Since, they were well treated by their counterpart most of visitors to the village always went back home late. Based on that experience they said *lasi gwavi gufuvika* literally meaning that their bamboo wine make them dazzled. However, the past glory of Lifua had gone and currently the village does not attract much attention of its neighbours and it is experiencing food shortage and out-migration.

Prior to villagization programme in the mid 1970s, Kipangala was a collection of scattered hamlets along the Mchuchuma basin and part of Luilo village. During villagization programme, most of its people were settled in area dominated by trees locally known as *mipangala*. In 1993, the village acquired a full village status. The dominant ethnic group in Kipangala village is the Manda and some few Kisi.

In addition to population dynamics and village history, the study area farming systems was among the forces behind land degradation and change in livelihoods. The farming systems in the study area included both annual food crops and cash crops. The main food crops include cassava (*Manihot esculenta*), rice (*Oryza sativa*), maize (*Zea mays*), sweet potatoes (*Ipomoeat batatas*), groundnuts (*Arachis hypogaea*), cowpeas (*Vigna sinensis*), pigeon peas (*Cajanus cajan*), velvet beans (*Mucuna pruriens*), lablab beans (*Lablab purpureus*), and common beans (*Phaseolus vulgaris*). Cassava which replaced finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*) and bulrush millet (*Pennisetum glaucum*) as the preferred food in early 1900s is the staple food in the study villages of Ludewa District. But, increasingly maize is replacing cassava in some villages, especially in Kimelembe village. After the termination of tobacco (*Nicotiana tabacum*) cultivation in 2000, attempts are being made by District Council to revive cashew nuts production as a main cash crop in the study area inspite of its marketing problems. Cashew nut was among the neglected crop in mid 1980s. Other perennial crops in the study area include coconuts, citrus fruits, and mangoes.

3.3 Research Design

This study combined cross-sectional and longitudinal design in data collection. Cross-sectional survey constituted a collection of data from stratified population of smallholder farmers in the study villages of Ludewa District at a single point-in-time on aspects of householdsô characteristics and livelihood strategies. The cross-sectional design allowed collection of evidence of various livelihood aspects across households and within households in the study villages. Given limited time and resources for study, cross-sectional survey was desirable to gain insights of existing livelihood situations of smallholder farmers across the study area (Stern *et al*., 2004). Besides, the cross-sectional design research provided data used for both descriptive purpose and for bivariate analysis. As cross-sectional study is not sensitive to situational changes over time it was complimented by longitudinal study to assess change in livelihoods due to land degradation. Longitudinal studies based on satellite images were used to capture change in land use/covers at three periods separated by years (1979, 1990, 2002). The use of satellite data came as the study area lacked long-term agronomic experiments to track change in land quality, especially soil fertility and crop yields.

3.4 Selection of Study Villages

Four villages, namely Lifua, Kipangala, Kimelembe, and Kiyogo in Masasi Division (Fig.2) were purposively selected during research inception meeting with District Agricultural and Livestock Development Officeôs (DALDOôs) staff. The study villages were selected based on population movements and trends in land uses. The criteria for selection were for the villages being in Masasi Division and experiencing

out-migration and/or in-migration. Besides, for the village experiencing out-migration whose land should be considered as degraded and of low soil fertility. Whereas the village experiencing in-migration should be areas considered having high rates of soil fertility (UNDP/FAO, 1976). Based on these criteria, Lifua and Kipangala villages in Luilo ward were purposively selected to represent areas experiencing out-migration. According to discussions with DALDOôs staff, Luilo ward represented an old occupied area whose soil had been exhausted. Population exodus in these villages was associated with field abandonment and frequent food shortages that made the provision of food aid inevitable in the 2000s (Nyangôali *et al.*, 2001). The dependency in food aid handouts in the area with food surplus was a paradox as Iringa region is one of the main grain producers in Tanzania. On the other hand, Kiyogo village in Masasi ward and Kimelembe village in Nkomang'ombe ward were purposively selected to represent areas that had experienced massive in-migration from neighbouring villages since mid 1990s, and have moderate to high soil fertility.

3.5 Sampling Procedures and Sample Size

A multiple-stage sampling was applied in this study to accommodate various data needs in assessment of livelihood changes due to land degradation. First, households in the study area were stratified by gender into male headed and female headed households. The separate lists of female and male headed households were extracted from village registers and used as sampling frames. Households were assigned as main unit of analysis as livelihood changes could easily be captured and differentiated at that level. Samples of 60 households in each of the four villages

yielding a total of 240 respondents were randomly selected from two strata using table of random number to meet the minimum statistical requirements (O'leary, 2004). The size of each stratum was decided based on human development study (R&AWG, 2005) which reported that 39 percent of all households in Ludewa District were female headed households. For convenience, the proportional of female headed households was rounded to 40 percent of all respondents in each study village. In this case, out of 60 respondents in each village, 24 and 36 were female and male headed households, respectively. The sample size of 240 (31.5%) households taken was representative of 760 households in the study area. Kiyogo village with 137 households, the sample represented 44 percent of all households. On the other hand, the sample size in Kipangala village with 230 households represented 26 percent of all households in that village. With 200 households in Kimelembe village, the sample represented 30 percent of all the households. Similarly, with 193 households in Lifua village the sample accounted 31 percent of all the households.

Apart from stratified random sampling used to select 240 respondents for main survey, snowball sampling was employed to get 80 farmers who participated in focused group discussions (FGDs). With advice of Village Executive Officers (VEOs), two to three participants well informed on the village history and resources were selected. These assisted in selection of remaining members of FGDs for each village. Each village had four groups of FGDs. The first group was made of five male members aged above 40 years old. The second group was that of five female members aged above 40 years old. The third and fourth group were of five male and

female members aged below 40 years old, respectively. The composition of FGDs members based on age and gender enabled to get differences on their perceptions and experiences about changes in land conditions and the effects on peopleôs livelihoods. Besides, 86 members of the village government councils (VCs), two Ward Agricultural/Livestock Extension Officers (WEOs) and ten members of the District Council Management Team (CMT) were purposively selected and used as key informants on various issues related to changes in land conditions, land degradation, policies, farming systems, and natural resource management.

3.6 Data Collection

3.6.1 Secondary data

Secondary data were collected to gain insights on global, regional, national and local status on state of knowledge on changes in land conditions, land degradation and aspects related to smallholder farmersô livelihoods. Various documents including population and agricultural censuses, research reports, project reports, national development plans, budget speeches, and journals were reviewed at libraries of Sokoine National Agricultural Library, University of Dar es Salaam, and The Open University of Tanzania. District social and economic profiles were obtained from Ludewa District Council Office. In addition, topographic maps at a scale of 1:50 000 of 1975 were acquired from the Department of Survey and Mapping of the Ministry of Lands, Housing, and Human Development. The topographic maps provided data on location of villages, landform features, and vegetation that complimented interpretation of change in land use/cover as provided by satellite images. Also, records of crop yields estimates for maize and cassava for various sub-villages were

gathered at the WEOs. Determination of cassava root yield pose a difficulty due to flexibility in planting date, flexibility in age at harvest, intercropping that affect both plant density and yields, varying root size from the same place, and piecemeal harvesting (Nweke *et al*., 1998). On that understanding it was decided to use available official records to limit variability of the results.

3.6.2 Remote sensing data

Remote sensing was the major method used to capture longitudinal data on the trends of changes in land use/cover in the study areas. Landsat4 Multispectral Scanner (MSS) path 180 row 067 of 25 July, 1979, Landsat5 Thematic Mapper (TM) path 168 row 067 of 10 July, 1990, and Landsat7 Enhanced Thematic Mapper plus (ETM+) path 168 row 067 of 18 June, 2002 satellite images were freely obtained from USGS and downloaded at the Open University of Tanzania library. The images of early dry season (June, July) for the study area were selected as they had little burning, little atmospheric haze, more visible cultural features, and vegetation growth (King, 1984).

3.6.3 Primary data

A questionnaire designed by researcher was main instrument used to collect information from households (Appendix 1). A questionnaire was pre-tested in Luilo and Nkomangôombe villages found in study area but not included in the main survey. The two villages represented similar trends of out and in-migration. During the pre-testing of the questionnaire, minor modifications were made in its content. The content of the questionnaire enabled collection of specific and quantitative

information on household characteristics, livelihood strategies, assets, and outcomes. The questionnaire was administered by the researcher. Interviews with the head of households were held in their homesteads. The researcher was led by sub-village chairmen/secretaries and/or Village Executive Officers (VEO), and Ward Extension Officers (WEOs) who identified the selected households. The staffs led the researcher from one identified selected household to another and from one sub-village to another and were of great help in post-interview discussions by clarifying emerging issues and various contextual conditions in the villages concerned.

On the other hand, FGDs were conducted to get complementary information to household interviews. FGDs were guided by a checklist. In contrast to household interviews, FGDs were held at the village offices. All FGDs were tape recorded except in Kimelembe village due to technical problems experienced with the tape recorder. A total of 8 sessions of FGDs were conducted for each village that is, two sessions age/gender group. One session was for general discussion and the second for ranking exercise. FGDs allowed research to gain understanding and insight into smallholder farmersô knowledge on changes in land conditions, various cropping systems, land tenure, rationale for various farming practices, and sources of income (Appendix 2). Each reason for cropping practice and choice of alternative farming practice was ranked. If there were four reasons, the highest ranked reason for each criterion received a score of four and the lowest ranked received a score of one. The scores across all the four groups were added up to get a total ranking for each reason.

Moreover, informal discussions were held with key informants to improve the validity of information provided by household heads. The key informants in this study included members of VCs, VEOs, WEOs, retired government officials, elders, and District Council staff from departments of planning, agriculture and livestock, land, water, and forestry. The discussions provided information on enforcement of bylaws, procedures in land allocations, programmes done in natural resource management, monitoring of changes in the status of land resources, and support given to smallholder farmers in the use and access to various natural resources.

In addition to discussion with key informants, transect walks across the study villages were made in order to identify existing land use/cover categories and changes that had taken place over time. Transect walks enabled the researcher to get general view of change in land uses in the study areas. Number of transect walks made depended on the setting of the village in terms of topography and kind of land uses undertaken in a particular area. With rolling to hilly topography in the study area, two transect walks were made from east to west and south to north for Lifua and Kimelembe village. In contrast, three transect walks were made for Kiyogo village with flood plain in the south east, rock outcrops in the north, and escarpment in the west. Similarly, three transect walks were conducted for Kipangala villages with dispersed sub-villages. One transect walk was conducted for each of the two dispersed sub-villages, that is Maramba and Uhanje. The third one was conducted for the remaining three sub-villages (Kipangala Kati, Kipangala Asili, and Ntunduwalo) with rolling topography. Participants in transect walks provided information on cropping patterns, change in crop grown in different locations,

changes in locations of fields and settlements. The information given by participants in transect walks expanded researcherôs understanding of temporal and spatial changes in land use/cover as given by satellite images and existing diversity of cropping patterns.

3.7 Data Analysis

3.7.1 Remote sensing and GIS

Three sub-scenes of different temporal dimensions (1979, 1990, 2002) covering the study area (Appendix 3) were extracted from the three satellite images. The sub-scenes were geo-referenced to the coordinates and national mapping system as per UTM zone 36 south, WGS84 projection by ERDAS imagine. The images enhancements were accomplished by colour composite image printouts that were used to identify and extract land use/cover categories. On screen computer digitization of land use/cover categories were made using ARCVIEW GIS procedures. A post classification system was used for land cover change detection for the period of 1979-1990, and 1990-2002. Data on changes from one land use/cover category to another in terms of area established trend in land degradation (Fig. 1) and change matrix tables for interpretation of direction of land use/cover as suggested by Cohen (1994).

3.7.2 Qualitative data analysis

The techniques used in qualitative data analysis depend on the source of data, data collected, participants in generation of data, and the procedures used in the interpretation of data (Lee and Fielding, 2004). The content analysis was applied to

the FGDs and key informants. The analysis was grounded on the original accounts of experiences and observations of the people and their interactions of land resources in the field. The information from the FGDs and key informants were transcribed, sorted, and labelled to make judgements about meanings as it stands or in the context of interviews, relevance, and importance of key emerging issues. Besides, suggested reasons for adopting various cropping patterns, for instance, gave insights for smallholder farmersô rationale for practicing a particular land use in the study areas. Themes and meanings extracted from reported data were analysed based on the context of social process that produced the evidences. The purpose, time, occurrence of the events, and credibility of the reporter were used to show how evidence was produced and its usefulness to the current study.

3.7.3 Statistical analysis

Data collected in the household interviews were coded, entered, and cross-checked for accuracy, verified and analysed using the Statistical Package for Social Scientists (SPSS) computer programme (Field, 2000). Cross-tabulations of study variables and groups in Figure 1 were run to summarise data on household characteristics, livelihoods strategies, resources used in production, level of incomes and food security to generate descriptive statistics such as means, modes, percentages, ranges and standard deviations. Categorical nature of data made use of chi-square (G2) more suitable for determination of whether there were differences and/or associations between variables and group of households in the study area. For instance, the use of inorganic fertilizers, new crop varieties, animal manure, and irrigation were used to describe the adoption of improved crop production techniques. In addition, chi-

square was used to compare the outcomes of livelihood strategies adopted to ensure food security between the villages that had experienced out-migration and those that had experienced in-migration. Differences between variables and groups were considered to be significant at p Ò0.05 level of confidence.

Apart from descriptive statistics, logistic regression model was used to determine changes of smallholder farmersô livelihoods due to land degradation in the study area (Sapsford, 1999; Frankena and Graat, 2001). The choice of logistic regression came from the fact that change of smallholder farmersô livelihoods due to land degradation was not linear but influenced by socio-economic factors (Fig. 1). In addition, Dankyi and Adjekum (2007) argue that use of logistic regression was suitable where dependent variable like changes in livelihood is dichotomous, with value of 1 where change in livelihood occurred or else is 0. The use of logistic regression in this study guaranteed the probability of obtaining a particular value of a dependent variable, which took the values from 0 to 1. A value close to 1 meant that Y was very likely to have occurred and a value close to zero meant that Y was very unlikely to have occurred (Field, 2000). Five aspects of change in livelihoods namely, smallholder farmerôs expansion in area planted with cassava and maize, involvement in fish selling, casual labour, and keeping of cattle were considered. Furthermore, the use of logistic regression was preferred as the nature of predictor (independent or explanatory) variables (i.e. socio-economic factors) sought to influence the change in livelihoods composed of both categorical and continuous predictors (Appendix 4).

The use of logistic regression assumes relationship between independent and dependent variables by calculating the logistic coefficients that compare the probability of change in livelihood occurring with the probability of change not occurring. The occurrence of change in livelihood aspect (Y) for one independent variable (x_1) is given by equation 3.1.

$$p(Y) = 1/1+e^{-(\beta_0 + \beta_1 x_1 + \mu)} \quad (3.1)$$

Where

p(Y) = the probability of change in livelihood occurring

e = is a base of natural logarithm =2.718

As argued by Field (2000) and Long and Cheng (2004) when there are several predictors as was the case for this study, the probability of undertaking a particular livelihood is a function of the linear combination of coefficients (-y) as given in equation 3.2 and 3.3:

$$p(Y) = 1/1+e^{-y} \quad (3.2)$$

where

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \text{é}\ \text{é}\ ..+ \beta_n x_n \quad (3.3)$$

Where

β_0 = intercept or constant term

β_n = Coefficients of independent variables to be estimated

X_n= are sets of independent variables

Unlike for the linear regression, relationships of variables which lead to livelihood change were neither linear nor normally distributed (Field, 2000). To fit the assumptions of parametric statistical tests better, data used in logistic regression models were logarithmic transformed. Square root transformations and log transformation were applied for count and size data, respectively (De Coster, 2001). The transformations of data were made to meet the assumption of linearity required for interpretation of logistic regression. Coefficients in the logistic regression models were estimated by maximum likelihood method. Maximum likelihood finds the values of the parameters under which you would be most likely to get the observed results. The outputs of logistic model was tested through the log-likelihood ratio tests (-2LL) and chi-square distribution. As is error sum of squares in multiple regressions, log-likelihood ratio is an indicator of how much unexplained information there is after the model has been fitted (Field, 2000). Large value of the log-likelihood ratio means more unexplained observations, that is, worse the prediction of the change of particular livelihood aspect in the model (Sapsford, 1999). In contrast, small values of log-likelihood ratio after inclusion of predictor variables mean the model is predicting the dependent variable more accurately. In SPSS, rather than reporting log-likelihood ratio itself, the value is multiplied by -2 (that is why sometimes referred to as -2LL) to make it have an approximate chi-square distribution.

On the other hand, goodness of fit of the model was determined by model chi-square test. This statistic measures how much better the model predicts the occurrence of dependent variable. The model chi-square is an analogue of F-test for the linear

regression sum of squares (Field, 2000). In addition, useful of the explanatory variables in predicting the response variable, that is, measure of effect size is given by Nagelkerke R-squared which is an adjusted version of Cox and Snell R-squared. Low values of Nagelkerke R-squared suggested that the model is not very useful in predicting the dependent variables. The explanatory variables in the logistic regression models consisted of socio-economic factors influencing livelihoods as outlined in Appendix 4.

3.8 Limitations of the Study

The major constrain of this study in respect to assessment of land degradation was the nature of available satellite images. The researcher could not acquire satellite image for the period beyond 2002 as the available ones were of poor quality. In this case, satellite images alone could not provide valid trend in projection of future changes in land use/cover in the study area. This problem is compounded by lack of spatial and temporal information on past crop yields and soil fertility changes for various land use/cover categories. The challenges were overcomed by incorporation of documented crop yield and soil fertility data and respondentsô views on soil fertility status of their fields. Besides, transect walks were made to get general view on status of land resources in the study area. On the other hand, the expected take off of Mchuchuma Coal Mine and diminishing pressure of villagization programme and tobacco cultivation is likely to set new population dynamics and land use/cover. On that ground the results of this study are contextual to existing socio-economic conditions and can not be generalized to all changes in land use/cover and smallholder farmersô livelihoods in rural areas of Tanzania.

CHAPTER FOUR

4.0 ANALYSIS OF LAND USE CHANGES, POLICIES AND INSTITUTIONAL FRAMEWORK

4.1 Overview

This chapter presents and discusses the results of the study on objective one, two and three. The discussion starts by looking at changes in land due to land degradation, which is followed by a discussion on the potential of policies and effectiveness of institutions in natural resource management in the study area.

4.2 Changes in Land due to its Degradation

4.2.1 Patterns and magnitude of changes in land use/cover in the study area

Change in state of land resources over time in the study area is illustrated by the variations in distribution of land use/cover types based on Landsat imagery of 1979, 1990, and 2002 given in Figs. 3 to 5 and Table 1. The major land use/cover types identified in the study area are bushed grassland (*lutala*), bushland with scattered cropping (*ndumba*), grassland with scattered cropping (*ruhaha/madimba*), settlement with mixed cropping (*luvala*), closed woodland, open woodland, woodland with scattered cropping (*matema*). The analysis of land cover results in the study areas, show that in 1979 open woodland dominated land cover type by 30 percent followed by bushed grassland by 20 percent. By then, the area covered by the bushland with scattered cropping (*ndumba*) was less than five percent. In contrast, in the 1990s the study area was dominated by the bushland with scattered cropping followed by closed woodland.

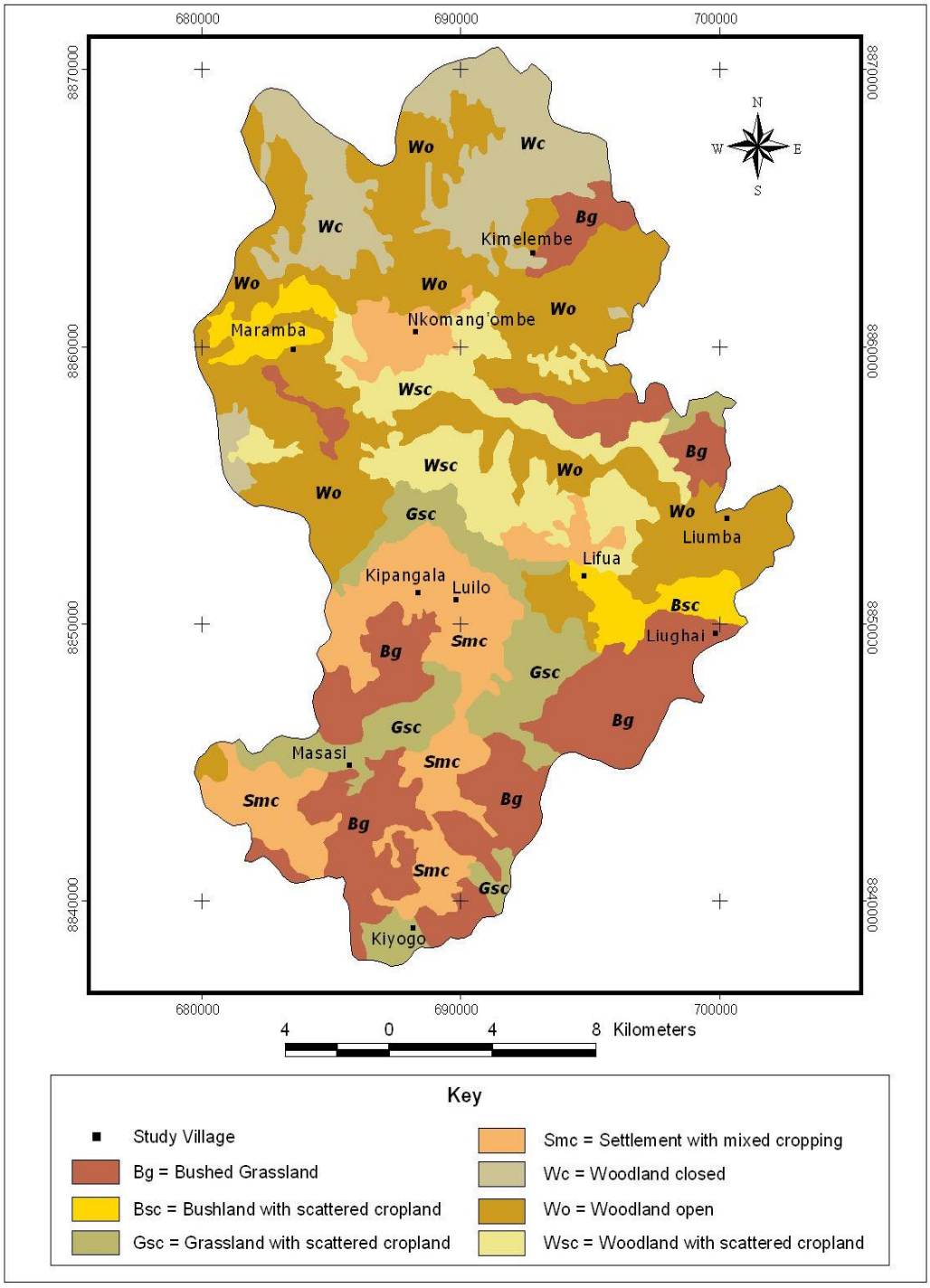

Figure 3: Land use/cover map of study area in Ludewa District for 1979

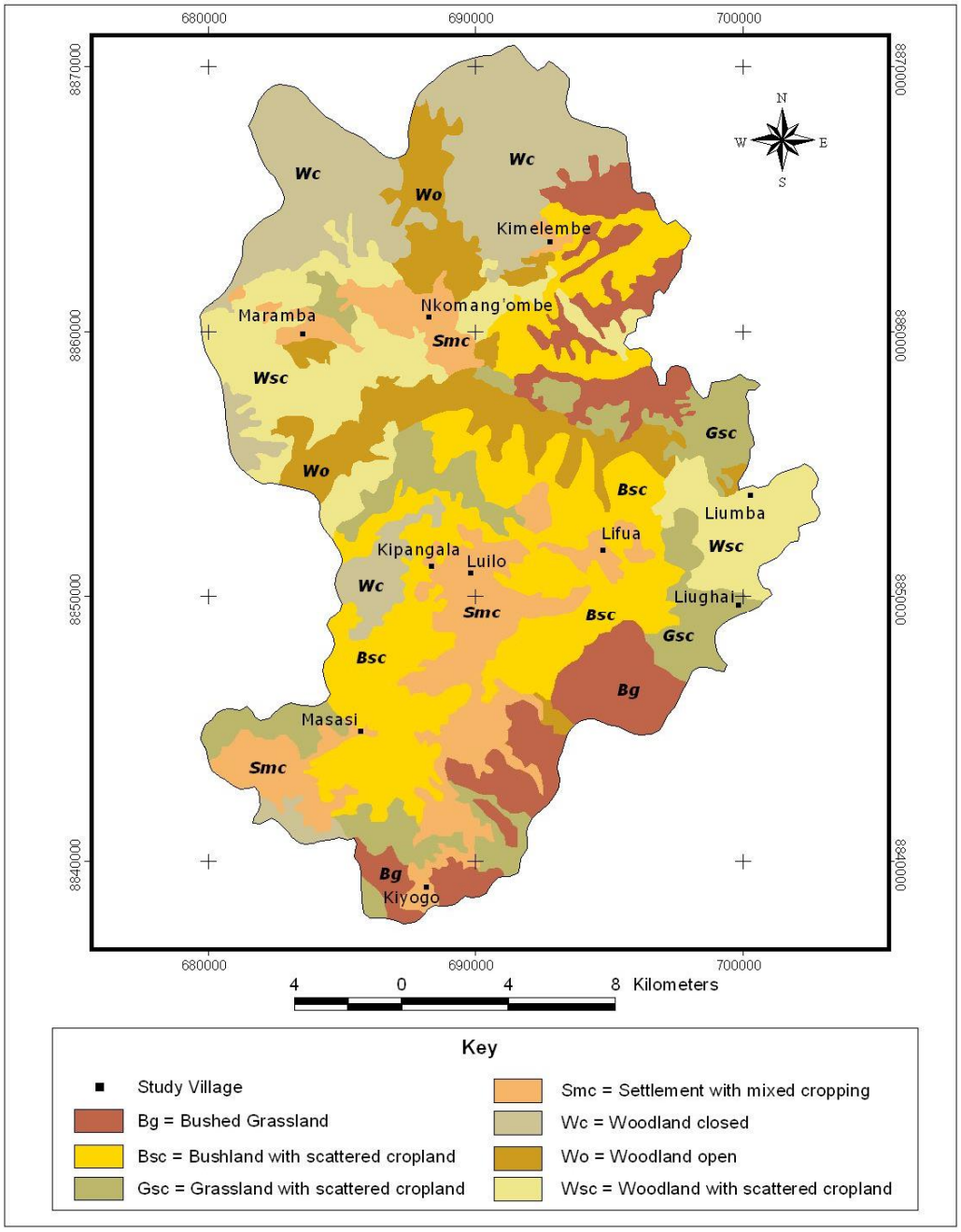

Figure 4: Land use/cover map of study area in Ludewa District for 1990

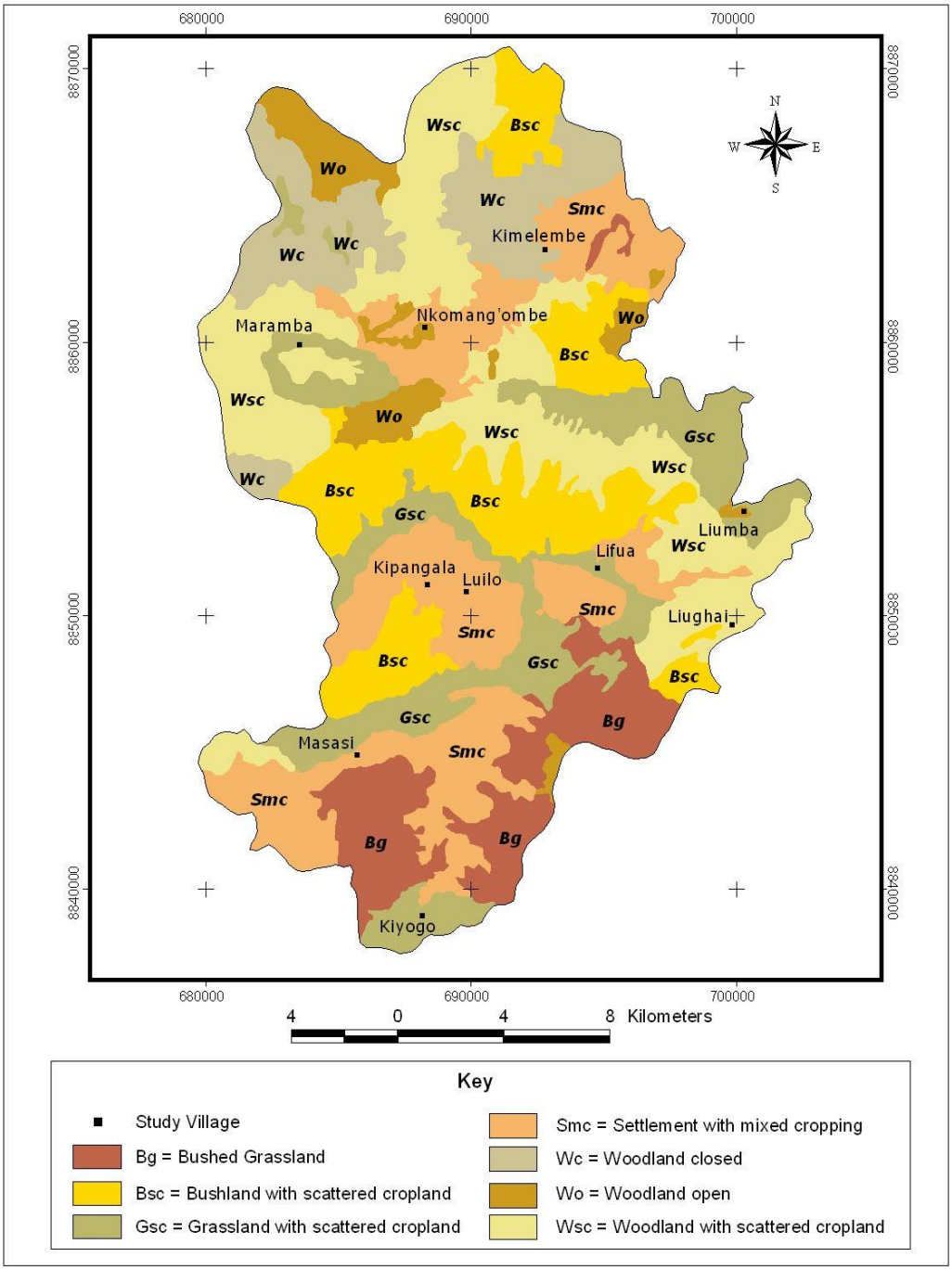

Figure 5: Land use/cover map of study area in Ludewa District for 2002

In 2002, settlement with mixed cropping (*luvala*) and woodland with scattered cropping (*matema*) were the leading land use/cover types followed by bushland (Table 1). The results in Table 1 show that the combined area covered by closed and open woodland declined from over 40 percent in 1979 to 15 percent in 2002 as deforestation increased. The total natural forest cleared between 1979 and 2002 amounted to 12 135 ha, corresponding to annual loss of 528 ha. This total loss was 65 percent of the 1979 woodland cover in the study area.

Table 1: Area coverage of land use/cover types in the study areas of Ludewa District

Variable	1979		1990		2002	
Land use/cover types	ha	%	ha	%	ha	%
Bushed grassland (Bg)	8,987	20	5,228	12	4,544	10
Bushland with scattered cropping (Bsc)	1,773	4	9,966	22	7,219	16
Grassland with scattered cropping (Gsc)	4,286	10	5,162	11	7,093	15
Settlement with mixed cropping (Smc)	6,626	15	6,136	14	9,791	22
Closed woodland (Wc)	5,104	11	7,854	17	4,395	10
Open woodland (Wo)	13,578	30	4,492	10	2,152	5
Woodland with scattered cropping (Wsc)	4,734	10	6,250	14	9,894	22
Total	45,088	100	45,088	100	45,088	100

In order of importance, participants in the focused group discussions (FGDs) associated *miombo* woodland depletion to increasing clearance of forest for new farms and settlements. Similar trends of deforestation have also been reported in Nguru Mountains in Morogoro (Monela and Solberg, 1998). Besides, the results

show that the bushed grassland cover in the study area declined from 20 percent in 1979 to 10 percent in 2002. The decline in the bushed grassland cover implied increased encroachment of the pasture lands by farming activities. The results concur with Kummer (1992) findings in Philippines who reported that there was spread of agricultural lands into non-forested area, which led to degradation of grassland, shrubland, and open land. Similarly conversions of marginal lands in the study area threaten smallholder farmersô livelihoods.

Apart from increasing land degradation due to encroachment of marginal lands, the results in Table 1 show that from 1990 to 2002 the study area experienced increase in the area covered by woodland with scattered cropping (*matema*), grassland with scattered cropping (*ruhaha/madimba*), settlement with mixed cropping, and bushland with scattered cropping (*ndumba*). The increase and/or decrease of land use/cover from a land use/cover category mean are given in Figure 6. The results in Figure 6 show that in 1979 area covered by bushed grassland and open woodland were above mean while in 1990 the area covered by bushland with scattered cropping, settlement with mixed cropping and closed woodland were above the mean value. The steady increase in area covered by closed woodland in 1990s was attributed to the villagization programme in mid 1970s that saw farmers in the northern parts of the study area being moved to the southern parts. The shift in settlements associated with villagization programme led to the abandonment of farms. This allowed the regeneration of woodlands.

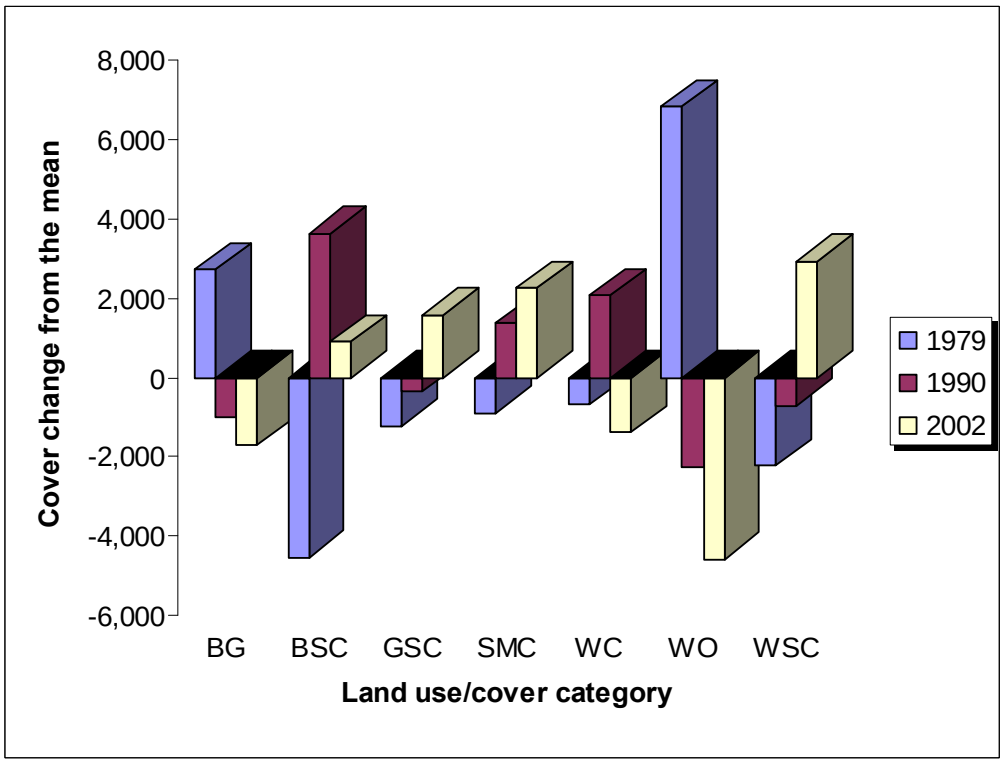

Figure 6: Land use/cover change from the category mean in study area

BG=Bushed grassland, BSC=Bushland with scattered cropping, GSC=Grassland with scattered cropping, SMC=Settlement with mixed cropping, WC=Closed woodland, WO=Open woodland, WSC=Woodland with scattered cropping

Similar increases in woodland following field abandonment have also been reported in Iringa District (Mbilinyi, 2000) and Mediterranean Europe (Houéruo, 1993). However, between 1990 and 2002 the area covered by closed and open woodland declined following their conversion to farming and/or settlements (Table 2). In the mid 1990s, new trends of population movements were experienced in the study area. There was an increase in establishment of new farms and settlements in areas formerly occupied by closed woodlands especially in Maramba sub-village and Kimelembe village (Fig. 3). Unfortunately, the area covered by closed woodlands in

Kimelembe was not only in the hilly and sloping areas but also in the catchments of main rivers of Mchuchuma and Ketewaka, which increase the vulnerability of the area to land degradation. The spatial patterns of deforestation related to settlement establishment were also reported in Riam Kanan Watershed, Indonesia by Indrabudi *et al.* (1998). Similarly, in former Soviet Union, Glantz (1994) found that the Virgin Lands Scheme increased use of marginal lands for crop production in western Siberia and northern Kazakhstan.

Table 2: Change detection matrix for the period of 1979 to 1990 and 1990 to 2002

Land use/cover changes between 1979 and 1990 (ha)								
Variable	Bg	Bsc	Gsc	Smc	Wc	Wo	Wsc	1979
Bg	3502	2374	2075	477	270	43	245	8987
Bsc	0	420	155	336	20	0	842	1773
Gsc	251	1948	1112	838	51	86	0	4286
Smc	170	1387	326	3664	737	56	285	6626
Wc	163	8	0	30	4674	92	137	5104
Wo	883	2096	723	423	2068	3546	3839	13578
Wsc	260	1733	770	367	33	670	901	4734
1990	5228	9966	5162	6136	7854	4492	6250	45088
Land use/cover changes between 1990 and 2002 (ha)								
Variable	Bg	Bsc	Gsc	Smc	Wc	Wo	Wsc	1990
Bg	2193	428	1184	875	151	200	196	5228
Bsc	1193	3092	1961	2769	13	29	910	9966
Gsc	863	971	1618	263	28	2	1417	5162
Smc	242	242	1005	4107	64	166	310	6136
Wc	7	1041	230	931	3626	915	1103	7854
Wo	45	652	90	171	113	519	2901	4492
Wsc	0	790	1005	678	400	320	3058	6250
2002	4544	7219	7093	9791	4395	2152	9894	45088

The magnitude of land degradation as land use/covers were converted from one category to another is provided by land use/cover change detection matrix in Table 2. The results show that all land use/covers had changed from one type to several others. As illustrated by Mnkabenga (2001) the numbers along each row represent

part of land use/cover category (in ha) replaced by the category in columns during the temporal period. On the other hand, numbers along the column represents transformation (in ha) of the categories (arranged in rows) towards the category bearing the heading of the column. Row total represent area coverage of the category of land use/cover in the initial year, while column total represent area coverage of the category in the final year of temporal period.

The major land use/cover change for the period of 1979 to 1990, and 1990 to 2002 was the conversions of woodland with scattered cropping (*matema*) into bushland with scattered cropping (*ndumba*). The conversion of former major cropping area, the *matema*, saw steady increase in the area covered by bushland with scattered cropping, the *ndumba*. The bushland with scattered cropping gained 420 hectares in 1990 from woodland with scattered cropping and further 3 092 hectares in 2002. The increase in area covered with bushland with scattered cropping came as more fields were abandoned following fall in soil fertility in the *matema* making them unsuitable for crop production (Table 4). A study by McAlister *et al*. (1998) in Brazil found that in tropics fieldsô abandonment come as a result of decrease in nutrients availability to plants after one year forest clearance. For instance, the findings show that N contents drop from 0.2-0.4 percent to 0.1 percent after five years. Organic carbon levels drop from 4 percent to 0.9 percent, while pH values fall from 5.3 to 4.7 after five years of forest clearance. Discussions with key informants suggested that decline in woodland with scattered cropping in the study area has increased the utilization of the narrow river valley bottoms (*madimba*) and wetlands (*ruhaha*) for crop production. The increased use of river valley bottoms (*vinyungu* as

known among the Bena and Hehe) following decline in crop productivity due to depletion of soil fertility in upland fields was also reported in Kilolo and Iringa Districts, in Iringa region, Tanzania by Majule and Mwalyosi (2005).

4.2.2 Implications of changes in land use/cover to smallholder farmers' livelihoods

The changes in land use/covers have a number of implications on smallholder farmersô livelihoods. The changes in land use/covers either increase or decrease the distance walked by farmers from their homesteads to the fields (Table 3).

Table 3: Average distance (km) covered by farmers from home to the fields

Village	Average distance (km) covered						
	0.0-1.00 km	1.1-2.5 km	2.6-3.5 km	3.6-5.00 km	5.1-6.0 km	6.1-9.0 km	9+ km
Kimelembe (n=60)	29(38.3)	3(5)	18(30)	7(11.7)	1(1.7)	0(0)	2(3.3)
Kipangala (n=60)	24(40)	14(23.3)	16(26.7)	3(5)	2(3.3)	1(1.7)	0(0)
Kiyogo (n=60)	44(73.3)	5(8.3)	9(15)	1(1.7)	1(1.7)	0(0)	0(0)
Lifua (n=60)	28(46.6)	7(11.7)	16(26.7)	8(13.3)	1(1.7)	0(0)	0(0)
% of Total	125(52.1)	29(12.1)	59(24.6)	19(7.9)	5(2.0)	1(0.4)	2(0.8)

Figures in parentheses are percentages and those out of it are frequencies, $G2 = 75.791$, $p = 0.001$

The results show that the distance walked varied from one village to another. Most of the respondents, 125 (>50%) in the study area, reported to walk a distance of less than one kilometer from their homes to the fields. Kiyogo village led with more than 44 (70%) of the respondents walking the shortest distances to the fields than other villages. The presence of escarpment with rock outcrops in the North, North West and North East parts of the village made the farmersô farming activities depend on the narrow strip of flood plain of Ruhuhu River. Since, rock outcrops and bushland

with scattered cropping (*ndumba*) areas were less attractive and unsuitable for annual crop farming due to limited soil depth and moisture, and low soil fertility, most of the settlements and fields in the village were located close to the river flood plains. With population growth due to incoming migration, the concentration of fields in the flood plain in Kiyogo village increased the intensive use of marginal lands, especially the river banks. Cultivation in the river banks was liable to cause further land degradation as vegetation protecting them were cleared as shown by disappearance of bushed grassland close to the village in the 2000s (Fig.5).

In this case, Glantz (1994) study in West Africa Sahel asserted that increased use of marginal lands was an option open for farmers reluctant to leave the degraded areas. Similarly, conversion of forest in Riam Kanan Watershed, Indonesia started from the most accessible area, that is, areas close to the villages (Indrabudi *et al.* (1998). In contrast, Ruheza (2003) reported increased deforestation as more *miombo* woodlands in Uluguru Mountains, Tanzania were converted into crop fields. The conversion of woodlands implied an increase in average distance from homesteads to the fields. The increased average distance to the fields in Kipangala, Kimelembe and Lifua villages implied invading the catchments, that is, Mchuchuma catchment for the first two villages and natural springs in the later village. The increased average distances to the fields in the study area suggest creation of new settlement dynamics that extend land degradation far from the village centres.

Consistent with Indrabudi *et al.* (1998) findings in Indonesia, key informants in the study villages reported that increased distances farmers walked from homesteads to

the fields in the 1990s led to encroachment of closed woodland and establishment of new sub-villages. In Lifua, two sub-villages, namely, Liumba and Liughai sub-villages were established in the 1990s while in the same period Maramba sub-village was established in Kipangala village. The establishment of settlements came as farmers could not afford the frequent go and return trips to attend their fields. The new sub-villages were about eight to 12 kilometres away from the village centres of Lifua and Kipangala, respectively (CONCERN, 2000). Similar trends of changes in settlement patterns as distance to the fields increased were also reported in the neighbouring districts of Njombe and Makete (Friis-Hansen, 1987). Search for suitable land for farming was the main reason for migration suggested by key informants and FGDs participants in the study area. Their views confirm the assertion reported in Kagera region that conversion in land use/cover is promoted by change in value of land used for crop production (Rugalema, 1999).

Apart from increase in migration and change in settlement patterns, the change in the land use/covers especially use of grassland with scattered cropping (*ruhaha*/*madimba)* for annual crops reduced the pasture land and size of cattle herds in the study area (Table 4). According to discussions with key informants and FGDs, the use of *madimba* for annual crops in the study area corresponds to reduced grazing area and ultimately decline in size of cattle herd. Key informants reported that the size of cattle herd had fallen from an average of 10 cattle to hardly two cattle per household. In addition, as the available pasture lands continue to be encroached by annual cropping, its further use lead to land use conflicts (Table 5). Of all the land use conflicts in the study villages, the results (Table 5) show that livestock

invasion is statistically significant at p = 0.011. The importance of livestock invasion is obvious as crops were grown within the grazing lands.

Table 4: Changes associated with change in land use/cover in the villages experiencing out-migration in Ludewa District

Activities	Major changes associated with land use/cover change		
	Prior to 1980s	Mid 1980s to 1990s	Early 2000s
Important land use	*Matema*	*Ruhaha*	*Madimba*
Staple food crops	Cassava, Finger millet, Rice	Cassava	Maize, Cassava
Main cash crops	Cashew nuts	Tobacco	Cashew nuts, Rice, Groundnuts
Owner of cattle	Few elders	Few elders	Young men
Size of cattle herd	Large	Large	Small
Location of kraal	Close to homestead	Far Away (Ó5km)	Close to homestead
Pig grazing areas	Tethered in Swamps	Indoor	Indoor, Tethered close to homestead

The increase in land use conflicts due to livestock invasion had forced tethering of pigs to tree trunks at home. In the past, pigs were tethered in the swamp areas during the dry season and kept in-door during the wet season. Tethering of pigs at home during the dry season had increased the feed demand that is not affordable by most farmers, forcing them to reduce the number of pigs kept. In Northeast Thailand, Little and Edwards (2003) found increased pig herd size by factor of 8 as farmers used of concentrate to compliment local rice bran. Besides, as reported by Shinjo *et al.* (2000) study in Northeastern Syria, the encroachment of cropland onto former grazing areas has potential to increase erosion due to decrease in vegetation cover and infiltration rate as herds are pushed further into more marginal lands. But, in the

study area reduction in size, indoor husbandry and use of animal manure if integrated into crop production have potential to improve land management.

Table 5: Type of land use conflicts in the study villages of Ludewa District

Type of land use conflicts	Kimelembe	Kipangala	Kiyogo	Lifua	G2	p-value
Invasion of uncultivated land	3(5)	8(13.3)	5(8.3)	6(10)	2.602	0.457ns
Farm boundaries	6(10)	9(15)	6(10)	6(10)	1.127	0.771ns
Livestock invasion	11(18.3)	2(3.3)	3(5)	10(16.7)	11.215	0.011*

Figures in parentheses are percentages and those out of it are frequencies,* Significant at p Ò 0.05

4.2.3 Farmers' view on soil fertility status and its implications to land use

Apart from change in land use/cover, variation in status of soil fertility across fields was another indicator that revealed the change in land conditions in the study. Figure 7 shows farmerôs views on status of soil fertility in their fields for a period of five years (2000-2005). The results show that over two thirds of the respondents, 86(71.7%) in the villages that had experienced out-migrated reported decline in soil fertility in their fields. In contrast, more than half, 65(54.2%) of the respondents in the villages that had experienced in-migration were of the opinion that the status of soil fertility in their fields had not changed since 2000 (Figure 7). Chi-square (G2) analysis of respondentsô views on the status of soil fertility showed significant difference at p Ò 0.05 between the villages that had experienced out-migration and those with in-migration.

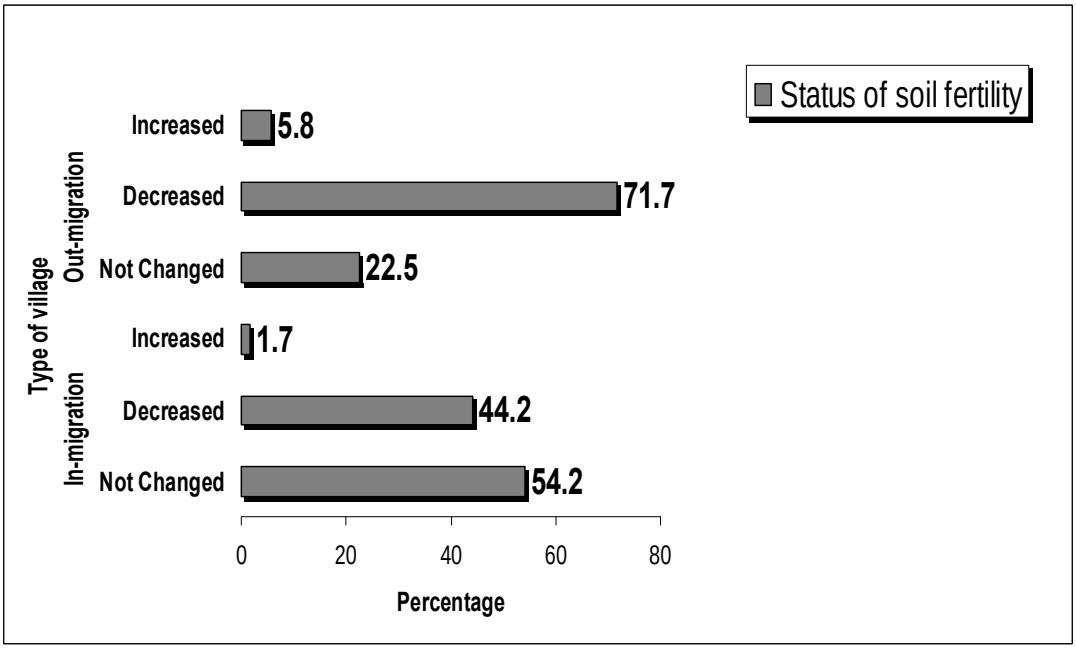

Figure 7: Farmer's views on status of soil fertility

When asked to identify the reasons for the decline in soil fertility, continuous cultivation was mentioned by 63(69%) and 27(51%) of the respondents in the villages that had experienced out-migration and in-migration, respectively (Fig. 8). Furthermore, survey results in Figure 8 show that the contribution of flood incidence and drought to the change in soil conditions was negligible in the study villages. According to this study only 6(4.2%) of the respondents in the villages that had experienced in-migration attributed change in soil conditions to floods. The respondents who felt the impact of flood in change of soil fertility were mainly from Kiyogo village. In that village, most the fields are located along the Ruhuhu Riverôs floodplain and river banks and therefore prone to floods. The impact of floods and drought to farming activities are determined by vegetation cover. The reduction in vegetation cover due to over cultivation tends to increase runoff and erosion, which

is the main agent in decline of soil fertility. In addition, as reported in previous studies (Sivakumar *et al*., 1992; Milner and Douglas, 1989 cited by Mnkabenga, 2001), forests clearing in tropical areas tend to increase the reflectivity of bare soil, keep the atmosphere warmer, disperse clouds, break the hydrological cycles, and decrease the amount of rain. Besides, loss of crop cover and associated prolonged drought reduce the capacity of soil to retain water.

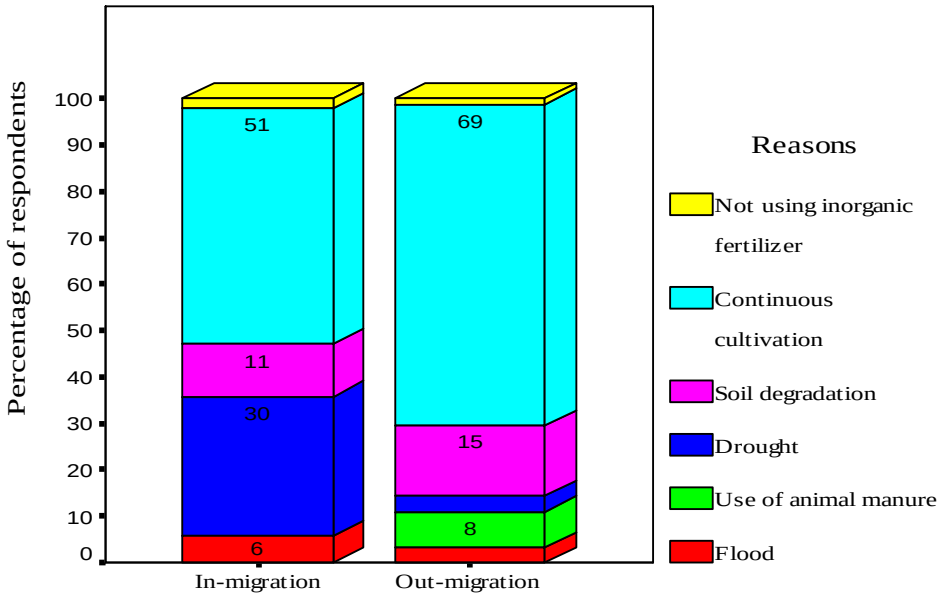

Figure 8: Reasons for change in status of soil fertility in the study villages in Ludewa

Other reasons for continuous cultivation according to FGDs tended to vary from one village to another (Table 6). FGDs participants in Kipangala and Kiyogo attributed continuous cultivation on a piece of land as a result of land shortages. High concerns for land shortages were noted among male participants aged below 40 years old and female participants aged above 40 years old in Lifua village. This was due to the fact

that young male were at stage of establishment of their families, and were in great need for land to increase production to meet both income and food needs.

Table 6: Scores on reasons for continuous cultivation as reported by FGDs participants by age group and gender at Lifua, Kipangala and Kiyogo Village

Variable	Participants above 40 years		Participants below 40 years		
	Male	Female	Male	Female	Total score
Reason for continuous cultivation	Participantsô scores in Lifua village				
Land shortage	15	17	20	15	67
Shortage of labour for farmsô clearance	18	16	9	20	63
Population growth	9	9	9	9	36
High soil fertility	8	9	12	6	35
	Participantsô scores in Kipangala village				
Land shortages	12	13	13	9	47
Enable effective use of animal manure	10	9	6	9	34
Farms being close to the homesteads	10	6	11	6	33
	Participantsô scores in Kiyogo village				
Land shortage	9	10	12	12	43
Land considered fertile	6	10	8	4	28
Farms being close to the homesteads	3	4	4	8	19

In contrast, males aged above 40 and females aged below 40 years old felt that labour shortages for clearing new lands was the main reason for continuous cultivation of their fields. The ability to clear new lands decreased with increase in age. FGDs participants argued that in the past, most of the intensive land clearing work were done by hired labour. But, the deterioration of land and worsening of livelihoods in the study area had lowered the incomes of most farmers, making hired labour unaffordable to them.

As noted in other studies (Rugalema, 1999; Ley *et al*., 2002; Amede, 2003), the results from this study show that the decline in soil fertility due to continuous cultivation was also associated with shortening of fallow period (Fig. 9).

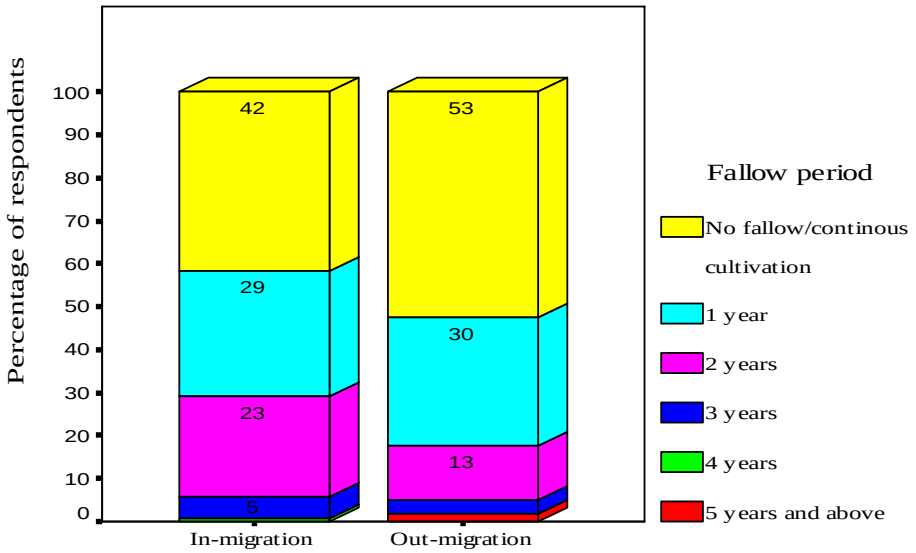

Figure 9: Fallow periods for villages experiencing in-migration and out-migration in Ludewa District

Traditionally, the fallow periods in the study areas had been long enough to allow for soil fertility replenishment. More than half of the respondents, 63(50%) in the villages that had experienced out-migration cultivated their fields continuous (Figure 9). Besides, less than half of the respondents, 50(42%) in the villages that had experienced in-migration were forced to cultivate their farms continuously. Because of this, only 13(6%) of all the 240 respondents reported to had left their fields fallow for three to five years. This was the longest period the fields were allowed to rest in the study area. Cross tabulation of the findings in Figure 9 showed that there were no significant differences (at p Ò 0.05) in the trends of fallow period between the

villages that had experienced in-migration and out-migration. The reported shortened fallow periods in study area implied that there was no sufficient time for regeneration of organic matter, an important element in soil fertility replenishment.

In addition, shortened fallow periods in the villages that had experienced out-migration induced land shortage as most of the upland fields (*ndumba*) were abandoned and cultivation concentrated in valley bottoms (*madimba*). Experiences from Machakos in Kenya showed that the induced land shortage created opportunity for agricultural intensification (Tiffen *et al*., 1994). But, with no addition of external inputs such as organic manure and inorganic fertilizers due to its availability or affordability, the reduced fallow period and continuous cultivation lead to soil mining. A study in Iringa District by Birch-Thomsen *et al*. (2002) showed that most of the existing technologies and their accompanied land use aim at increasing productivity and rarely address the improvement of exhausted land. The unattended exhausted lands such as the abandoned fields increase the problem of land shortage among smallholder farmers. As reported in Australia by Hamilton (1998) natural fallowing by itself is not sufficient to restore soil fertility. In the tropics, the use of managed fallows with crop cover such as *mucuna* as reported by Sauerborn (1999) have minimized soil erosion, increased the content of organic matter, suppressed weeds, replaced a long period of fallow and avoided the problem of land shortage among smallholder farmers.

4.2.4 Implications of decline in water level on farmers' efforts to ensure food security

In addition to change in land use/cover and soil fertility, another important indicator of the change in land conditions was the decline in river water levels and drying of natural springs. Three aspects of decline in river water levels and drying of natural springs were assessed. The first impact of the drying of natural springs was shortening of off-season cultivation period. FGDs participants asserted that the off-season cultivation period in upland wetlands (*ruhaha*) and river valley bottoms (*madimba*) had changed. In the past, off-season cultivation for cassava in upland wetlands was from April to October. During the study, off-season cultivation in the *ruhaha* had been shortened up to July due to reduced soil moisture. The FGDs participants in all the villages attributed the drying of natural springs to decline in amount of rainfall in the study area. The FGDs assertion was in line with the available rainfall data for Luilo station. The rainfall data indicate that for the period of 10 years, rainfall amount and duration in the study area had been declining (Fig. 10). Days with rain in a year have declined from over 70 in 1995 to less than 30 in 2005. Similarly, the amount of rainfall has fallen from 1 750 in 1995 to about 450 in 2005. FGDs participants suggested that the decline in amount of rainfall has contributed to changes in cropping patterns as manifested by increased use of river valleys. The obvious change in cropping patterns identified was transplanting of finger millet and rice against the tradition of direct seeding by broadcasting. Transplanting is taken as a strategy to counter unreliable on set of rainfall.

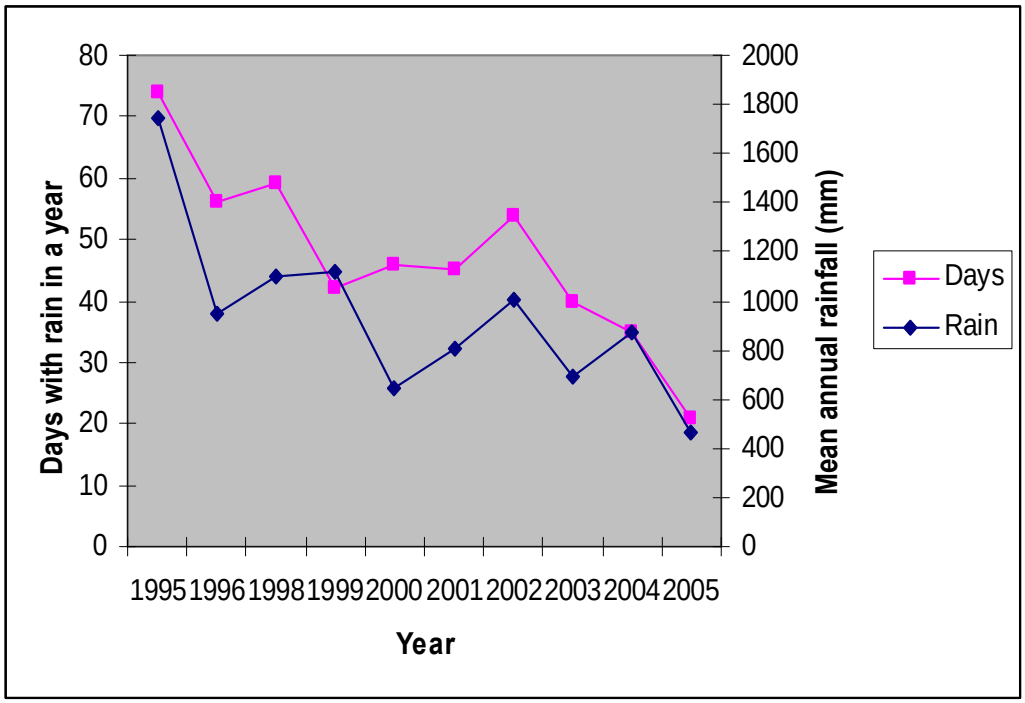

Figure 10: Rainfall patterns at Luilo Mission rainfall recording station in Ludewa District

Source: WEO at Luilo ward

Other reasons mentioned by FGDs participants for the drying of natural springs in the study area included continuous cultivation and establishment of settlements in the uplands. Both of these activities had increased tree cutting especially *Mivengi/Miwenge* (*Syzygium guineense*) that are found in the upland wetlands (*ruhaha*). Similarly, loss in vegetation cover, especially *Syzygium guineense* and drop in water table levels was reported in other countries of Southern Africa by Loubser (2005). FGDs participants in Lifua village reported that the drop in water table levels and drying of *ruhaha* and natural springs has enabled encroachment of cassava fields in the traditional rice irrigated areas. The invasion of cassava in former wet areas has forced utilization of waterlogged swamp areas. Swamps close

to the river banks had been drained and planted with rice. In the past, prior to the 1990s, swamps were planted with sugarcane and used for off-season cultivation of maize and pumpkins. Furthermore, key informants in Lifua village reported that the drop in water levels as a result of both decline in rainfall amount and cultivation in upland wetlands had made the Nyangundi Irrigation Scheme to be viable only in the wet season. Water intake dries up as the water levels in the main river in the dry season dropped.

In addition to change in cropping patterns and land use, the drying of natural springs had increased distance walked by women to collect drinking water. Women participants in FGDs of all age groups in Lifua and Kipangala complained of acute shortages of drinking water, which occurred from September to November. FGDs participants reported that in the 1970s, each hamlet had its own natural spring well in a nearby area that supplied them with drinking water throughout the year. But, as the area surrounding the natural springs were wet throughout the year, it attracted farming activities. This led to continuously clearing of natural vegetations and preparation of raised ridges. The raised ridges planted with cassava drained water and led to the drying of most of the wells in study villages. For instance, in Nkinila, a sub-village in Lifua village, the distance that women walked in search of drinking water had increased from half a kilometre in the 1980s to about three to five kilometres in 2007.

The drying of wells has led to change in water sources in the study area. Discussions with key informants in all the study villages indicated that the major source of

drinking water in the 1970s was the natural spring wells. In the 1980s, the government started the Luilo-Manda water project in the area. The project was supposed to supply water to 10 villages (EWB-SFP and NGEDEA, 2005). However, the change in land use as indicated by encroachment of farming activities in water sources led to drying of natural springs. The drying of natural springs led to drop in water levels in Mchuchuma River, especially in the dry seasons. The drop in river water intake levels reduced amount of water supply and made water pipes in all project area with exception of Luilo village remain dry for most of the time in a year. Similar change in rivers from perennial to seasonal rivers, reduced river regimes, have also been reported in other studies (Burbridge *et al*., 1988; Nindi, 2007) in humid tropics and Luekehi River in Mbinga District.

The reasons for catchments encroachment vary from one area to another in the study area. In Kimelembe, key informants reported encroachment of Mchuchuma catchments by farmers from villages surrounding Ludewa town. Farming activities in the catchments are motivated by the presence of fertile land that demands no use of inorganic fertilizers for maize production. In contrast, FGDs participants in Lifua and Kipangala village reported that smallholder farmers invade the catchments areas with extra moisture where cassava can be grown without threat of the cassava mealy bug. The invasions of catchment areas in the study area are in agreement with findings observed in northern Zambia by Sikana and Mwambazi (1996). With different socio-economic circumstances, farmers in northern Zambia grew upland crops in wetlands to utilize the fluctuating water levels and avoid risk of drought in uplands. It can be concluded that motive for invasion of catchments was different. In

Kimelembe village encroachment of catchments strategy aimed at minimizing the costs of production, while in the villages that had experienced out-migration encroachment of catchments was a strategy taken by smallholder farmers to ensure food security.

4.3 Policies for reducing land degradation

Policies potential in land degradation control come from their central role in development of frameworks for sustainable natural resource management. Table 7 shows that in the study villages, about 100(41.7%) respondents established new fields in the nearby forests, while 25(10.4%) and 39(16.3%) respondents were farming in the wetlands and river banks, respectively. The establishment of fields in marginal lands (forests, wetlands and river banks) was statistically significant at p Ò 0.01 to number of respondents in the study areas (Table 7). The study also found increased importance of farming activities in the wetlands though at low level as reported by 14(23.3%) and 10(16.7%) of the respondents in Kipangala and Lifua villages, respectively. Faced with decline in soil fertility in upland fields (*ndumba*) in the villages that had experienced out-migration (Fig. 7), farming activities in wetlands had significant impact for the survival of people in the two villages. But, with decline in amount of rainfall (Fig.10), continued farming in wetlands destroys the critical resources essential for off-season cultivation in the study area. The use of sensitive areas, as reported by increasing cultivation in catchments, wetlands and river banks came despite the existence of restrictions and prohibitions on their use (Table 7).

Table 7: Fields location and respondents' knowledge on bylaws prohibiting the use of sensitive areas in the study villages

Variable	Distribution of respondents in the study villages						
Fields location	Kimelembe (n=60)	Kipangala (n=60)	Kiyogo (n=60)	Lifua (n=60)	Total (n=240)	ɢ2	p value
Forest	45 (75)	21(35)	19(31.7)	15(25)	100(41.7)	37.851	0.000**
Wetlands	1(1.7)	14(23.3)	0(0)	10(16.7)	25(10.4)	25.139	0.000**
River banks	3(5)	17(28.3)	16(26.7)	3(5)	39(16.3)	22.380	0.000**
Pasture	3(5)	2(3.3)	2(3.3)	1(1.7)	8(3.3)	1.034	0.782ns
Knowledge on by-laws	(n=60)	(n=60)	(n=60)	(n=60)	(n=240)		
Cultivation in water sources	18(3)	1(1.7)	0(0)	16(26.7)	35(14.6)	36.761	0.000**
Grazing in water sources	1(1.7)	0(0)	0(0)	0(0)	1(0.4)	3.013	0.390ns
Cutting of trees	7(11.7)	3(5)	0(0)	0(0)	10(4.2)	13.774	0.003**
Setting fire	0(0)	0(0)	0(0)	0(0)	0(0)	NA	NA
Invasion of public area	0(0)	1(1.7)	0(0)	0(0)	1(0.4)	3.013	0.390ns

Figures in parentheses are percentages and those out of it are frequencies, NA = not applicable, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

Protection of sensitive areas is one of the objectives of natural resources policies (Land Policy, Forest Policy, Water Policy, Environmental Policy) in Tanzania. For instance, the Forest Law No. 14 of 2002 (URT, 2002) insist on setting boundaries and management plans for sensitive areas (like village forest reserves) to be protected. Similarly, according to the environmental conservation bylaws in Ludewa District it is strictly prohibited to cut trees and cultivate in catchments and along the river banks (URT, 2005b). Study by Frenken and Mharapara (2004) found increased cultivation of wetlands by smallholder farmers in other SADC countries. Increasing cultivation of wetlands aggravates forest clearing in catchments and speed-up drainage of exposed land. In practice, what was happening in the study area, imply that decision-makers at district and village levels take policy as an end in itself. For a policy to be realised it must be part of the natural resource protection programme or part of an agricultural development programme (Hudson, 1995). Collaboration

between the government and five villages in management of Mgori *miombo* woodland in Hanang and Singida districts, Tanzania ensured the conservation of forest (Wily, 1995 cited by Barrow *et al*., 2000). Similarly, in Handei and Kitulangalo forest area in Tanzania, Zahabu (2006ab) report increased tree stock in village managed forests compared to adjacent public lands under open access as a result of community involvement in forest conservation.

The increasing use of sensitive area like river banks indicate the existing gap between directives and prescriptive solutions given in national policies and farmersô practices as also reported by Hatibu *et al*. (1999) and Foeken *et al*. (2004). The discrepancy highlights the lack of understanding among policy-makers and decision-makers on underlying factors for farmerôs use of sensitive areas. As asserted by FGDs with males and females participants aged above 40 years old in Kipangala village, cultivation in the river banks was prompted by presence of soil moisture. Such claims are supported by other studies in semi-arid areas of Tanzania that soil moisture is the main constrain in crop production among smallholder farmers (Gowing *et al*, 1999; Hatibu *et al*., 1999). In contrast, FGDs with females aged below 40 years old attributed increased use of the river banks not only to its high soil fertility brought by floods, but also for being cheap. This group was made of participants with limited resources to acquire farms in wetlands. As with depletion of soil fertility in the upland fields, wetlands became the most important land resources especially in the villages that had experienced out-migration. Further, key informants in all the study villages revealed that river banks were formerly covered by bamboos (*Oxytenathera abyssinica*). The bamboo shade limited the use of river

banks for crop production. But, as soil fertility of the main farming area kept on declining and in absence of bylaws enforcement, bamboos in the river banks were cleared and cultivation set in.

Consistent with the danger of land degradation posed by the utilization of sensitive areas, survey results indicated that only 47(19.58%) of the 240 respondents had knowledge on the existing environmental conservation bylaws restricting the utilization of sensitive areas (Table 7). The results show that knowledge on bylaws prohibiting cultivation in water sources and cutting of trees were statistically significant at p Ò 0.01. Following the decline in soil fertility and little use of inorganic and organic fertilizers, the ban on cultivation in water sources and forest clearing for new fields were the most felt decisions among smallholder farmers in the study area. The significance that farmers attached to areas close to water sources and forest for establishment of new fields could be the reasons why none of the respondents reported being aware of the restrictions on setting bushfires and only two had knowledge on restriction on use of public areas. This was contrary to evidence given by all village council members that villagers were forbidden to start bush fires.

Discussions with village council members indicated that for one to be allowed to use fire for bush clearing and farm preparation she/he had to ask for permission from the Village Executive Officer (VEO). In addition, a farmer would have to make a firebreak of five metres around the area to be cleared. This was consistent with practice in Botswana, Namibia and South Africa where they prepare extensive

networks of firebreaks annually (FAO, 2007). Also, village council members reported that a farmer was required to inform other farm owners on the borders of his/her field and have five people to assist him/her in case fire crossed the fire breaks. The activity was supposed to be inspected by the sub-village chairman. Despite acknowledgement of existence of rules governing use of bushfires by village council members, there were no records of such bylaws in all study villages. In contrast, discussions with District Council Management Team indicated that the villages that were under the Hifadhi Mazingira (HIMA) Project had explicit stated bylaws (see Appendix 5). The implicit stated bylaws imply that the consequences of fires go unmonitored and/or underestimated and underreported. Underreporting of fire occurrence is also reported in Russia where official figure put burnt area in 2002 at 1.7 million hectares of forest and non-forest land whereas the actual area affected by fires as reported by satellite imagery was 12 million hectares (FAO, 2007).

For the community to comply with rules and regulations governing use of natural resources, the rules must be known to all villagers. As reported in other studies in Uluguru Mountains (Munishi *et al.*, 2007; Paulo *et al*., 2007), knowledge of the environmental conservation bylaws to all stakeholders have potential to protect the natural resources and avoid resource misuse. In this case, the lack of knowledge on environmental conservation bylaws among smallholder farmers in the study area had several implications. First, there were little or no concerted efforts made by decision-makers to arouse farmersô awareness on environmental conservation. The land and forestry officials at district level take for granted that the bylaws were known among the villagers. Experiences with wildlife management as reported by

Cirelli (2002) show that people participation in decision making and implementation increased support for adopted conservation measures and improved both implementation and enforcement. Second, the existence of bylaws and government continued use of command and control instruments to protect the natural resources were not sufficient by themselves as long as most of the villagers did not see the benefits of land conservation. The continued use of command and control instruments to protect the natural resources is created by emphasis placed on exploitation of resources by the central government as against conservation (Barrow *et al*., 2000). In the field, the negative impacts of this attitude was expressed by the Village Council members in Kimelembe, who blamed the District Forest Officials tendencies of issuing permits to harvest forest in their village without the concert of village government.

Besides, discussions with village council members indicated that there were no village land use plans for protection of natural resources in the study areas. Experiences with forest conservation in eastern and western Rift Valley in Kenya show that management plans are yardstick against which one could gauge implementation of various programmes (Njuguna *et al*., 1999). The absence of management plans in the study villages imply that the boundaries of resource to be protected, actions needed to conserve the resource, and mobilization of funds and facilities to implement the conservation of the resources are unknown. In this case, policies have little impact to reduce or eliminate the problems of land degradation. As noted in the Eastern Arc Mountains of Tanzania, the uninformed decision-makers have little chance of guiding ways in which resources can be used and

managed as management interventions are found within the management plans (FBD, 2006b).

In addition to existence of management plans on natural resource conservation, another important aspect is existence of secure land tenure. Table 8 summarizes six main ways of land acquisition used by smallholder farmers in the study area.

Table 8: Ways used by farmers to acquire land in the study villages

Variable	Distribution of respondents in the study villages					
Ways of land acquisition	Kimelembe (n=55)	Kipangala (n=47)	Kiyogo (n=36)	Lifua (n=32)	Total (n=170)	G2=72.994 p=0.000**
Purchased from others	5(9.1)	1(2.1)	0(0)	2(6.3)	8(4.7)	
Given by relatives	4(7.3)	11(23.4)	3(8.3)	7(21.9)	25(14.7)	
Allocated by village government	28(50.9)	1(2.1)	4(11.1)	2(6.3)	35(20.6)	
Forest clearance	8(14.5)	8(17)	14(38.9)	3(9.4)	33(19.4)	
Rented	0(0)	0(0)	0(0)	1(3.1)	1(0.6)	
Inheritance	10(18.2)	26(55.3)	15(41.7)	17(53.1)	68(40)	
Who certified land transfer	n=60	n=60	n=60	n=60	n=240	G2=173.750 p=0.000**
Neighbours	1(1.7)	0(0)	27(45)	0(0)	28(11.7)	
Relatives	41(68.3)	6(10)	7(11.7)	3(5)	57(28.8)	
Village government	18(30)	54(90)	26(43.3)	57(95)	155(64.6)	
View on women access to land	n=60	n=60	n=60	n=60	n=240	G2=64.872 p=0.000**
Not easy	8(13.3)	32(53.3)	52(86.7)	32(53.3)	124(51.7)	
Easy	52(86.7)	28(46.7)	8(13.3)	28(46.7)	116(48.3)	

Figures in parentheses are percentages and those out of it are frequencies, * Significant at p Ò 0.05

**Significant at p Ò0.01 ns Not Significant

The results show significant difference at p Ò0.01 in the modes of land acquisition used by smallholder farmers in the study area. The multiple nature of land acquisition in the study area was similar to situation reported in Iringa District by Odgaard (2002) where a farmer used different types of land tenure for various pieces of land. Inheritance and allocation of land to farmers by village government were the

leading means of land acquisition in the study area (Table 8). The handing over of land rights from one generation to another explained the increasing land fragmentation in the study villages. Prevalence of land fragmentation does not conform to the acceptable methods of management and conservation. A study by Msumali *et al*. (2007) in the Usambara Mountains, Tanzania found that land fragmentation increased threat to deforestation and land degradation. Since, land fragmentation increases the difficulty in coordination of resource conservation among farmers.

The increased importance of inheritance in the acquisition of land in the study area is because kinship links were still being adhered to. In Kiyogo village, kinship links allowed other villagers to return to the area they occupied prior to villagization. Close relatives confirmed individual claims to clan land and original field boundaries for different families. In contrast, at Kimelembe village new comers used kinship links to gain access to land and to the village government. Similarly, Odgaard (2002) study among the Hehe in Iringa District found that land rights depend on social relations within the family/clan relations, marital relations, and friendship. This was illustrated by the patterns of migration in the study area, where abundance of land in the village did not guarantee an equal access to land to all. Key informants reported unequal distribution of agricultural lands, especially wetlands. So it was not by accident that most of the emigrants in Lifua and Kipangala villages were former immigrants who had experienced out-migration elsewhere. Similar observations were noted in Iringa District (Odgaard, 2002), where the indigenous residents prior to villagization had more access to land compared to new comers.

Further inquiry was made to establish if it was easy for women to access land as responses given in Table 8. The results show that over half, 124(51.7%) of the respondents acknowledged that it was not easy for women in the study villages to acquire land. However, more than half, 52(86.7%) of the respondents at Kimelembe village reported that it was easy for women to access land. The results are statistically significant at p Ò 0.01, implying that there was difference in accessing land among the respondents in the study area. In new settled area like Kimelembe village, there was ample arable land compared to vast exhausted land in the villages that had experienced out-migration. This was confirmed by FGDs participants who argued that the practices of denying land inheritance rights to women existed, especially in the villages with acute shortages of land. The FGDs arguments are supported by empirical evidences from other studies in Africa (Hebo, 2006; Msumali *et al*., 2007) which found that the inheritance rights to land excluded and denied the share of family land to daughters and married women. FGDs with males aged above 40 years old in this study suggested that extending land rights to married women meant not only transferring clan land to another family, but also legalizing the intrusion of the family territory. Similar thinking has also been found to exist among the Arsii Oromo of southern Ethiopia (Hebo, 2006).

The difficulty of women to access land in the study area was illustrated by the increase in land renting in Lifua village (Table 8). According to FGDs land renting were common among female headed households and for fields located in river valley bottoms that were either planted with rice during the rain season or maize and beans in the dry seasons. FGDs participants reported rate of land renting to vary

from Tshs. 2 000 to 5 000 per half an acre. About 16 (57.14%) out of the 28 respondents in Lifua village acknowledged that women could easily access land by renting. Similarly in Nicaragua, Deininger *et al*. (2003) found that 80 percent of landless accessed land by renting. In line with this study, the results implied that women were categorically landless as only eight (3.3%) respondents reported women to be allocated land belonging to their families. In Bangladesh, Indra *et al.* (1997) found that *uthuli* (settle on others land without monetary payment) provided access to land to women through extended entitlements as daughters, sisters and mothers. Only four (1.7%) respondents found easy access for women to acquire land allocated by the village government. But, all female participants in FGDs claimed that renting land was not a secure means as land acquired could be repossessed by the landlords once fields performed well. Consistent to FGDs views, Shetto and Owenya (2007) found that improvement of hired land in Karatu district was associated with raise in rent, take over, and termination of hire contract. Similarly, Blay and Damnyag (2007) reported association of land renting and lack of incentives to invest in conservation and increased danger of land degradation in Ghana and Southern Honduras. Lack of incentives to invest in conservation is also reported among the female-headed households in Uluguru Mountains, Tanzania (Ruheza, 2003; Paulo *et al*., 2007).

Apart from inheritance, the study found that land allocation by the village governments served 35(20.6%) of the respondents in the study villages. Land allocation by the village governments was an important means of land acquisition, especially among the new comers. In Kimelembe village, 28(50.9%) of the

respondents reported to acquire land allocated by a village government. Discussions with village council members showed that in the early 1990s, the village had abundant uncultivated arable land, and an in-coming family could be allocated up to ten acres, but as of 2007 only three acres could be allocated per family. The reduction in size of land allocated to new comers implied an increased pressure on land. The reduced land area allocated to farmers forced villagers to clear forests which increased the threat of land degradation in the newly established settlements. In this case, these results are in line with other studies in Tanzania (Barrow *et al*., 2000; Cohen, 2002) and Ghana (Mensah-Bonsu and Sarpong, 2007) that show that the change in land tenure does not automatically guarantee control of land degradation. Based on experiences in East Africa, Cohen (2002) argued that development of appropriate land tenure depend on culture, history, present situation and people trust on the existing tenure systems developed through experiences. For instance, existence of corruption in land allocation by village government when combined with the absence of land registers and maps for the allocated land in the village office could lead to reduction on the trust and sometime create uncertainty about ownership of land, leading to land use conflicts and more land degradation.

Apart from the ways in which land is acquired, another aspect of land tenure that was essential for the protection of land resources was certification of the owned land. Results in Table 8 show significant differences at p Ò 0.01 in ways farmers ensured their land ownership in the study area. In contrary to how they acquired land, over 111(93%) of the respondents in the villages that had experienced out-migration had their land ownership certified by village government. In addition to

involvement of village government, in Kimelembe village, about 19(32%) of the respondents indicated to had documents for the land allocated to them. In contrary, most 21(87.5%) of the female headed households in Kimelembe village lacked documents for the land they owned as they showed to acquire land through relatives. In this case, their claims to land depended on the wish of the male members in their families. Women dependency on extended access to land was also reported in Bangladesh by Indra and Buchignani (1997). Another study in Africa by Platteau (2000) found that many people in rural area are unaware of the new land provisions and do not grasp the implication of land registration. In this case, women who lack documents for the land they own find it to be normal as far as their relatives are around to defend them in times of intrusion.

FGDs with smallholder farmers suggested that village government was involved in acquisition of land that was not under the clan ownership. The increased importance of village governments in land certification was due to increasing land scarcity that created land use conflicts, which demanded formalizing land tenure. The involvement of village governments in land transactions offered an opportunity for them to use their authority to intervene in land management. However, experiences with land registration in Brazil was associated with deforestation of Amazon as land titles increased farmersô access to credit to implement activities like cattle ranching that promoted land degradation (Kanninen *et al.*, 2007).

During FGDs, it was asserted that relatives were mostly used in certification of land transfer at Kimelembe village. This was attributed to the nature of migration in the

village. Unlike the earlier migrations in early 1980s from Lituhi village in neighbouring Mbinga District, which were supervised by government, the 1990s migrations depended on the information offered by close relatives about the availability of arable land in Kimelembe village. Relatives of the migrants did not only support the new comers during their establishment, but also introduced them to the village government. The importance of relatives as social capital in land rights have also been reported in Iringa District by Odgaard (2002).

4.4 Institutions' Effectiveness in Reducing Land Degradation

In Ludewa District, there were a number of institutions, concerned with natural resource management, which included governmental, non-governmental, religious, and community based organizations. The governmental organizations at district level included departments of Forestry and Natural Resources, Agricultural and Livestock Development, Water, and Land, which were under the District Council. In this case, the District Council was responsible for planning and development of natural resources in the district, and establishment of bylaws on management of natural resources. During the study period, only one department, that is, Department of Agricultural and Livestock Development had its representatives in the two study wards of Luilo and Nkomangôombe. The Masasi ward was served by an extension officer from Manda ward. The absence of staffs of other key departments in the use and management of natural resources implied that farmers were unprepared, uninformed and unsupported by their expertise in attempts to reduce land degradation.

Apart from governmental organizations, LDC (2003) reported a total of six registered Non Governmental Organizations (NGOs) involved in environmental conservation, especially tree planting and bee keeping in Ludewa District. The organizations included Lupanga Youth Society (LUYOSO), Mlangali Development Association (MLADEA), Mlangali Progressive Youth Association (MPYA), Ludewa Environmental Conservation and Poverty Alleviation (LECAPOA), Lusala Development Association (LUDEA), and Integrated Farming for Small Scale Holders (INTER FARM). The NGOs operated in three divisions of Ludewa district namely, Mlangali, Mawengi, and Liganga and none of the above organizations operated in the study area. This limited the potential of beekeeping in protection of water sources and catchment areas that increase income among smallholder farmers and add value to conservation activities. As reported in other studies (Barrow *et al.*, 2000; Rutatora and Mattee, 2001), the limited coverage of NGOs operations was due to lack of coordination in objectives, activities, strategies, resources allocation (sources of funds, staff) and information sharing. The lack of coordination among different organizations is attributed to forces behind their evolution as they emerged from different circumstances and conditions. In this case, it becomes difficulty for the NGOs to share the mission of natural resource management with other institutions (Barrow *et al*., 2000). In addition, Rutatora and Mattee (2001) found limited coverage of operation of the NGOs in agricultural extension in Tanzania due to dependency on donor funding and their favour in higher potential areas. Similarly, according to discussions with Council Management Team, extension activities by CARITAS, a religious organization of the Roman Catholic Church on sustainable

agriculture and food security in the villages that had experienced out-migration were not incorporated into the District Agricultural Development Programmes (DADPs).

The little use of the existing institutions in the implementation of various programmes to reduce land degradation was also supported by discussions with key informants. For instance, key informants at Lifua village reported that extension services provided by CONCERN to support smallholder farmers to reduce land degradation were terminated with the end of the project. The supports of CONCERN to smallholder farmers in the study area were in the improvement of water intake and irrigation canal in Nyangundi irrigation scheme (CONCERN, 2000). In addition, CONCERN trained farmers on how to conserve the catchment area, animal husbandry, use of animal manure, group formations, and farmer to farmer extensions through trained Village Development Workers. A study in Asian countries by Baulderstone (2006) term the phenomenon as fund us to produce outputs phenomenon. Another study in education sector in Tanzania (Mpamila, 2007) also found end of cooperative working arrangements between the government and NGOs with termination of the project. These results imply that for the initiatives by NGOs to be effective and sustainable they had to be coordinated and regulated by the local authority development programmes such as District Agricultural Development Programmes (DADPs).

According to the national Land Policy of 1995 and Village Land Act of 1999, management of village land is the responsibility of village councils. Village councils are supposed to report all decisions on natural resource management for approval to

the village assembly. The village councils assign the natural resources related responsibilities to various committees. Discussion with village council members indicated that all villages had land committees as stipulated in the Land Law of 1999, which had seven members and two of them being women. The work of Land Committees varied from one village to another. For instance, a Land Committee at Kimelembe village mainly resolved land conflicts and allocated land to new comers, while at Kiyogo the committee allocated land for new cashew growers. As reported by FAO (2007) in India, creation of Joint Forestry Committees increased villagersô willingness, cooperation and responsibility in forest management. However, discussions with village council members in both Kipangala and Lifua villages indicated that the duties of land committees were not clear to most villagers. A study by Barrow *et al*. (2000) on institutions governing wildlife management in East Africa found that lack of control of and/or access to and undefined responsibilities on natural resource management reduce their ability to enforce the rules that control individual behaviour. In this case, the unchecked behaviour of resource users such as smallholder farmers increases the danger of unsustainable resource use. This implies the need to build capacity of smallholder farmers and their institutions for them to be in a position to access information that is essential in addressing land degradation issues.

At the district level, the District Council Management Team (CMT) is supposed to control the use and management of natural resources. Discussions with some of the CMT members indicated that the District was in the process of developing a district environmental management plan. The plan will state the objectives of natural

resources conservation and identify resources in critical need of conservation, establish mechanisms for involving various users of the resources, and state their responsibilities. Further, the plan will establish a process to enhance partnership, sharing of resources, delegation of power, and capacity building in reducing land degradation.

For effective coordination of use and management of natural resources the Environmental Management Act of 2004 calls for the appointment of Environment Inspectors at different levels. The existence of coordination between village and district levels not only ensure enforcement of laws, but provide fora for smallholder farmers to discuss issues related to resource use. This allows the voices of the voiceless to be heard by higher organs in decision-making. Discussions with the CMT members indicated that currently there were no environmental inspectors even at the district level. The absence of district environment inspectors increases the patchwork operations of organizations that are based on sectoral setting. As reported by FBD (2006a) lack of sectoral coordination in Tanzania led to provision of mining license in forest reserves in the Eastern Arc Mountains. Similarly in Indonesia, rent seeking behaviour among local officials led to issuing permits to legitimize timber harvest in forest reserves (Kanninen *et al*., 2007). This gives insights on the need to have capable local institutions that can monitor the implementations of various policies on natural resources use and management (Hudson, 1995; Kanninen *et al*., 2007).

On the other hand, the enforcement of environmental conservation bylaws at the village level is the duty of the village government. Experiences from Hifadhi Ardhi Shinyanga (HASHI) project (Mlenge, 2004) in Tanzania show that through enforcing the bylaws, the Wigelekelo village was able to protect its dam and its catchments. During discussions with the village councils in the study area, members blamed the district officials for issuing permits to cut trees in their villages without their consent. This is in line with the continuity of command and control systems that persist despite policy acknowledgement of the participatory management of resources (Barrow *et al*., 2000). Government reluctance to delegate power is engendered by long held views that state knows what is best for rural people and their resources. Besides, FGDs participants attributed breach of existing bylaws to the laxity and nepotism among village leaders. Similarly, lack of enforcement and/or enforced on ad hoc basis of bylaws was found by Kahurananga (1999) to increase degradation of Lake Babati and its immediate surroundings. The reluctance in implementation of laid down procedures implied lack of accountability among responsible organizations and officials. In this case, leaders at district and village levels appeared to lack political will and commitment to natural resource management.

CHAPTER FIVE

5.0 LIVELIHOOD STRATEGIES AND LAND DEGRADATION

5.1 Overview

This chapter presents and discusses the results of the study for objective four and five. The discussion starts by looking at socio-economic factors influencing change of livelihoods among smallholder farmers and end with livelihood strategies changes observed in the study area.

5.2 Socio-economic Factors Influence on Farmers' Livelihoods

5.2.1 Influence of socio-economic factors on increase in cassava grown area

Empirical results of logistic regression models used to assess the influence of socio-economic factors on change in smallholdersô livelihoods in the study area are given in Tables 9 up to 14. The first aspect of change in livelihoods considered was expansion of cassava cropped area. The results in Table 9 show that data fit well to the model when the predictor variables level of income (INCATT), total cultivated land (TOFSIZET), gender of household head (GENDERT), level of education (EDUCT), age (AGET), number of fields (FARMST), number of dependents (DEPAGET), village type (VITYPET), household size (FSIZET), distance to the fields (DISFARMT), marital status (MARITALT), land tenure (HOWNEWT), fallow period (FALLOWT), cassava yield (CASIELDT) were included in the model. The value of -2Log Likelihood (-2LL) when the predictor variables were included dropped from 226.169 with only constant to 196.821. The likelihood of smallholder farmers to expand cassava cropped area was also confirmed by the value of overall percentage of correct prediction which increased from 61.8 to 69.4 percent (Table

9). As asserted statistically (Field, 2000), the inclusion of the predictor variables maximize how well the model predict the observed data and likelihood of every respondent to belong to outcome category which most of them fall. For instance, in this study the model predicted correctly that 90 respondents expanded area grown with cassava and misclassified 15 respondents (i.e. correctly classified 85.7% of the respondents).

Table 9: Logistic regression model for increase in area grown with cassava

Variable	Coefficients	Standard error	Wald	Exp(ϐ)	df	p-value
Age	-0.808	0.621	1.691	0.446	1	0.193 ns
Marital status	0.577	0.697	0.686	1.781	1	0.407 ns
Fallow	1.673	0.912	3.364	5.330	1	0.067 ns
Number of fields	1.137	0.577	3.883	3.116	1	0.049*
Land tenure	0.528	0.370	2.034	1.695	1	0.154 ns
Total field size	-0.378	0.382	0.979	0.685	1	0.322 ns
Village type	-0.348	0.416	0.699	0.706	1	0.403 ns
Number of dependents	-2.410	1.233	3.818	0.090	1	0.051 ns
Number of productive adults	-2.271	1.273	3.184	0.103	1	0.074 ns
Household size	3.383	1.797	3.544	29.448	1	0.060 ns
Level of education	1.006	0.847	1.409	2.735	1	0.235 ns
Distance to the field	-0.181	0.262	0.475	0.835	1	0.491 ns
Income level	-0.053	0.536	0.010	0.949	1	0.922 ns
Gender	0.053	1.069	0.002	1.055	1	0.960 ns
Constant	-3.658	4.292	0.726	0.026	1	0.394 ns
I -2LL = 226.169 F -2LL = 196.821		Model Chi-Square = 29.349** Nagelkerke R Square = 0.216			Overall percentage 61.8 and 69.4 for I and F, respectively	

I for Initial, F for Final* significant at p Ò0.05, ** significant at p Ò0.01, ns Not significant

Besides, the results in Table 9 show that fallow periods (FALLOWT with coefficient of 1.673 and wald statistic of 3.364), number of fields (FARMST with coefficient of 1.137 and wald statistic of 3.883), being a female as gender coding was increasing with being a female (GENDERT with coefficient of 0.053 and wald statistic of 0.002), household size (FSIZET with coefficient of 3.383 and wald statistic of

3.544), renting as land tenure coding was increasing from purchase to renting (HOWNEWT with coefficient of 0.528 and wald statistic of 2.034), and being single as marital status coding was increasing from married to single (MARITALT with coefficient of 0.577 and wald statistic of 0.686) had positive coefficients meaning that expansion of cassava cropped area in the study area increased with increase in those variables. However, only one variable, that is, number of fields (FARMST) was statistically significant (at p Ò 0.049) in explaining the increase in area grown with cassava (Table 9). The results in Table 9 further indicate that with exponential coefficient greater than one, increased number of fields in the study area increased likelihood of household expands cassava cropped area. The increase in area cropped with cassava with increase in the number of fields (FARMST) was consistent with Burbridge *et al*. (1988) who found that farmers increased number of fields so as to compensate the loss in yields associated with decline in soil fertility. The increase in number of fields resulted in land fragmentation, which implied that there was more encroachment of marginal lands (Table 22), which is supported by change in land use/cover as discussed in section 4.2 of this study. The encroachment of marginal lands, use of river banks and water catchments for cassava production is in agreement with Enger and Smith (2000) who found that starving people were forced to overexploit the accessible resources.

In addition, farmersô encroachment of marginal lands increased field abandonment, and in absence of soil fertility improvement of the abandoned fields, the length of fallow automatically increased, especially in the villages that had experienced out-migration. Further, the results in Table 9 show that even though cassava was the

staple food in the study area, its area under cultivation decreased in the villages that had experienced in-migration as village type coding was increasing from in- to out-migration (VITYPET with coefficient of -0.348 and odds ratios less than one). The results implied that with relative fertile soil in the villages that had experienced in-migration, small area under cultivation could suffice food requirements of a household. Also, the study findings showed that cassava cropped area decreased with increase in age of respondents (AGET with coefficient of -0.808), number of dependents (DEPAGET with coefficient of -2.410), distance to the fields (DISFARMT with coefficient of -0.181), income level (INCATT with coefficient of -0.053), and total cultivated area (TOFSIZET with coefficient of -0.378). The decrease in cassava cropped area with age was expected as old and exhausted people could not afford labour demanded in establishment of new fields. Then, it was unlikely for them to search for new fields.

5.2.2 Influence of socio-economic factors on expansion of maize cropped area

Another aspect of change in farmersô livelihoods assessed was expansion of maize cropped area (Table 10). As seen for cassava, there was a large drop in the values of -2Log Likelihood (-2LL) for maize. The values of -2LL in expansion of maize cropped area model with inclusion of the predictor variables, namely, INCATT, TOFSIZET, GENDERT, EDUCT, AGET, FARMST, DEPAGET, VITYPET, FSIZET, DISFARMT, MARITALT, HOWNEWT, FALLOWT, CASYIELT dropped from 237.715 to 164.327. As argued for error sum of square in multiple regressions, large drop in log-likelihood ratio implied that more observations were explained by the model (Field, 2000). In this case, the model (with Nagelkerke R

Square = 0.43) was able to explain 43 percent of farmersô likelihood of expanding maize cropped area. Besides, the results in Table 10 revealed that the model chi-squared (73.388) was statistically significant at p = 0.000. This means that inclusion of the predictor variables brought change in likelihood of the respondents growing maize.

Table 10: Logistic regression model for increase in area grown with maize

Variable	Coefficients	Standard error	Wald	Exp(b)	df	p-value
Gender	2.194	1.321	2.757	8.971	1	0.097 ns
Fallow	0.106	1.000	0.011	1.112	1	0.916 ns
Land tenure	-0.585	0.218	7.183	0.557	1	0.007**
Number of fields	-0.117	0.656	0.032	0.890	1	0.858 ns
Village type	0.148	0.558	0.070	1.159	1	0.791 ns
Number of productive adults	0.344	1.222	0.079	1.411	1	0.778 ns
Household size	-1.515	1.787	0.719	0.220	1	0.396 ns
Income level	-1.588	0.695	5.214	0.204	1	0.022*
Cassava yield	0.406	0.504	0.650	1.501	1	0.420 ns
Age	1.179	0.757	2.425	3.251	1	0.119 ns
Marital status	-1.208	0.861	1.969	0.299	1	0.161 ns
Total field size	1.478	0.449	10.848	4.384	1	0.001**
Number of dependents	1.029	1.218	0.714	2.799	1	0.398 ns
Level of education	1.075	1.085	0.983	2.930	1	0.322 ns
Distance to the field	-0.346	0.305	1.286	0.707	1	0.257 ns
Constant	-6.127	5.543	1.222	0.002	1	0.269 ns
I -2LL = 237.715		Model Chi-Square = 73.388**			Overall percentage 76.7	
F -2LL = 164.327		Nagelkerke R Square = 0.430			and 84.0 for I and F, respectively	

I for Initial, F for Final* significant at p Ò0.05**, significant at p Ò0.01, ns Not significant

This is supported by further increase in values of overall percentage of correct prediction from 76.7 percent with only constant to 84.0 percent with the predictors (Table 10). The model correctly predicted 24 out of 51 respondents to had expanded area cropped with maize, but misclassified 27 others (i.e. correctly classified 47.1% respondents). In addition, the model correctly predicted 160 out of 168 respondents

to had not expanded area cropped with maize and misclassified 8 others (i.e. correctly classified 95.2% respondents), which concur with the fact that staple crop in the study area was cassava. Besides, of the sixteen variables in the expansion of area cropped with maize model only three variables, namely, income level (INCATT), land tenure (HOWNEWT), and total cultivated area (TOFSIZET) were statistically significant at p Ò 0.022, 0.007 and 0.001, respectively. With exception of total cultivated area (TOFSIZET with coefficient of 1.478), area cropped with maize decreased with increase in level of incomes (INCATT with coefficient of -1.588) and land tenure (HOWNEWT with coefficient -0.585). The decrease in likelihood of household increasing area cropped with maize is also supported by low value of exponential coefficient of 0.537 and 0.204 for land tenure and income level, respectively. The decrease in maize cropped area with land tenure came as tenure was increasing from purchase, given by relatives and village government to forest clearing and renting. Renting was common among women and in area of exhausted soil fertility. Households with renting as means to acquire land were unlikely for them to expand maize cropped area. Maize requires soil with high nutrient content, which in absence of inorganic fertilizers could be supplied with animal manure. But, Hella (2003) in semi-arid areas of Tanzania found that willingness to invest in soil improving techniques was associated with security of tenure and unlikely to be under renting.

As in other parts of the country, maize in the study area was grown for both cash and food. Here, the importance of maize as a cash crop was also associated with termination of tobacco cultivation in the early 2000s. In this case, households with

high income tended to increase area under maize cultivation. As there was little or no application of chemical and/or organic fertilizers (Table 15), increasing incomes from maize meant expanding areas cultivated. Expansion of maize cropped area in Kimelembe village meant opening up of new areas, which were located in catchments, hence, more prone to danger of land degradation. Positive note in this study was the increasing use of animal manure, especially in the villages that had experienced out-migration (Table 11).

Table 11: Logistic regression model for increased use of animal manure

Variable	Coefficients	Standard error	Wald	Exp(b)	df	p-value
Gender(1)	0.745	0.471	2.503	2.106	1	0.114 ns
Fallow	0.152	0.911	0.028	1.164	1	0.868 ns
Land tenure	-0.088	0.062	2.035	0.916	1	0.154 ns
Number of fields	2.915	0.972	8.999	18.455	1	0.003**
Village type(1)	-1.906	0.567	11.318	0.149	1	0.001**
Household size	-0.354	0.475	0.555	0.702	1	0.456 ns
Income level	1.671	0.711	5.520	5.316	1	0.019*
Age	-1.700	0.717	5.625	0.183	1	0.018*
Total field size	0.214	0.508	0.178	1.239	1	0.673 ns
Level of education	-0.460	1.016	0.204	0.632	1	0.651 ns
Number of productive adults	0.388	0.546	0.505	1.475	1	0.477 ns
Cassava yield	-1.616	0.589	7.533	0.199	1	0.006**
Constant	1.266	4.850	0.068	3.547	1	0.794 ns
I -2LL = 268.005 F -2LL = 161.186		Model Chi-Square = 106.879** Nagelkerke R Square = 0.547			Overall percentage 69.9 and 84.0 for I and F, respectively	

I for Initial, F for Final* significant at p Ò0.05, *** significant at p Ò0.01, ns Not significant

Model on use of animal manure (Table 11) shows that values of -2LL with inclusion of the predictor variables, namely, INCATT, TOFSIZET, GENDERT, EDUCT, AGET, FARMST, DEPAGET, VITYPET, FSIZET, DISFARMT, HOWNEWT, FALLOWT, CASYIELT dropped from 237.715 to 164.327. The results also show positive coefficients are associated with a household head being a male

(GENDERT1 with coefficient of 0.745 and wald statistic of 2.503), increase in fallow period (FALLOWT with coefficient of 0.152 and wald statistic of 0.028), income level (INCATT with coefficient of 1.671 and wald statistic of 5.520), household size, and number of fields (FARMST with coefficient of 2.915 and wald statistic of 8.999) meaning that use of animal manure in the study area increased with those variables. The significance of number of fields and income level is also confirmed by odds ratios, which indicated likelihood of using animal manure increased by a factor of five and 18, respectively for the two factors.

The use of animal manure was statistically significant at p Ò 0.003, 0.001, 0.019, 0.018, and 0.006 for increase in number of fields, being in the villages that had experienced out-migration, increase in incomes, decreased age, and decrease in cassava yields, respectively. The significance of these factors in use of animal manure was in agreements with key informantsô suggestions that animal manure enabled the use of exhausted fields, especially those close to homesteads. In this case, the use of animal manure offered a chance for improving soil fertility, which stimulated increase in crop yields. The increased crop yields likely improved not only levels of incomes, but also limited encroachment of marginal lands. In contrast, application of animal manure was negatively related to increase in cassava yield (with coefficient of -1.616 and wald statistic of 7.533), age of household head (with coefficient of -1.700 and wald statistic of 5.625), and land tenure (with coefficient of -0.088 and wald statistic of 2.035). The decrease in use of animal manure with increase in cassava yields, age and land renting is supported by lower value of exponential coefficients which are smaller than one (Table 11).

5.2.3 Socio-economic factors influencing fish selling in Ludewa District

Another change in livelihood among smallholder farmers considered in this study was an increase in importance of fish selling, and its coefficients are summarized in Table 12.

Table 12: Logistic regression model for participation in fish selling

Variable	Coefficients	Standard error	Wald	Exp(b)	df	p-value
Gender(1)	0.758	0.839	0.816	2.134	1	0.366 ns
Age	-2.918	0.659	19.614	0.054	1	0.000**
Marital status(1)	-0.720	0.888	0.657	0.487	1	0.418 ns
Marital status(2)	-0.222	0.885	0.063	0.801	1	0.802 ns
Marital status(3)	0.439	0.757	0.336	1.551	1	0.562 ns
Number of fields	-0.575	0.493	1.362	0.563	1	0.243 ns
Total field size	0.527	0.347	2.304	1.694	1	0.129 ns
Village type(1)	-0.089	0.386	0.053	0.915	1	0.818 ns
Number of dependents	0.179	1.099	0.027	1.196	1	0.870 ns
Number of productive adults	0.055	1.171	0.002	1.057	1	0.962 ns
Household size	-0.079	1.649	0.002	0.924	1	0.962 ns
Level of education (1)	0.209	1.622	0.017	1.232	1	0.898 ns
Level of education (2)	-0.145	1.535	0.009	0.865	1	0.925 ns
Level of education (3)	-0.525	1.503	0.122	0.592	1	0.727 ns
Level of education (4)	0.293	1.589	0.034	1.341	1	0.854 ns
Income level	0.985	0.528	3.479	2.679	1	0.062 ns
Constant	9.741	3.254	8.959	16997.251	1	0.003**
I -2LL = 269.921 F -2LL = 227.810		Model Chi-Square = 42.111** Nagelkerke R Square = 0.238				Overall percentage 75.0 and 76.3 for I and F, respectively

I for Initial, F for Final* significant at p Ò0.05** significant at p Ò0.01, ns Not significant

The results show that the data fit well with the model as the value of -2Log Likelihood (-2LL) dropped from 269.921 to 227.810 when predictor variables INCATT, TOFSIZET, GENDERT, EDUCT, AGET, FARMST, DEPAGET, VITYPET, FSIZET, and MARITALT were included in the model. The results

suggest that with inclusion of those predictors the model better predicted the likelihoods of a farmer engaged in fish selling (Table 12). Respondents involvement in selling fish was negatively related to increase in age (with coefficient of -2.918), being married (with coefficient of -0.720) or divorced (with coefficient of -0.222), number of fields owned by a household (with coefficient of -0.575), being in village that experienced in-migration (with coefficient of -0.089), and having large family size (with coefficient of -0.079). With exponential coefficient less than one, engagement in fish selling was associated with being single. Since, marital status coding increased from being married to single, which is 1 for married, 2 for divorced, 3 for widows, and 4 for single.

In addition, the results show that of the 11 variables included in the model only age of household head (AGET) was statistically significant at p Ò 0.000 with change in patterns of households involvement in selling fish in the study area (Table 12). In absence of reliable transport infrastructure in the study area, physique was a critical resource for one to engage in fish selling. Good health for a household engaged in fish selling determined the ability to carry heavy loads on head and walk to far away (about 100 kilometres) markets such as those in Mbinga and Songea towns. In addition, FGDs participants asserted that fish business involved being absent from home for some days or weeks. By its nature fish selling business was mostly done by male youth and unmarried women. In that case, it was unlikely for married woman who are occupied with household chores to participate in fish selling. The insignificance of other variables in the model such as increase in total acreage cultivated (at p = 0.129) show limited production of surplus. The surplus from

agricultural production was essential in generating income that was used as capital in fish selling, capital that was not easily raised by elders, married women, and people with poor health.

Besides, model correctly predicted membership of non-involvement in fish selling for 166 respondents and misclassified only 14 of them (i.e. correctly classified 92.2% of the respondents). The model correctly predicted 17(28.3%) of the 60 respondents involved in fish selling. None involvement in fish selling for majority of the respondents in the study area was confirmed by slight increase in overall percentage of correct prediction from 75.0 to 76.3 percent (Table 12). Similarly, though statistically significant at p = 0.000, the model chi-squared (42.11) and Nagelkerke R Squared (0.238) were able to explain only 24 percent of farmers decision to engage in fish selling. The results suggest that other predictor variables not included in the model such as credit, transport and storage facilities were important in influencing a person to engage in fish selling. FGDs participants reported that elders, married women, and people with poor health excluded themselves from selling fish as it involved traveling on foot to distant markets.

5.2.4 Socio-economic factors and engagement in causal labour in Ludewa District

Apart from fish selling, smallholder farmers in the study area results in Table 13 show increasing engagement of smallholder farmers in casual labour in others fields and/or construction works. The results show that the values of initial -2Log Likelihood (-2LL) for model with only constant was 296.525 and that of the overall

percentage of correct prediction was 69.2 percent. The inclusion of predictor variables INCATT, TOFSIZET, GENDERT, AGECATT, EDUCT, AGET, FARMST, DEPAGET, VITYPET, FSIZET, and MARITALT in the model saw the values of -2LL dropping to 247.259 and that of overall percentage of correct prediction increasing to 71.1. The results show that decrease in smallholder farmersô involvement in causal labour was statistically significant at p Ò 0.001 with increase in age of household heads (with coefficient of -1.994).

Table 13: Logistic regression model for involvement in casual labour

Variable	Coefficients	Standard error	Wald	Exp(ß)	df	p-value
Gender(1)	0.249	0.771	0.104	1.283	1	0.747 ns
Age	-1.994	0.590	11.425	0.136	1	0.001**
Marital status(1)	-0.648	0.835	0.602	0.523	1	0.438 ns
Marital status(2)	-0.667	0.747	0.798	0.513	1	0.372 ns
Marital status(3)	-1.494	0.778	3.691	0.224	1	0.055 ns
Number of fields	-0.594	0.491	1.465	0.552	1	0.226 ns
Total field size	-0.075	0.331	0.052	0.927	1	0.820 ns
Village type(1)	0.134	0.365	0.135	1.144	1	0.713 ns
Number of dependents	0.220	1.042	0.045	1.246	1	0.833 ns
Number of productive adults	0.081	1.064	0.006	1.085	1	0.939 ns
Household size	0.459	1.531	0.090	1.583	1	0.764 ns
Level of education (1)	-0.938	1.618	0.336	0.392	1	0.562 ns
Level of education (2)	-0.911	1.523	0.358	0.402	1	0.550 ns
Level of education (3)	-0.559	1.487	0.142	0.572	1	0.707 ns
Level of education (4)	-0.215	1.581	0.019	0.806	1	0.892 ns
Income level	0.185	0.496	0.139	1.203	1	0.709 ns
Constant	8.158	3.053	7.141	3491.845	1	0.008**
I -2LL = 296.525 F -2LL = 247.259		Model Chi-Square = 49.267** Nagelkerke R Square = 0.262				Overall percentage 69.2 and 71.1 for I and F, respectively

I for Initial, F for Final* significant at p Ò 0.05** significant at p Ò 0.01, ns Not significant

Also, though not statistically significant (at p > 0.05), farmers involvement in causal labour decreased with being married (with coefficient of -0.648 and p = 0.438),

divorced (with coefficient of -0.667 and p = 0.372), and widowed (with coefficient of -1.494 and p = 0.055). Furthermore, results show negative coefficients for number of fields (with coefficient of -0.594 and p = 0.226), total cultivated area (with coefficient of -0.075 and p = 0.820), and educational level (with coefficients of -0.938, -0.911, and -0.559 for primary education and -0.215 for secondary education) with involvement in causal labour. The results confirm other findings in India (Balakrishnan, 2005; Kumar and Varghese, 2008) where labouring was high and important livelihood among the landless peasants, especially women.

The results (Table 13) further suggest that increased number of fields and total cultivated area implied increased access to land and unlikely for smallholder farmers to labour to others. Besides, the negative coefficient for education suggests that respondents with lower education had more likelihood of working on others fields than otherwise. However, the increase in the number of dependents and productive members in the households (with odds ratios greater than one in Table 13) implied that large household size increased the likelihood of a household head to look for casual labour. This is supported by Hella (2003) findings in semi-arid areas of Tanzania where large family meant more mouths to feed. Hence, increased likelihood to labour in the villages that had experienced out-migration (with coefficient of 0.134) was obvious as with low soil fertility, they could not produce enough food.

5.2.5 Socio-economic factors influencing cattle keeping in Ludewa District

Smallholder farmers involvement in cattle keeping was the last aspect of change in livelihoods considered in this study. Influences of socio-economic factors on the

smallholder farmersô decision to keep cattle are summarized in Table 14. The results indicated that the inclusion of INCATT, TOFSIZET, GENDERT, EDUCT, AGET, FARMST, DEPAGET, VITYPET, FSIZET, and MARITALT was associated with increased overall percentage of correct prediction. The overall percentage of correct prediction increased from 63.8 percent when a constant was considered to 80.0 percent when the predictor variables were included in the model. The model correctly predicted 64 of the 87 respondents to keeping cattle, but misclassified 23 respondents (i.e. correctly classified 73.6% respondents). Besides, the model correctly predicted 128 of the 153 respondents to have not kept cattle and misclassified 25 others. Increase in percentage of correct prediction implied that predictor variables included had influence on smallholder farmerôs decision to keep cattle.

In addition, -2LL dropped from 314.325 with only constant in the model to 207.689 when other predictors were included in the model. Drop in the -2LL value means that inclusion of socio-economic factors improved predictive power of the model. Keeping of cattle was positively related to number of fields (with coefficient of 1.160 and wald value of 3.953), household size (with coefficient of 0.368 and wald value of 1.288), income level (with coefficient of 3.367 and wald value of 27.625), being divorced (with coefficient of 1.585 and wald value of 1.533) or widowed (with coefficient of 0.552 and wald value of 0.192), age (with coefficient of 1.060 and wald value of 2.927), being male (with coefficient of 2.350 and wald value of 2.198), and being in the villages that had experienced out-migration (with coefficient of 0.256 and wald value of 0.415). On the other hand, keeping of cattle was

negatively related to total cultivated land (with coefficient of -0.512), distance to the field (with coefficient of -0.240), level of education (with coefficient of -0.589), and being married (with coefficient of -0.181). The results suggest that keeping of cattle was statistically insignificant to gender at p = 0.138, though its decrease with being married implied that it was gender biased.

Table 14: Logistic regression model for cattle keeping

Variable	Coefficients	Standard error	Wald	Exp(ß)	df	p-value
Gender(1)	2.350	1.585	2.198	10.490	1	0.138 ns
Number of fields	1.160	0.583	3.953	3.190	1	0.047*
Household size	0.368	0.324	1.288	1.445	1	0.256 ns
Income level	3.367	0.641	27.625	28.988	1	0.000**
Marital status(1)	-0.181	1.440	0.016	0.834	1	0.900 ns
Marital status(2)	1.585	1.280	1.533	4.878	1	0.216 ns
Marital status(3)	0.552	1.258	0.192	1.737	1	0.661 ns
Total field size	-0.512	0.373	1.886	0.599	1	0.170 ns
Distance to the field	-0.240	0.274	0.764	0.787	1	0.382 ns
Age	1.060	0.620	2.927	2.886	1	0.087 ns
Village type	0.256	0.397	0.415	1.291	1	0.520 ns
Level of education	-0.589	0.842	0.489	0.555	1	0.484 ns
Constant	-13.834	3.439	16.187	0.000	1	0.000**
I -2LL = 314.325		Model Chi-Square = 106.636**			Overall percentage 63.8 and 80.0 for I and F, respectively	
F -2LL = 207.689		Nagelkerke R Square = 0.491				

I for Initial, F for Final,* significant at p Ò0.05, ** significant at p Ò0.01, ns not significant

However, it was the number of fields (FARMST with coefficient of 1.160 and odds ratios of 3.190) and income levels (INCATT with coefficient of 3.367 and odds ratios of 28.988) that were statistically significant at p Ò 0.047 and 0.000, respectively in influencing the smallholder farmerôs decision to keep cattle. The importance of the two variables in the model was confirmed by higher values of Model Chi Square (106.636) and Nagelkerke R Square (0.491), implying that the included socio-economic variables had great explanatory power for individuals to

decide to keep cattle (Table 14). For instance, the increase in number of fields (FARMS) reflects the increasing decline in soil fertility in the study area, especially for the villages that had experienced out-migration. The deterioration in soil fertility and its associated crop failures could be the reason for increased farmersô dependency on cattle. Besides, a study in pastoral areas of Horn of Africa (Djibouti, Ethiopia, Kenya, Somalia, Sudan) by Abebe (2005) found that livestock especially cattle was a form of asset accumulation that increased level of householdsô incomes and could be shared or loaned among cattle keepers to enhance social capital essential in times of hardship like drought. Johnsen and Tarimo (2007) study on optimization of usage of local resources for improving livelihoods in Tanzania found that cattle are highly valued in terms of price, therefore selling of one cow could compare with several bags of maize or rice. That is why likelihood of smallholder farmers keeping cattle increased by a factor of 28. Similarly, Hella (2003) found that in semi-arid areas of Tanzania, cattle offered reliable assurance for smallholder farmers in case of total crop failure due to drought. In addition, Mlenge (2004) found that cattle ability to reproduce had replaced savings deposited in cash at bank or in trade among the Sukuma agropastoralists in Shinyanga, Tanzania.

5.3 Livelihood Strategies Change due to Land Degradation

5.3.1 Adoption of improved crop production practices

Faced with land degradation as manifested by change in land use/cover, decline in soil fertility, and drying of natural springs, smallholder farmers in the study area adopted a number of improved crop production practices to counter impact of reduced productivity. The adoption of improved crop production practices in the

period between 2000 and 2005 is one of the important elements that increased agricultural production among villagers (Table 15).

Table 15: Adoption of improved crop production techniques in the four study villages

Variable	Percent of respondents using improved crop production techniques											
	Inorganic fertilizer		Animal draught		Pesticides		Compost		Animal manure		Irrigation	
Villages	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
In-migration	98.3	1.7	98.2	1.7	99.2	0.8	95.0	5.0	93.3	6.7	100	0.0
Out-migration	100	0.0	100	0.0	83.3	16.7	96.7	3.3	50	50	91.7	8.3
Total	99.2ns	0.8ns	99.2	0.8ns	91.3*	8.8*	95.8ns	4.2ns	71.7*	28.3*	95.8*	4.2*

* Statistically significant at p Ò0.05; ns not statistically significant at p Ò0.05

The results showed that most of the respondents 238(99.2%) indicated to had not applied inorganic fertilizers in their farms. The number included all the 120 respondents in the villages that had experienced out-migration and 118(98.3%) of those who in-migrated. The results concerning the use of inorganic fertilizers in the study areas (out-migration and in-migration) are supported by the results of chi-square test (G2) which suggest that there were no statistical significant differences at p = 0.1 in the use of inorganic fertilizers. The results of this study implied that low adoption rate of inorganic fertilizers among farmers was in line with the reported small percentage (15%) of smallholder farmers who use inorganic fertilizers in the country (Pinda, 2008). Ludewa District is among the areas in the Southern Highlands of Tanzania that received government fertilizer transport subsidy since 2003. The low use inorganic fertilizers in the study area are contrary to governmentôs efforts in recent years. Participants in the FGDs asserted that the use of inorganic fertilizers was only common in tobacco fields and it stopped in 1999

when its cultivation was stopped. The termination of tobacco cultivation in the study area also saw the quitting of major tobacco buyer (DIMON) and other institutions (cooperative unions) that supported smallholder farmers with input supply. The quitting of input suppliers increased the costs of inorganic fertilizers making them inaccessible and unaffordable to most of the smallholder farmers in the study area. However, the study found statistically significant (at p Ò0.01) increase in the use of animal manure, for 60(50%) respondents in the villages that had experienced out-migration. The use of animal manure in the villages that had experienced out-migration was one of the attempts to redress the decline in soil fertility in their fields (Fig. 7). According to field experiences in Asia, the adoption of intensive agricultural technologies such use of animal manure has pulled land resources out of extensive agriculture, hence reducing land degradation (Kanninen *et al*., 2007).

FGDs with female participants aged below 40 years old in Lifua village showed that cattle keepers offered animal manure free of charge for only one season. Later requests for animal manure were for cash. In contrast, FGDs with males aged below 40 years old showed that they were willing to buy inorganic fertilizers, and traditionally it was unfair for one to buy animal manure. Such negative thinking among males could have been influenced by government emphasis on inorganic fertilizers. While there was government subsidy on inorganic fertilizers, there were no such mechanisms for animal manure. In this case, the government overemphasis on use of inorganic fertilizers towards soil fertility replenishment could be the reason for low animal manure adoption among smallholder farmers in the study area.

Other studies (Jackson and Mtengeti, 2005 cited by Bayer and Kapunda, 2006) done in the Southern Highlands of Tanzania found that farmers failed to manure their croplands due to its low supply as the number of cattle kept were few. Their findings are consistent with official figures offered by the Village Executive Officers, which indicated that Lifua had 603 cattle, Kipangala 850, Kiyogo 420, and Kimelembe 140 during the time of the survey. Taking manure output of 1.4 tonnes of dry matter per head per annum, the cattle in the study area could produce 844.2 tonnes in Lifua, 1 190 tonnes in Kipangala, 588 tonnes in Kiyogo, and 196 tonnes in Kimelembe village. Assuming manure application of 4t/ha, the outputs suffice for 211 ha at Lifua, 297.5 ha in Kipangala, 147 ha in Kiyogo and only 49 ha in Kimelembe village. Limited amount of manure available and poor quality of manure from unimproved livestock keeping systems has also been reported in African Savanna by Müller-Sämann and Kotschi (1994) and in Asia by Little and Edwards (2003). The problem of quantity and quality of animal manure is important especially for husbandry systems that keep animal in pen with no roof for the night as was common practices in the study area.

Other reasons for limited use of animal manure that members of FGDs mentioned were laziness to collect and spread animal manure in the fields for villagers at Kipangala, fear of increased weed growth, increased soil temperature during dry spells, distances to the fields, lack of transport, and availability of nutrients from acacia tree stems and leaves in Kiyogo village. Studies in the tropics show that crop growth and productivity suffer if the soil temperature exceeds 35 °C (Sivakumar *et al.*, 1992; Müller-Sämann and Kotschi, 1994). Müller-Sämann and Kotschi (1994)

further argue that process of animal manure decomposition can heat up to 70 °C depending on the manure composition. Other findings in sandy soils of West Africa show that for every 10 °C rise in temperature, increase velocity of chemical reaction by a factor of two to three (Sivakumar *et al*., 1992). The extreme heating and rise of soil temperature associated with the use of animal manure during the prolonged drought are detrimental to crop growth especially on its early stage of establishment as reported by FGDs participants in Kiyogo village. Besides, a study among the Sukuma in Mwanza and Shinyanga, Tanzania by Meertens *et al*. (1995) found that farmers abandoned use of animal manure in the fields close to homesteads as they were able to migrate to new lands. In this case, the presence of out-migration in the study area could be the reason for low application of animal manure as farmers could afford moving away to new area when soil fertility got low. The establishments of new settlements need to be monitored otherwise the problem of land degradation could spread having a negative impact on peopleôs livelihoods.

Despite efforts made by CONCERN in the study area in mid 1990s to promote improved crop production practices, study results showed that there were no significant increases at $p = 0.156$ in the adoption of draught animal power (Table 15). Only two respondents in the villages that had experienced in-migration reported to use draught animal power, whereas none reported its use in the villages that had experienced out-migration. This come as introduction of animal draught power in the study area was not linked to other aspects of livestock keeping, which among others was limited by the size and scattered nature of the fields. The low uses of mechanization for cultivation, farm transport, and processing have also been

reported in Tanzania by Mpanduji *et al*. (2007). Besides, the study results revealed high use of pesticides though among few surveyed households in the villages that had experienced out-migration. The results were statistically significant at p Ò 0.01 for both villages and gender. FGDs participants attributed the increase in pesticides use to the revival of cashew nut production. The necessity of applying sulphur dusts on the cashew trees to control powdery mildew disease that infest terminal buds, young shoots, flower buds, young fruit and nuts in southern Tanzania was also reported by Ngatunga (2001). The increased uses of pesticides remind us the need for improving farmersô access to support services such as servicing of sprayers.

Also, the study found that few smallholder farmers 10(4.2%) irrigated their field crops, especially those in the Nyangundi irrigation scheme in Lifua village. According to the district socio-economic profile, Lifua had an area about 1,500 hectares potential for irrigation, and the irrigation scheme served only 60(5%) households, who irrigated 279 hectares growing paddy rice (LDC, 2003). The increase in irrigated land away from the river banks had potentials for reducing the invasion of water sources. But, such expansion was limited due to inadequate water supply. Discussions with key informants at Lifua village indicated that for the 2005/06 and 2006/07 growing seasons, water failed to reach the scheme area as flood swept away part of the poorly constructed canal. Lack of water for two seasons was a great loss to farmers since participants in the FGDs reported that incomes from irrigated rice were high next to those obtained from cashew nuts and cattle. Similarly in Malawi, Lwesya and Vedeld (2008) found that adoption of treadle

pump increased farmersô income as irrigation prolonged the effective crop growing period and raised crop yields.

5.3.2 Adoption of improved crop varieties

Another strategy that villagers took to mitigate the impact of reduced crop production due to land degradation in the study area was to adopt new crop varieties. Respondents in the study villages indicated to adopt five new cassava varieties namely, *Sawalepi*, *Gomani*, *Kifuu cha Nazi*, *Goma Stella* and *Leonia* as shown in Table 16. The adoption of new cassava varieties was reported to be statistically significant at p Ò 0.01. Of the 240 respondents, 88(37%) and 77(32%) indicated to had adopted *Gomani* and *Kifuu cha nazi* varieties of cassava, while *Leonia* and *Sawalepi* were mostly adopted in Kiyogo and Lifua, villages.

According to discussions with key informants, of all the new varieties grown, the bitter *Sawalepi* did well in sandy soils provided there was enough moisture. *Sawalepi's* high demand for moisture could be the reason for increasing trend of villagers to encroach water sources and river banks as earlier discussed. The adoption of new cassava varieties has replaced most of the local varieties except the *Kagunila*. Key informants reported that most of the traditional cassava varieties like *Songoro* and *Bandua meno* had vanished with the outbreak of Cassava Mealy Bug. The disappearance of local varieties was also contributed by harsh measures taken by the government through the Ludewa District Council. First, the Council forced farmers in Masasi Division to uproot all growing cassava stocks in their farms. Second, the Council banned cassava growing for three consecutive years, and in the

absence of planting materials production centres the uprooting of cassava denied the farmers with the sources of cassava planting materials.

Table 16: Adoption of new crop varieties by respondents in study villages

Variable	Study villages									
Adoption of new cassava varieties	Kimelembe (n=60)		Kipangala (n=60)		Kiyogo (n=60)		Lifua (n=60)		G2	p-value
	No	Yes	No	Yes	No	Yes	No	Yes		
Gomani	50	10	11	49	53	7	38	22	78.804	0.000**
Goma Stella	51	9	57	3	59	1	57	3	9.643	0.022*
Kifuu cha nazi	57	3	31	29	18	42	57	3	87.54	0.000**
Leonia	60	0	60	0	16	44	60	0	161.633	0.000**
Sawalepi	60	0	59	1	60	0	19	41	143.261	0.000**
Adoption of new maize varieties										
TMV	60	0	48	12	60	0	60	0	37.895	0.000**
Katumani	59	1	44	16	36	24	49	11	27.300	0.000**
Kilima	37	23	60	0	60	0	60	0	76.313	0.000**

* Significant at p Ò0.05 **Significant at p Ò0.01 ns Not Significant

Apart from adoption of new cassava varieties, respondents in the study area indicated to adopt new maize varieties (Table 16), which was statistically significant at p Ò0.01 between the villages. The results showed that the adoption of *Katumani* was wide spread across the study villages, while the adoption of TMV and *Kilima* were common among the respondents in Kipangala and Kimelembe villages, respectively. According to discussions with the Council Management Team, new maize varieties were introduced to suit the agro ecological conditions. DALDO staff confirmed that *Kilima* did well in high altitudes, while TMV in low altitudes as per technical recommendations.

Maize was an important crop in the study area, and it accounted for about one third, 243(31%) acres of the total cultivated area (773 acres cultivated by respondents)

compared to 445 acres (57%) of cassava. The general increase in the share of area occupied by maize was more pronounced in Kimelembe village. In this village, 54(90%) of the respondents interviewed had planted maize in the 2004/05 growing season. The percentage of respondents growing maize in Kimelembe village was higher compared to 38(63%) respondents in Kipangala village, 22(36%) in Lifua, and 11(19%) in Kiyogo. However, in the villages that had experienced out-migration the size of fields under maize as reported by 58(48.3%) respondents was less than the mean (3.2 acres) field size. In contrast, 19(28.4%) out of 67 respondents in the villages that had experienced in-migration reported fields size to range between 3.5 and 15 acres per household.

Furthermore, FGDs participants in the villages that had experienced out-migration attributed the increase of maize in the traditional cassava producing areas to increased use of animal manure. The use of organic manure enabled smallholder farmersô utilization of degraded sandy soils close to homesteads for maize production. In addition, the increase of maize was attributed to shorter time (two to three months) it took to mature compared to cassava, which took more than a year in Kipangala and Lifua villages. A study (Meertens *et al.*, 1995) in Sukumaland showed that the short maturing period of maize allowed it to escape impact of dry spells and drought.

Discussions with key informants in Kipangala and Lifua villages revealed that some farmers preferred maize against cassava due to low labour requirement of the later, especially in making big ridges. Cassava fields in the former water logged wetlands

and swamps required large sized ridges to drain the excessive water. Similarly, the availability of labour has also been reported by Simon (2006) in Tabora to be an important factor for one to increase tobacco cultivation among smallholder farmers. The results implied that the increased importance of maize in the study area demanded support from other institutions to teach smallholder farmers on how to manage the new crop.

5.3.3 Sources of improved crop varieties

Table 17 indicates that the leading source of cassava planting materials for most, 170(99.4%) of the respondents in the study area was neighbouring farmers. This fact was typified by the names given to new cassava varieties such as *Sawalepi* and *Leonia* that had been named after those who introduced them (Table16). At p Ò0.01, neighbouring farmers were also the main sources for adopted maize varieties in the study area. According to the District Council staff, farmers who supplied new maize seeds were those who collaborated with researchers from Agricultural Sector Programme Support (ASPS) in on-farm seed production projects. The importance of knowledge sharing among smallholder farmers as a means of improving and transferring the existing knowledge and technologies has also been reported by Asefa *et al*. (2008) in Ethiopia. Effectiveness of using farmers in extension comes from their high degree of credibility with their peer groups. Unlike the agricultural/livestock extension officers, Conroy (2005) based on ethnoveterinary knowledge in Kenya found that the credibility of farmer extensionist arise from the fact that he/she has actually used the technology, understand their situation, and can speak from the first-hand experience. Consistent with this study, the involvement of

farmers in technology transfer bridge the existing gap between generation of technology by research and its communication by agricultural/livestock extension officers to farmers.

Table 17: Respondents' sources of new cassava and maize varieties

Variable	Distribution of households in the study villages			
Introducer of new cassava varieties	Kimelembe	Kipangala	Kiyogo	Lifua
Extension officer	1(9.1)	0(0)	0(0)	0(0)
Neighbouring farmer	10(90.9)	57(100)	56(100)	47(100)
Introducer of new maize varieties				
Extension officer	5(21.7)	0(0)	7(29.2)	6(50)
Neighbouring farmer	11(47.8)	18(66.7)	10(41.7)	1(8.3)
NGOs	5(21.7)	8(29.6)	7(29.2)	5(41.7)
Pilot Project	2(8.7)	1(3.7)	0(0)	0(0)

Figures in parentheses are percentages and those out of it are frequencies

Unlike the case for cassava, there were more of participants who introduced new maize varieties in the study area (Table 17). The large number of participants who introduced new maize varieties implies that maize production in the study area was given high attention by both decision-makers and donors. Similar support and importance given to grain crops like maize in extension packages was also reported by Mapfumo *et al.* (2001) in Zimbabwe. Despite the increasing number of actors participating in the promotion of improved maize varieties, only three (3.5%) female headed households reported to had accessed agricultural and livestock extension officersô information/services compared to the 15(17.4%) male headed households. This could be due to dominance of male extension officers in the study area. The results correspond to Pangani (2007) findings in Mvomero district, Tanzania where female officers worked much better with female farmers. This happened although male agricultural and livestock extension field officers had relative equal contact

with male and female farmers growing maize. In contrast, NGOs managed to supply improved maize varieties to 13(15.1%) of the female headed households respondents compared to 12(14%) males and no single female headed household was accessed by the pilot projects. These results implied that with weak technology transfer systems the multiplicities of actors do not always guarantee accessibility to all. Also, study results show that there is a need for the current agricultural/livestock extension services to heed the gender balance.

5.3.4 Livestock keeping

Table 18 shows that livestock keeping was common among smallholder farmers in the study area. Over two third, 174(72.5%) of the respondents reported kept pigs at an average of three to five per household. Pigsô keeping was statistically significant at p Ò 0.038. In the study area, pigs were tethered under tree trunks, especially cashew nuts, mangoes and baobab and fed with sweet potato vines, cassava peels, pumpkins, and swills. The increased use of sweet potato roots and tuber crops to feed pigs in absence of maize bran has also been reported by other studies (Kurosaki, 2007; Mhando and Itani, 2007) in Matengo Highlands, Tanzania. Similarly, other studies (Castillo, 1998; Little and Edwards, 2003; Campilan, 2005) in Philippines and Viet Nam report the potential use of sweet potatoes as pig feed. The use of sweet potatoes as feed in central Luzon, Philippines, reduced animal production costs by 30 to 75 percent (Campilan, 2005). A study by Berhanu (2008) in Ethiopia found that smallholder farmers preference of raising of pigs was due to their minimal management risk and disposal compared to cattle. According to discussions with key informants pork was an important source of protein taken more

often next to fish. In addition, piglets were sold soon after weaning and provided income during lean time. In the study area, pigs were important in upgrading of women status as they could keep, own, manage, and control their sales.

Table 18: Types of animals kept by respondents in study villages

Variable	Village						
Type of animals kept	Kimelembe	Kipangala	Kiyogo	Lifua	% of Total	G2	p-value
Cattle	10(16.7)	23(38.3)	28(46.7)	26(43.3)	87(36.3)	14.190	0.003**
Goats	24(40.0)	23(38.3)	26(43.3)	15(25.0)	88(36.7)	5.024	0.170ns
Pigs	42(70.0)	36(60.0)	49(81.7)	47(78.3)	174(72.5)	8.443	0.038*
Chicken	20(33.3)	14(23.3)	18(30.0)	25(41.7)	77(32.1)	4.800	0.187ns
Rabbits	0(0)	0(0)	2(3.3)	0(0)	2(0.8)	6.050	0.109ns

Figures in parentheses are percentages and those out are frequencies, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

Unlike the case of pigs, only 87(36.3%) out of the 240 respondents indicated to keep cattle in which Kiyogo village had 28(46.7%), Lifua had 26(43.3%), Kipangala had 23(38.3%) cattle keepers compared to only 10(16.7%) in Kimelembe village. Cattle keeping among smallholder farmers were statistically significant different at p Ò 0.01 (Table 18). The size of cattle herd per household ranged from three to 40 animals. Key informants indicated that while the number of cattle keepers had increased, the size of herd per household had decreased. More young villagers invested their money acquired from fish and crop sale trade in buying cattle. Similarly, previous studies (Whitehead, 2002; Batterbury and Baro, 2005; Kitalyi *et al.*, 2005) in developing countries have shown the role of livestock in capital accumulation and saving among the resource-poor people such as smallholder farmers.

Table 19 shows that of the 240 respondents, 160(66.7%) indicated that livestock were kept as main source of income, while 64(26.7%) and 58(24.2%) respondents used livestock to cover the costs of farm preparation and as source of food, respectively. Other 42(17%) respondents kept livestock as a source of animal manure. In addition, livestock were used to meet various social obligations and source of income used to build improved house. The results on the role of livestock were statistically significant at p Ò0.05 for all uses except for building of houses (at p = 0.331) and payment of school fees (at p = 0.078).

Table 19: Role of animals to smallholder farmers' livelihoods

Variable	Distribution of respondents by village						
Use of animals	Kimelembe	Kipangala	Kiyogo	Lifua	% of Total	ç2	p-value
Source of food	20(33.3)	16(26.7)	6(10)	16(26.7)	58(24.2)	9.731	0.021*
Building house	0(0)	2(3.3)	1(1.7)	3(5)	6(2.5)	3.419	0.331ns
Social obligations	20(33.3)	5(8.3)	0(0)	11(18.3)	36(15)	29.020	0.000**
School fees	3(5)	0(0)	1(1.7)	5(8.3)	9(3.8)	6.811	0.078ns
Foot costs of farm preparation	7(11.7)	20(33.3)	3(5)	34(56.7)	64(26.7)	50.284	0.000**
Source of income	27(45)	46(76.7)	54(90)	33(55)	160(66.7)	33.750	0.000**
Source of manure	6(10)	19(31.7)	3(5)	14(23.3)	42(17.5)	18.586	0.000**

Figures in parentheses are percentages and those out are frequencies, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

The household survey results in Table 19 correspond to FGDs ranking of major sources of income in Kipangala and Kiyogo village. In both villages, income from sale of livestock was ranked first by the FGDs participants. The income from livestock was followed by that of local beer brewing and casual labour for Kipangala and Kiyogo village, respectively. Livestock keeping was the most viable land use in Kiyogo village as they could browse on shrubs found in shallow soils and rock outcrops. The importance of livestock as a source of income for Kipangala village

was attributed to termination of tobacco growing, abandonment of cashew nuts fields, and limited area for irrigated rice which were the main cash crops in the study area with exception of Kimelembe village which largely depended on maize. The use of animal manure by smallholder farmers in the villages that had experienced out-migration created an opportunity for integration of crop production and livestock keeping. The low application of animal manure in the villages that had experienced in-migration especially Kimelembe village, come as farmers could afford establish new fields in other area when soil fertility got low. While in Kiyogo village alluvial soils brought by floods had high level of nutrients and reduced need for animal manure.

Despite the importance of livestock and existence of Heifer in-Trust-Scheme for dairy cattle project in the district, which was part of the Southern Highlands Dairy Development Project (SHDDP), village government members in the study area reported none existence of livestock improvement programmes in the study area. The study area lacked even the vital veterinary facilities like dips. Ulotu (1997) findings in central Tanzania found that non-functioning of dips were behind loss of cattle. Availability of dip services has potential to reduce cattle mortality from incidence of ticks and tick-borne diseases among agro-pastoralists. In Zimbabwe, Mudimu (1999) reported that lack of local livestock improvement programmes due to attention given to exotic breeds hindered pasture improvement that could support off-season feeding systems.

5.3.5 Cropping systems

To overcome the decline in yields as a result of reduced soil fertility in the study areas, smallholder farmers used different cropping systems, most, 182(75.8%) of the respondents reported to practice intercropping and 79(32.9%) practiced monoculture. The results show that at p = 0.76 and p = 0.89, there were no statistical significant differences in number of smallholder farmers practicing intercropping and monoculture, respectively, in the study area. Table 20 provides the reasons for intercropping given by FGDs participants in Lifua and Kimelembe villages.

Table 20: FGDs' reasons for intercropping and monoculture by age group and gender at Lifua and Kimelembe villages

Variable	Participants above 40 years		Participants below 40 years		
	Male	Female	Male	Female	Total score
Reasons for intercropping	Participants scores at Lifua village				
Shortage of labour	17	25	15	30	87
Land shortage	18	23	25	19	85
Traditional methods of cropping	24	16	18	25	83
Timing of early rain for planting	16	10	16	13	55
Improve soil fertility	16	15	20	10	61
Need for diverse crops	14	19	11	8	52
Reasons for intercropping	Participants scores at Kimelembe village				
Timing of early rain for planting	25	24	23	23	95
Land shortages	15	18	20	22	75
Need for diverse crops	18	16	15	15	64
Lack of enough seeds for preferred crop	15	15	11	10	51
Prevent spread of pests	5	8	6	5	24
Reasons for monoculture	Participants scores at Kimelembe village				
Good crop growth	24	24	20	21	89
More yield	19	21	24	22	86
Simplify weeding	15	14	16	17	62
Simplify harvesting	8	11	10	10	39
Soil type	8	5	5	5	23

The reasons for intercropping in Lifua and Kimelembe villages given by FGDs participants were shortage of land and labour, being accustomed to the cropping systems, need to improve soil fertility, need to diversify crops, control crop pests, and to ensure proper use the first rains (Table 20). Another reason given by smallholder farmers for intercropping was to avoid total crop failure and maximise use of first rains. Tengö and Belfrage (2004) in Mbulu highlands of Tanzania reported that use of first rains was one of the local management practices essential in spreading the drought risk and dealing with unreliable onset of rainfall. Besides, the study found that sequential cropping was statistically significant at p Ò0.01 between villages. In Kiyogo village, 16(6.7%) of the respondents practiced sequential cropping along the Ruhuhu floodplain. In areas of acute shortages of arable land (more than 50% of land in Kiyogo village is rocky outcrops), sequential cropping maximized crop harvested per unit area of land. Excess moisture stored in Ruhuhu floodplains enabling maize and sweet potatoes to be planted and harvested more than once per year in Kiyogo village. The first crop was planted during the normal rain season in December whereas the second cropping was carried out in June when flood threats from Ruhuhu River were over. Emerging double cropping was also observed in Lifua village. In Lifua village, sweet potatoes were planted after rice harvest which allowed utilization of limited moisture in the wetlands. In this case, marginal lands especially wetlands in the villages that had experienced out-migration need to be protected to avoid further degradation and collapse of farmersô livelihoods.

The conserved marginal lands such as upland springs could increase area under sequential cropping and enhance food security in the study area as demonstrated by reduction in number of food insecure households in the villages that had experienced in-migration (Appendix 6). The results in Appendix 6 show that only the need to purchase cassava more often was at p Ò0.01 statistically significant indicator of the eleven items used to assess farmerôs perception on food insecurity. The study found that 75(62.5%) of the respondents in the villages that had experienced out-migration indicated that they always needed to purchase cassava. In contrast, over half, 71(61.7%) of the respondents in the villages that had experienced in-migration never purchased cassava. The importance of need to purchase cassava as the right indicator of food insecurity comes from the fact that cassava was a staple food in the study area. Cassava was purchased either in kind or in cash. For the villages that often purchased cassava, 9(7.5%) of her respondents were also reported obliged to eat leafy vegetables more often compared to 4(2.3%) respondents in the villages that had experienced in-migration (Appendix 6).

Further logistic regression analysis of factors that influenced farmers need to purchase cassava is given in Table 21. The results show that need to purchase cassava increased with being single (MARITALT with coefficient of 0.801), keeping cattle (CATTLET with coefficient of 0.389), renting land (HOWNEWT with coefficient of 0.067), increased household size (FSIZET with coefficient of 0.503), increase in number of fields (FARMST with coefficient of 2.048), and being in the villages that had experienced out-migration (VITYPET with coefficient of 0.198). The results suggest that single respondents who mostly were youth are less

likely to own land and those with larger number of fields produced less but with more people to feed, while land renting implied being landless hence more likely to depend on purchased cassava.

Table 21: Logistic regression model for factors influencing purchase of cassava

Variable	Coefficients	Standard error	Wald	Exp(b)	df	p-value
Age	-0.898	0.596	2.272	0.407	1	0.132ns
Marital	0.801	0.646	1.540	2.228	1	0.215ns
Cattle	0.389	0.407	0.911	1.475	1	0.340ns
Number of fields	2.048	0.564	13.167	7.753	1	0.000**
Fish	-0.818	0.412	3.936	0.441	1	0.047*
Brewing	-0.493	0.343	2.064	0.611	1	0.151ns
Causal labour	0.647	0.390	2.761	1.911	1	0.097ns
Land tenure	0.067	0.051	1.745	1.069	1	0.187ns
Total field size	-1.866	0.424	19.372	0.155	1	0.000**
Village type	0.198	0.358	0.305	1.219	1	0.581ns
Household size	0.503	0.329	2.342	1.654	1	0.126ns
Level of education	-0.553	0.805	0.472	0.575	1	0.492ns
Income level	-0.181	0.560	0.105	0.834	1	0.746ns
Gender	-0.069	1.038	0.004	0.933	1	0.947ns
Constant	2.254	3.459	0.424	9.521	1	0.515ns
I -2LL = 332.694 F -2LL = 244.226		Model Chi-Square = 88.468** Nagelkerke R Square = 0.411			Overall percentage 50.4 and 72.9 for I and F, respectively	

I for Initial, F for Final* significant at p Ò0.05** significant at p Ò0.01ns

In contrast, need to purchase cassava decreased with household engagement in fish selling (FISHT with coefficient of -0.818) and local beer brewing (BREWT with coefficient of -0.493), increase in total cultivated land (TOFSIZET with coefficient of -1.866), being female (GENDERT with coefficient of -0.069), increase in income (INCATT with coefficient of -0.181), age (AGET with coefficient of -0.898) and education (EDUCT with coefficient of -0.553). Of all 14 predictors, number of fields, total cultivated area, and fish selling were statistically significant at p = 0.000,

0.000, and 0.047, respectively. The positive relation between number of fields and food insecurity come from the fact that increase in number of fields was associated with decline in soil fertility and crop yields. In contrast, the increase in total cultivated area compensated the decline in crop yields, hence, leading to more food secure households. Similarly, discussions with key informants showed that exchange of cassava with fish enabled household engaged in fish selling to access food all the time.

The increasing food insecurity in the villages that had experienced out-migration is in agreement with early observations that the decline in soil fertility was high in those villages. The decline in soil fertility is supported by low crop yields as shown in figure 11 and 12.

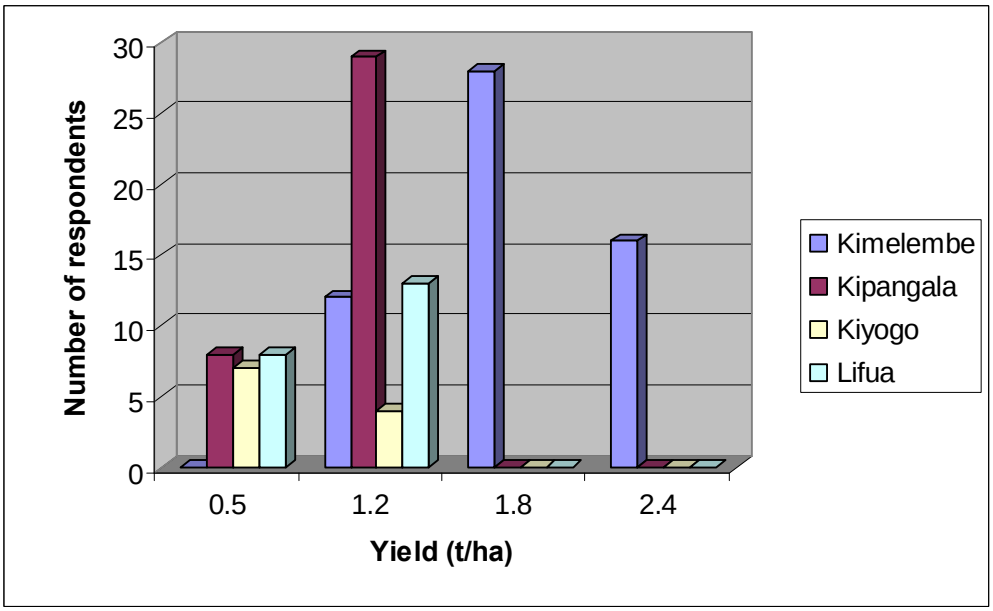

Figure 11: Mean maize yield in study villages of Ludewa District

The results in Figure 11 show that high maize yields were recorded in new established village of Kimelembe. Similarly, records of cassava yields in the study area (Fig. 12) indicate that majority of respondents in the villages that had experienced out-migration (Lifua, Kipangala) attained yields of less than 5 t/ha. The results are consistent to Shisanya (2005) findings in Kenya who argue that soil fertility depletion is a root cause of persistent food insecurity in East Africa.

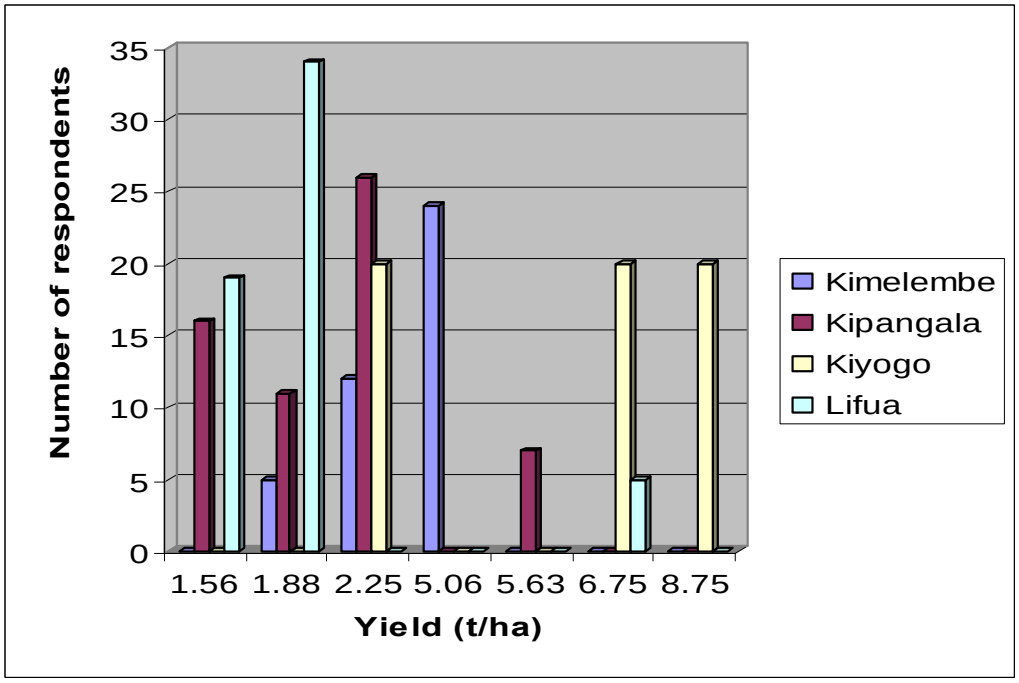

Figure 12: Mean cassava yield in study villages of Ludewa District

The reported low crop yields and increasing food insecurity is also reflected by change of food storage structures as reported by key informants. In the study area, it was observed that the traditional cribs located outside the main house were replaced by in-roof and improved cribs located in the main houses. The increased crop theft and change in storage structures was also reported in other parts of Tanzania (CDTF,

1991). The problem of food insecurity in the study area was also attributed to absence of local markets apart from Sunday gatherings and monthly auctions commonly known as *lembuka* carried out in the ward centres.

5.3.6 Increase in number and size of fields

Apart from adopting different cropping systems, farmers increased the number of fields owned by a household as an important compensatory strategy to overcome the loss in productivity due to land degradation. Table 22 presents the number of fields that respondents owned in the study area. The number of fields ranged from one to eight per household.

Table 22: Number and size of fields cultivated per household in 2004/05 growing season

Variable	Distribution of households across villages			
Number of fields per household	Kimelembe (n=60)	Kipangala (n=60)	Kiyogo (n=60)	Lifua (n=60)
1-3	49(81.7)	8(13.3)	17(28.4)	10(16.7)
4-6	11(18.3)	49(81.7)	41(68.3)	49(81.7)
7+	0(0)	3(5.0)	2(3.3)	1(1.7)
Field size (acres) per household				
Below 1.75	2 (3.3)	18(29.9)	23(38.3)	24(40.1)
1.76 ï 3.00	15(25)	22(36.7)	22(36.7)	25(41.6)
3.25 ï 3.75	8(13.3)	4(6.7)	2(3.3)	5(8.3)
3.76 ï 6.50	23(38.3)	16(26.7)	13(21.7)	5(8.3)
6.51 ï 11.00	9(15.1)	0(0)	0(0)	1(1.7)
11.01 ï 15.00	3(5)	0(0)	0(0)	0(0)

Figures in parentheses are percentages and those out of it are frequencies

Of all the respondents, most, 49(82%) respondents in Lifua and Kipangala, and 41(68%) respondents in Kiyogo villages indicated to had owned four to six farms. In contrast, 49(82%) of the respondents in Kimelembe village owned only one to three

fields. The results show that the number of fields owned by households between the villages that had experienced in-migration and out-migration and from one village to another were statistically significant different at p Ò 0.01. The poor soil fertility status in the villages that had experienced out-migration, the large land size required to grow a particular crop. Consistent to results in this study, Simon (2006) study in Tabora, Tanzania found that the amount of land required by a household depended on the type of crops to be grown and the differences in land quality.

Apart from the type of crops to be grown and the differences in land quality, FGDs participants revealed that the increase in number of fields was associated with land tenure. Inheritance as discussed in section 4.3 was the dominant way of getting land in Kiyogo, Kipangala, and Lifua, whereas allocations by village government prevailed in Kimelembe. In the former case, increase in number of fields was promoted by inheritance as clan land was subdivided into smaller pieces of land to family members. The role of inheritance in land fragmentation in Africa has also been reported by Boesen and Rukuni (2000). On the other hand, land allocations by village governments tended to consolidate land holdings as shown by limited number of fields in Kimelembe village, hence a start of proper land management.

Apart from nature of land tenure, smallholder farmers increased the number of fields in order to cope with growth in the family size as reported by 18(50%) respondents in Kiyogo, 22(46.8%) in Kipangala and 21(38.2%) respondents in Kimelembe villages. Other reasons for increase the number of fields, though also not statistically significant (at p = 0.170) were the need for money, food, and to rest the fields.

Besides, the need to own a personal land independent of clan land, avoid land encroachment by other farmers, and effective use of personal land were of little importance for a householdôs decisions to increase the number of fields in the study area. The results suggest that decline in soil fertility increased demand for additional land to meet subsistence needs among smallholder farmers in the study area.

In addition to variation in the number of fields owned by a household, the size of fields cultivated in the study area varied from 0.5 acre to 15 acres per household with a mean of 3.2 acres (Table 22). The sizes of cultivated fields in the study villages were statistically significant at p Ò 0.01 among smallholder farmers. On average, 40(67.7%) of the respondents in Kipangala, 49(81.7%) in Lifua, and 45(75%) in Kiyogo villages reported fields cultivated to be less than mean size of 3.2 acres. On the other hand, of all the respondents, 43(72%) respondents in Kimelembe reported to had fields larger than the mean size of 3.2 acres. Further analysis of the results revealed that the total cultivated land tended to decrease with the increase in the number of fields per household (Table 22). These findings confirm the fact that land fragmentation increased with the increase in land degradation. Following land degradation, there was increase in field abandonment as shown by increase in bushland with scattered cropping discussed in section 4.2. Unfortunately, majority of the respondents, 119(99.2%) in the villages that had experienced out-migration had no access to fields abandoned by the emigrating farmers. In most cases, the relatives left behind by the emigrating farmers took over ownership of the abandoned fields. Hamilton (1998) study in Southern Queensland, Australia found that the potential of natural fallow to replenish soil fertility of

abandoned fields is limited. Experiences in other countries (Meertens *et al*., 1995; Anthofer, 2000; Gachene and Kimaru, 2003) show that cultivation of cover crops such as velvet and lablab beans could help restore soil fertility of abandoned fields, suppress weeds, and increase yields. Gachene and Kimaru (2003) found that nutrient content of velvet and lablab beans are higher than that of animal manure as velvet and lablab beans could release 3.56% and 4.02% of N, while cow and goat manure give 0.4-0.8% and 1.4% of N, respectively.

Apart from the fact that majority of the respondents in the villages that had experienced out-migration had small cultivated fields (less than 3.2 acres), the study shows that there was relative limited field expansion during the study period (Table 23). Out of eleven crops commonly grown in the study area, respondents reported that expansion of cropped area for maize, cassava and beans at p Ò 0.01 were statistically significant (Table 23). As these crops were the main staple food crops, the results implied that crop production in the study area was mainly for subsistence. The infancy of commercialization in remote area is also shown by the insignificance of area grown with rice (at p = 0.390), finger millet (at p = 0.107), potatoes (at p = 0.569), groundnuts (at p = 0.161), sesame (at p = 0.105), vegetables (at p = 0.294), cashew nuts (at p = 0.555) and sunflower (at p = 0.294). In line with agricultural commercialization, study on maize marketing in Ludewa District by Kilima *et al*. (2000) found that there was lack of supportive institutions to market farmers produces, especially in remote villages. In addition, discussions with Council Management Team revealed that the District Council is about to introduce a compulsory minimum size of two acres cashew nuts fields for all residents aged

above 18 years old in Masasi Division. The campaign to revive cashew nuts production is one of the measures to improve income of smallholder farmers following termination of tobacco cultivation in Masasi Division. The revival of cashew nut production has potential to increase both number and size of fields owned by a household in the study area in a near future.

Table 23: Expansion of cropped area in the study villages by crops

Variable	Study village						
Type of crop	Kimelembe (n=60)	Kipangala (n=60)	Kiyogo (n=60)	Lifua (n=60)	% of Total	G2	p-value
Maize	36(60)	10(16.7)	5(8.3)	12(20)	63(26.3)	49.39	0.000**
Rice	0(0)	0(0)	0(0)	1(1.7)	1(0.4)	3.013	0.390ns
Finger millet	3(5)	6(10)	0(0)	4(6.7)	13(5.4)	6.100	0.107ns
Cassava	22(36.7)	35(58.3)	31(51.7)	17(28.3)	105(43.8)	13.731	0.003**
Potatoes	1(1.7)	0(0)	1(1.7)	0(0)	2(0.8)	2.017	0.569ns
Groundnuts	0(0)	2(3.3)	1(1.7)	4(6.7)	7(2.9)	5.150	0.161ns
Sesame	0(0)	0(0)	0(0)	2(3.3)	2(0.8)	6.050	0.105ns
Vegetables	2(3.3)	1(1.7)	0(0)	0(0)	3(1.3)	3.713	0.294ns
Beans	10(16.7)	1(1.7)	0(0)	0(0)	11(4.6)	26.963	0.000**
Cashew nuts	1(1.7)	2(3.3)	4(6.7)	3(5)	10(4.2)	2.087	0.555ns
Sunflower	2(3.3)	0(0)	0(0)	1(1.7)	3(1.3)	3.713	0.294ns

Figures in parentheses are percentages and those out of it are frequencies, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

5.3.7 Change in place of residence among respondents

Table 24 shows change in the place of residence among respondents and most migrated from one area to another in all the villages. In the villages that had experienced out-migration, it was reported that villagers shifted their residences from one area to another either within a sub-village or between sub-villages. Key informants reported that the movements within the sub-villages were mainly carried out by young couples who wanted to establish new homes far away from their parents, as a sign of maturity and to be independent. Besides, the shift between sub-

villages was mainly prompted by the need to be closer to others and/or near to social services such as schools and dispensaries. Unlike the villages that had experienced out-migration, no shift within and between the sub-villages was reported in the villages that had experienced in-migration. The results show that there were statistically significant differences at p Ò 0.01 in trends of migration. Consistently, Azevedo-Ramos (2008) found that in the past 30 years, there was deforestation of about 60 million hectares in Amazon forest in Brazil as a result change in location of settlements and agricultural activities following development of transport infrastructure. The findings suggest that changes in place of residence in rural context implied more land clearance, hence increased runoff and erosion. The two processes are the main agents of soil fertility depletion that engender further land degradation.

Table 24: Respondents change in place of residence and duration at the current villages

Variable	Distribution of respondents					
Place of residence before the current one	Kimelembe (n=60)	Kipangala (n=60)	Kiyogo (n=60)	Lifua (n=60)	% of Total	c2, p-value 188.626, 0.000**
Another area in the sub-village	0(0)	8(13.3)	0(0)	34(56.7)	42(17.5)	
Another sub-village in the village	0(0)	15(25)	0(0)	7(11.7)	22(9.2)	
Neighbour village	55(91.7)	19(31.7)	60(100)	7(11.7)	141(58.8)	
Village in another District	4(6.7)	3(5)	0(0)	2(3.3)	9(3.8)	
Town	1(1.7)	15(25)	0(0)	10(16.7)	26(10.8)	
Duration of stay in current villages (years)						37.315, 0.000**
1 - 4	1(1.7)	8(13.3)	4(6.7)	3(5)	16(6.7)	
5 - 10	17(28.3)	10(16.7)	14(23.3)	8(13.3)	49(20.4)	
11 - 15	20(33.3)	7(11.7)	8(13.3)	10(16.7)	45(18.8)	
16 - 19	10(16.7)	4(6.7)	5(8.3)	3(5)	22(9.2)	
20+	12(20)	31(51.7)	29(48.3)	36(60)	108(45)	

Figures in parentheses are percentages and those out of it are frequencies, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

Apart from changing place of residence within the sub-village, the depletion of soil fertility also appeared to trigger massive migration to distant places from the village centres. This was typified by the creation of new sub-villages about eight to 12 kilometres away from the village centres in both Lifua (Liumba, Liughai sub-villages) and in Kipangala village (Maramba sub-village). This was mainly in search for suitable land for crop farming. In 2006, Liughai sub-village was a full registered village, while Liumba was still a sub-village of Lifua. Results in Table 23 indicate that almost all respondents in Kiyogo village and most, 55(92%) in Kimelembe village reported to had migrated from neighbouring villages, either within or from outside the district. The distances of origin varied from less than ten kilometres (from Nkomangôombe Ward) to more 30 kilometres (Luilo, Masasi Wards) and as far away as 70 kilometres.

In the study area, the change in the places of residences and increased out-migration was more pronounced in mid 1990s. There was statistically significant increase in out-migration at p Ò 0.01 in mid 1990s as shown by the duration that respondents had continuously stayed at their current villages (Table 24). Over half of the respondents, 39(65%) and 35(58%) in Lifua and Kipangala villages, respectively, indicated to had stayed at their current residence for more than 16 years, that is, they had been in the area prior to 1990. Discussions with village council members in Lifua reported that Mapogoro sub-village was greatly affected by massive out-migration in mid 1990s forcing one of its hamlets, Lifua Juu to be abandoned. The findings are statistically significant (at $p < 0.05$) and are consistent with those reported by CONCERN (2000) that out-migration was high in mid 1990s.

In contrast, 38(63%) and 26(43%) of the respondents, in Kimelembe and Kiyogo villages, respectively, reported to had been in their villages for a period of less than 16 years. The results implied that majority of the villages that had experienced in-migration were established after the 1990s. The timing of the villagers influx in the villages that had experience in-migration corresponded well to the decrease in closed woodland cover type in the study area (see Tables 1, 2). Similarly, Kahurananga (1999) found great association between increased deforestation and length of stay as more settlements and agriculture were established along the Babati-Dodoma road in 1960 to 1970. However, this study shows that the trend of out-migration in the study area in the 2000s was on decline. This was confirmed by number of respondents, 85(70.8%) of the 120 respondents in the villages that had experience out-migration who reported to had not known neighbours who migrated in the past five years (from 2000) as against 35(29.2%) respondents who knew the out-migrated neighbours in the same period.

The reasons for migration given by respondents varied from one village to another (Table 25). Of the 120 respondents, 64(53.3%) asserted that they migrated to other villages (Kimelembe, Kiyogo) in order to repossess clan land left behind during the villagization programme of mid 1970s. Moreover, the need to occupy clan land and find better farm land accounted for more than 80 percent of all the migrations in the study area (Table 18). The presence of fertile land in the villages, which had experienced in-migration as mentioned by 29(24%) of the respondents was a pull factor to establish new settlements. Whereas degradation of land in the villages that experienced out-migration was a push factor for the people to leave the old

settlements (Figure 7). The establishment of new sub-villages in the villages that had experienced out-migration, such as Liumba sub-village in Lifua and Maramba sub-village in Kipangala village, which were eight to 14 kilometres away from the villagesô centres, respectively, explained the importance of presence of fertile land for villagersôlivelihoods improvements. Similarly, Narayan (1997) study in southern highlands of Tanzania reported that search for good arable land was the main reason for rural migration. Besides, Mungôongôo and Mwamfupe (2003) found that migration was not limited to search of arable land, but existed even among the pastoralist Maasai who migrated into southern and coastal regions of Tanzania in search of grazing lands.

Table 25: Respondents reasons to migrate in Kimelembe and Kiyogo village

Variable	Distribution of respondents by village and gender				
Reasons for shifting to the current settlements	Kimelembe (n=60)	Kiyogo (n=60)	Male (n=72)	Female (n=48)	% of Total
Invited by relatives/friends	9(15)	4(6.7)	5(6.9)	8(16.7)	13(10.8)
Occupy clan land	11(18.3)	53(88.3)	44(61.1)	20(41.7)	64(53.3)
Moved by government	7(11.7)	0(0)	4(5.6)	3(6.3)	7(5.8)
Find better land	29(48.3)	0(0)	18(25)	11(22.9)	29(24.2)
Marriage/divorce	1(1.7)	3(5)	0(0)	4(8.3)	4(3.3)
Leave space for mining	1(1.7)	0(0)	0(0)	1(2.1)	1(0.8)
Retired	1(1.7)	0(0)	0(0)	1(2.1)	1(0.8)
Start new business	1(1.7)	1(1.7)	1(1.4)	0(0)	1(0.8)

Figures in parentheses are percentages and those out of it are frequencies, G2=69.486, p-value = 0.000**,

**Significant at p Ò0.01

Attempts to explore future trends of migration showed that 38(31.7%) of the 120 respondents in the villages that had experienced out-migration mentioned that they were ready to shift their current residences if fertile land in other villages was available and accessible. However, reluctance to migrate was observed among older villagers and widows and the reasons given included old age, being used to the

areas, and lack of knowledge about the new locations. Similar reluctance to migrate among old people was reported in Zimbabwe by Chaumba *et al*. (2003) where informal established settlements were dominated by young men who invaded state land and white-owned commercial farmlands. Further, FGDs with all age groups revealed that the majority of the emigrants in their villages came from families with limited land. In the villages that had experienced out-migration, lack of access to wetlands and valley bottoms, was enough reason for a person to migrate. With the perceived declining soil fertility reported by smallholder farmers (Fig. 7), wetlands and valley bottoms were the major lands used for crop production as fields in upland continued to be degraded. Importance of wetlands and valley bottoms for agriculture and livelihoods improvements has also been reported in other studies in Njombe District in Iringa region (Lema, 1996), and in eroded villages in the Irangi Hills, in central Tanzania (Kangalawe *et al*., 2001). Also, the findings of this study are in agreement with Glantz (1994) who argued that use of marginal lands was an option available to those reluctant to migrate.

5.3.8 Participation in off-farm activities

Table 26 shows wide range of off-farm activities carried out by smallholder farmers in response to land degradation. The results show that off-farm activities carried out by smallholder farmers varied from one village to another. For instance, pit-sawing was dominant in Kimelembe village, which was close to *miombo* woodlands. Kimelembe at p Ò 0.01 had statistically significant more respondents who participated in pit-sawing than any other village. Even though the proportional of respondents who engage in pit-sawing looked small, the activity stimulated further

encroachment of woodland in distant areas for agriculture and settlements. In this case, given low capacity of local governments to monitor misuse of natural resources encroachment are likely to continue. Gender of the household heads significantly (at p Ò0.05) differentiated forms of off-farm activities that smallholder farmers did (Table 26). Cross tabulation results show that more women were engaged in mat/basket making (43 respondents) and grass thatching (23 respondents) than 36 and 15 male respondents engaged in mat/basket making and grass thatching, respectively. On the other hand, 52(36.1%) male headed households dominated in number of households engaged in casual labour, 12(8.3%) in brick making and nine (6.3%) in carpentry (Table 26).

Table 26: Respondents engaging in off-farm activities by type of village and gender

Variable	Type of village (n = 240)				Gender (n = 240)			
	In-migration	Out-migration	ɢ2	p-value	Male	Female	ɢ2	p-value
Fish selling/fishing	34	26	21.422	0.233ns	40	20	21.481	0.224ns
Local beer brewing	47	51	0.276	0.599ns	55	43	1.038	0.308ns
Mill machine	0	2	2.017	0.156ns	1	1	0.084	0.772ns
Tailor	5	4	0.115	0.734ns	6	3	0.173	0.677ns
Mat/basket making	42	37	0.472	0.492ns	36	43	10.218	0.001**
Stall	4	2	0.684	0.408ns	3	3	0.256	0.613ns
Carpentry	8	3	2.382	0.123ns	9	2	2.287	0.130ns
Masonry	9	5	1.214	0.271ns	13	1	6.688	0.010**
Brick making	10	4	2.731	0.098ns	12	2	4.096	0.043*
Crop/animal sale	49	58	1.366	0.242ns	66	41	0.228	0.633ns
Mining	1	3	1.017	0.313ns	4	0	2.712	0.100ns
Shop	1	3	1.017	0.313ns	4	0	2.712	0.100ns
Casual labour	41	33	1.250	0.263ns	52	22	4.702	0.030*
Pit-sawing	9	1	6.678	0.010**	7	3	0.435	0.510ns
Grass thatching	23	15	2.001	0.157ns	15	23	7.926	0.005**

Figures in parentheses are percentages and those out of it are frequencies * Significant at p Ò 0.05

,**Significant at p Ò0.01 ns Not Significant

FGDs suggested that women involvement in mat/basket making and grass thatching was attributed by low investment costs, that is, use of simple cutting tools, and required limited skills. Besides, mat making and thatching among female headed households was promoted by availability of raw materials in the outskirt of the villages and local market for the products. Gender differences were also observed in ranking of the five leading off-farm activities in the study area. Women ranked high local beer brewing, trade in crop/livestock, and mat/basket making whereas mat making was least ranked by male headed households (Table 27). The results implied that access to resources and division of labour was gender biased and perpetuated the existing stereotypes.

Table 27: Five leading off-farm activities in study area by gender and type of village

Variable	Distribution of respondents				
Five leading off-farm activities	Male (n=96)	Female (n=78)	In-migration (n=85)	Out-migration (n=92)	% of Total
Local beer brewing	27(21.4)	34(39.5)	22(21.0)	39(36.4)	61(28.8)
Trade in Crop/animals	23(18.3)	17(19.8)	29(27.6)	11(10.3)	40(18.9)
Fish selling/fishing	23(18.3)	10(11.6)	14(13.3)	19(17.8)	33(15.6)
Casual labour	20(15.9)	6(7.0)	12(11.4)	14(13.1)	26(12.3)
Mat/basket making	6(4.8)	11(12.8)	8(7.6)	9(8.4)	17(8.0)
Resources for off-farm activities	Male (n=126)	Female (n=86)	In-migration (n=105)	Out-migration (n=107)	% of Total
Sale of crops	9(7.1)	3(3.5)	10(9.5)	2(1.9)	12(5.7)
Training	16(12.7)	2(2.3)	16(15.2)	2(1.9)	18(8.5)
Ample raw materials	15(11.9)	21(24.4)	22(21)	14(13.1)	36(17.0)
Good health	40(31.7)	22(25.6)	17(16.2)	45(42.)	62(29.2)
Surplus yield	45(35.7)	36(41.9)	38(36.2)	43(40.2)	81(38.2)
Pension	1(0.8)	0(0)	0(0)	1(0.9)	1(0.5)
Loan	0(0)	2(2.3)	2(1.9)	0(0)	2(0.9)
Share of total income	Kimelembe	Kipangala	Kiyogo	Lifua	% of Total
Income from fish selling	4.5	14.3	10.0	9.1	5.31
Income from local beer	3.1	4.8	5.6	3.3	5.61

Figures in parentheses are percentages and those out of it are frequencies

Furthermore, the results (Table 27) show that there was an increase in activities that had local markets and required local raw materials. Similarly, FGDs with all age groups revealed that local beer brewing was one of the off-farm activities common for most of the women and was mostly done during the dry season. Tellegen (1997) reported the importance of beer brewing in enhancing women economic well-being in Malawi. In addition to availability of local raw materials and markets, the engagement in off-farm activities also depended on good health, good yields, loans, knowledge and skills in various activities such as weaving.

The chi-square (G^2) analysis of the results (Table 27) showed that engagement in beer brewing was not statistically significant at $p = 0.308$. Despite large number of participants, local beer-brewing contribution to the total income was meagre (5.6%). The mean income from local beer brewing was Tshs. 73 020 per year. More women engaged in beer brewing due to low entry capital requirements, which made it a competitive business as most participants competed for few customers hence reducing the profits (Bryceson, 2000). This was in agreement with findings in other studies (Ponte, 2002, Runyoro, 2007) in Tanzania, which found that increasing involvement in off-farm activities for people in remote areas had not necessarily led to increased level of income.

Table 28 gives respondents views on the status of income from year 2000 to 2005. Of all the respondents, most, 114(95%) of those in the villages that had experienced in-migration reported improvement in level of income from year 2000 compared to only 67(27.9%) of those from the villages that had experienced out-migration. The

results show that level of incomes among farmers was statistically significant different at p Ò 0.047 and p Ò 0.000 in relation to number of fields and type of village, respectively.

Table 28: Farmers' views on the level of income in the study areas from 2000 to 2005

Variable	Status of income		¢2	p-value
	Not improved	Improved		
Gender			0.539	0.463ns
Male	33(13.8)	111(46.3)		
Female	26(10.8)	70(29.2)		
Household size			12.06	0.441ns
1-4	29(12.2)	73(30.4)		
5-9	26(10)	100(41.7)		
10+	4(1.7)	8(5.0)		
Number of fields			14.223	0.047*
1-3	13(5.5)	71(29.6)		
4-6	43(17.9)	107(44.6)		
7+	3(1.2)	3(1.2)		
Number of dependants			6.770	0.817ns
0-4	49(20.4)	143(59.6)		
5-8	8(3.3)	36(15)		
9-12	2(0.8)	2(0.8)		
Age category			1.033	0.310ns
40 years and above	43(17.9)	119(49.6)		
Below 40 years	16(6.7)	62(25.8)		
Education			5.573	0.233ns
0-4	22(9.2)	79(33)		
5-8	31(12.9)	94(39.2)		
9+	6(2.5)	8(3.3)		
Type of village			49.645	0.000**
In-migration	6(2.5)	114(47.5)		
Out-migration	53(22.1)	67(27.9)		

Figures in parentheses are percentages and those out of it are frequencies, * Significant at p Ò0.05, **Significant at p Ò0.01, ns Not Significant

The results suggest that respondents in newly established villages had more opportunities of generating incomes than those in the villages that had experienced out-migration. Consistently, resettlements in Zimbabwe offered opportunities for young men, widows and divorcees to escape landlessness and start a new income generating opportunities (Chaumba *et al*., 2003). The perceived high soil fertility

status in the new established fields (Fig. 7) led to surplus farm produces, which could be behind improved incomes among the respondents in the villages that had experienced in-migration. Besides, increased number of fields up to six was optimal for a household to increase its incomes as beyond that field management proved difficulty (Table 22). In Kimelembe village, more 49(81.7%) respondents had field less than four where as for the rest study villages, respondents had more than four fields (Table 22). This meant that only 22 of the 180 respondents in Kipangala, Kiyogo, and Lifua village had less than four fields (Table 28). The increase in number of fields in the villages that had experienced out-migration was associated with deterioration of soil fertility.

But, as indicated in Table 22, fields in those villages were located in marginal lands, of small size, and scattered which could not generate enough produce to suffice their income needs. Furthermore, role played by differences in type of village in improving income levels of farmers made gender (at $p = 0.463$), household size (at $p = 0.441$), number of dependents (at $p = 0.817$), age category (at $p = 0.310$), and education at $p = 0.233$ (Table 28) to be statistically not significant. The insignificance of household size and number of dependents come from the fact that increase in the number of dependents (637 of the 1,233 members in 240 surveyed households) could not contribute to family labour, but consumed what was produced as most of them were at tender age and/or in school.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Overview

This chapter presents conclusion, contribution of the study and recommendations based on main findings of this study. The overall objective of this study was to investigate the changes in livelihoods among smallholder farmers as a result of land degradation in Ludewa District. More specifically the study was undertaken (i) to assess changes in land resources in terms of land use/cover, soil fertility status, and water level (ii) to identify and examine potential of policies in reducing land degradation, (iii) to examine institutionsô effectiveness in reducing land degradation, (iv) to explore the changes in livelihood strategies among smallholder farmers (v) to determine socio-economic factors that influence smallholder farmers livelihoods in selected village in Ludewa District.

6.2 Conclusion

6.2.1 Changes in land due to its degradation

The study findings have shown that land degradation manifest itself in various forms of change in land. The major changes in land that have direct impacts in livelihoods of smallholder farmers considered in this study were change in land use/cover, soil fertility loss, and decline in water level. Based on evidences from satellite images, it was found that between 1979 and 2002 the area covered by bushed grassland and open woodland in the study area dropped from 8 987 ha and 13 578 ha to 4 544 ha and 2 152 ha, respectively. In contrast, in the same period, the area covered by bushland with scattered cropping, grassland with scattered cropping, settlement with

mixed cropping, and woodland with scattered cropping increased from 1 773 ha, 4 286 ha, 6 626 ha, and 4 734 ha to 7 219 ha, 7 093 ha, 9 791 ha, and 9 895 ha, respectively. The decrease and/or increase in land use/cover types had various implications. First, farming activities in bushed grassland reduced grazing area, which resulted in small herd size but with more land use conflicts between livestock keepers and farmers. The reduced herd size offer an opportunity for introduction of improved livestock keeping such as zero grazing. Second, reduction in open woodland implied increased distance to the fields and encroachment of catchments areas. Third, increase in grassland with scattered cropping as more than 50 percent of respondents walked less than a kilometer to the fields meant increased use of marginal areas particularly upland wetlands (*Ruhaha*) and river valley (*Madimba*) for annual cultivation.

In addition to change in land use/cover, over two third 86(71.7%) of the respondents in the villages that had experienced out-migration perceived the status of soil fertility in their fields as declining. Whereas, 65(54.2%) of the respondents in the villages that had experienced in-migration perceived no change in the status of soil fertility in their fields. Continuous cultivation associated with shortening of fallow period was reported by 90(62.5%) of the 240 respondents to be the major reason for decline in soil fertility. In absence of soil fertility replenishment, continuous cultivation led to soil mining a situation that forced farmers to abandon their exhausted fields. In abandoning their fields farmers established new fields in the nearby area and/or migrated to distant location. In absence of natural resource management plans and viable extension systems, new fields in nearby area meant

intensive use of marginal lands whereas distant established fields led to encroachment of catchmentôs forests. This study has shown that use of animal manure and velvet beans in replenishing soil fertility could reduce impact of land degradation on farmersô livelihoods. Apart from change in land use/cover and decline in soil fertility, land degradation in the study area was associated with decline in water levels as manifested by drying of natural springs. According to FGDs, drying of natural springs was a combined effect of reduced rainfall and intensive use of upland wetlands (*Ruhaha*) for farming and settlements. The drying of natural springs led to shortening of off-season cultivation period from April-November to April-July, drying of water intake for irrigation, cropping of cassava in former rice cultivated areas, and increased distance walked to fetch drinking water from half a kilometre in 1980s up to five kilometres in 2007. The major conclusion that can be made from the findings is that continued use of marginal lands though meets current smallholder farmersô short term objectives of food security and income are far from the long term objective of sustainable use of natural resources.

6.2.2 Policies for reducing land degradation

Apart from identifying the change in land and its consequences in livelihoods of smallholder farmers, literature review and discussions with key informants revealed that existing policies have potential of protecting area prone to be degraded, by enacting laws and development of management plans. In Ludewa District, there was existence of bylaws prohibiting cutting of trees, cultivating in water sources, grazing in water sources, and cultivation in catchments. In regards to use of sensitive areas in the study area, 100(41.7%) respondents reported to own fields located in former

forest areas, 39(16.3%) were cultivating in river banks and other 25(10.4%) had fields in upland wetlands. However, of these only 35(14.6%) and 10(4.2%) respondents had knowledge on bylaws prohibiting cultivation in water sources and cutting of trees, respectively. Interesting none was knowledgeable on bylaws prohibiting bush fires.

Despite farmers being aware of laws prohibiting use of marginal lands, in absence of government support most of them were caught in dilemma of either ignoring the laws or starving. The continued cultivation of marginal lands meant that there was little or no effective enforcement of existing bylaws. The problem of none enforcement of existing bylaws was due to lack of natural resource management plans in the study villages. The absence of management plans implied that no interventions were put in place to deal with none-compliance. Besides, resources and boundaries of resources to be protected were undefined, and actions to be taken to conserve them and/or address land degradation absent. The results typify the existing gap between the government intentions and its commitment to natural resource management. From the study findings it can be said that policyï makers lack understanding of the environment surrounding farmersô decisions to use sensitive areas and/or lack commitment to support, monitor, and improve farmersô practices.

Besides, the study found that 68(40%) respondents acquired their land through inheritance, while other 35(20.6%) and 25(14.7%) through allocation by village governments and relatives, respectively. Still a relative large segment of

respondents, 33(19.4%) got their land through forest clearance. Continued honour of land acquired through forest clearance encourages extensive deforestation of catchments and river banks, which expand area prone to land degradation. Furthermore, unlike the expectations that existence of multiple means of land acquisition could make land more accessible to many, it was not easy for women to acquire land as reported by more than half, 124(51.7%) of the respondents. Common way women could acquire land was through renting as reported by 16(28%) respondents in Lifua village. In addition, no respondents had title deeds for the acquired land, though 19(32%) of the respondents in Kimelembe village had written documents for the land allocated to them by village government. On the basis of the existing land tenure, farmers are likely to cause further land degradation and loose their land if anticipated population explosions come following Mchuchuma coal mine take off.

6.2.3 Institutions' effectiveness in reducing land degradation

In addition to potential offered by policies in protecting natural resources, the enforcement of laws related to natural resource management depends on the effectiveness of existing institutions. In the context of literature review on natural resource management and discussions with key informants in Ludewa District, institutions responsible for natural resource management in the study area were government departments, NGOs and various village committees. However, operations of NGOs dealing with natural resource management in the district were limited to three divisions of Mawengi, Mlangali and Liganga as HIMA programme never covered Masasi Division. Besides, FGDs revealed that existing institutions

like village land committees not only lacked understanding of its duties but also were weak and unaccountable. This reduced their willingness to share responsibilities to what happened to natural resources. It was also apparent from the evidences of FGDs that to most people in the study area, conservation of natural resources was assumed responsibilities of central government. Also, there were no environmental inspectors at village, ward, and district levels to coordinate use and conservation of natural resources so as to reduce land degradation. The absence of natural resource management coordination was also responsible for lack of continuity of activities carried out by former programmes and projects in the study area. Lack of continuity reduced leadership role provided by building up skills, technologies and past experiences in extension programmes, which are important human and social capitals required to set foundation for success of new interventions and programmes.

6.2.4 Socio-economic factors influencing farmers' livelihoods

In this study, influences of socio-economic factors on farmersô livelihoods was assessed for expansion of cassava and maize cropped areas, farmersô increased participation in fish selling and casual labour, and keeping of cattle. In light of socio-economic factors particularly gender (GENDERT), age (AGET), level of income (INCATT), educational level (EDUCT), marital status (MARITALT), household size (FSIZET), total cultivated fields (TOFSIZET), land tenure (HOWNEWT), fallow periods (FALLOWT), cassava yields (CASIELDT), number of fields (FARMST), number of dependents (DEPAGET), number of productive adults (PAGET), village type (VITYPET), and distance walked to the fields

(DISFARMT) likelihood of involvement in the livelihood strategies was assessed. The results suggest that expansion of area grown with cassava increased with increase in number of new fields established. This implied that given absence of land management for exhausted fields, further expansion of cassava grown area could stimulate more encroachment of marginal lands. On the other hand, the increased maize production was positively related with increase in total cultivated area. Contrary, increased level of incomes and renting reduced the need to expand maize cropped area. In addition, engagement in fish selling and casual labour were negatively related to age as youth were more likely to travel for days or weeks selling fish in distant markets. In contrast, farmers with large number of fields and low income level were unlikely to keep cattle. The results suggest that households with large number of fields irrespective of their gender were unlikely to venture for alternative livelihood strategies as their concern was mainly for subsistence.

6.2.5 Change in livelihood strategies due to land degradation

From the observed changes in land conditions especially perceived change in soil fertility and its associated change in land value to ineffectiveness of existing policies and institutions, smallholder farmers have changed their livelihood strategies in order to meet the challenges posed by land degradation. Various livelihood strategies were taken to counter negatives consequences of land degradation particularly reduced yields. In order to improve productivity of land, 60(50%) farmers in the villages that had experienced out-migration had increased use of animal manure. In the same villages, 20(16.7%) and 10(4.2%) respondents were using pesticides in their cashew nut plants and irrigated their fields, respectively.

The results suggest that increased use of animal manure in maize fields, pesticides in cashew nuts and irrigation in paddy fields was likely to reduce use of marginal lands for annual crop production. This provides opportunities to improve farmerôs agricultural practices in the study area. However, there was limited use of inorganic fertilizers and draught animals, as applied by only two (1.7%) respondents for the villages that had experienced in-migration and none for the villages that had experienced out-migration. Limited use of animal power implied increased field work load to women as more men were participating in fish selling and casual labour.

In addition, farmers in the study area adopted new cassava and maize varieties. For cassava, *Leonia* and *Kifuu cha nazi* dominated in Kiyogo, *Sawalepi* in Lifua, *Gomani* in Kipangala, and *Goma stella* in Kimelembe village whereas for maize varieties, TMV was common in Kipangala, *Katumani* in Kiyogo and *Kilima* in Kimelembe village. The findings suggest that smallholder farmers adopt innovations in accordance to their needs and circumstances surrounding their production systems. Neighbouring farmers were major source of maize seeds and cassava planting materials for 40(46.5%) and 170(99.4%) respondents, respectively. This implied that farmers were central in introduction and conservation of agro-diversity in the study area. Furthermore, large number of participants (NGOs, extension officers, pilot projects and farmers) who promoted use of new maize varieties suggests that existing extension priority was given to grain crops though root and tuber crops were the major staple food crops in the study area.

On the other hand, intercropping was the main cropping systems for 182(75.8%) respondents, whereas 79(32.9%) respondents reported to practice monoculture and 16(6.7%) others practiced sequential cropping. While intercropping was a strategy to avoid crop failure and maximize timing of first rains for early planting, monoculture aimed at gaining high yields. Double cropping as provided by sequential cropping allowed effective use of stored soil moisture in the study area. Adoption of improved crop varieties and cropping systems had different impact as far as food security expressed in terms of need to purchase cassava more frequent was concerned. In the villages that had experienced in-migration, about 71(61.7%) of the respondents never experienced food insecurity whereas 75(62.5%) respondents in the villages that had experienced out-migration purchased cassava more often. Besides, over two third 170(72.5%) of the respondents kept three to five pigs whilst other 87(36.3) respondents kept cattle. Livestock used to cover costs of farm preparation for 64(27%) respondents and supplied animal manure to 42(17%) others. Absence of livestock improvement programmes, limit potential of livestock to support smallholder farmersô livelihoods.

Another change in livelihood strategy observed was increase in number of fields and limited size of total cultivated area per household. The number of fields ranged from one to eight per household. Average number of fields at Kipangala and Lifua ranged from four to six whereas at Kimelembe it was one to three. Size of cultivated fields ranged from half an acre to 15 acres, with mean of 3.2 acres. Total cultivated area for over half 134(55%) of the respondents was less than the mean size. In contrast, in Kimelembe village over half 43(72%) of the respondents owned fields larger than

the mean size. The decrease in total cultivated land with increase in number of fields in the villages that had experienced out-migration suggests increased land abandonment due to exhausted soil. Similarly, limited expansion of cultivated area suggests the constrained commercialization of agriculture in remote areas.

Apart from increasing the number of fields, other farmers responded to land degradation by migrating to other places. The findings of this study suggest that almost all respondents had changed their place of residence within sub-villages and/or between sub-villages, villages and across district. Duration of stay that respondents had spent in their current residences suggests that most of migration took place in mid 1990s mainly for search of arable land as reported by 93(77.5%) respondents. Given the reasons for continued stay in area with depleted soil fertility, old people were more comfortable with the established livelihoods. Future population growth without technological breakthrough on land management and/or alternative livelihoods means reluctance to migrate could increase land degradation in the study area. In contrast, youth willingness to migrate to other areas given that they had fertile lands suggests their likely dominance in future migration. In addition to land based strategies, farmers engaged in off-farm activities. Five leading off-farm activities were local beer brewing, trade in crops/livestock, fish selling, casual labour, and mat/basket making. Households headed by male dominated in fish selling and casual labour whereas female headed households led in local beer brewing and mat/basket making. Due to limited market and poor developed transport infrastructures the incomes earned by smallholder farmers from off-farm activities in the study area were meagre. The results suggest that improvement in

rural infrastructures is likely to add value to smallholder farmersô enterprises and increase their incomes.

6.2.6 Contributions of the study in knowledge generation

This study has contributed to knowledge generation in a number of ways:

i) This study has adopted and modified Carneyôs Sustainable Livelihood Framework and generated a new model, that is, Impact of Land Degradation on Livelihood (ILADEL). This model has broken the linear relationship between state of biophysical factors (such as soil fertility) and smallholder farmersô activities. The model developed by this study has established that smallholder farmersô activities and capacity to limit impact of land degradation and improve livelihoods is dependent on existing circumstances, especially socio-economic conditions, policies, laws, and institutions. The socio-economic factors establish a link between biophysical aspects of land resources and livelihood assets/capitals. Besides, policies and institutions create a context which enhance and/or limit livelihood strategies opted by smallholder farmers.

ii) In addition, this study has established new avenues of looking at change in land use/cover at local level by relating distance walked to the fields, establishment of new sub-villages and reduction in livestock size per household as pasture lands were encroached by annual cropping. The distance walked to the fields not only show variation in quality of land used by different households but also imply the differences in access to available land resources and potential for further degradation.

6.3 Recommendations

6.3.1 Policy recommendations

In view of the above study conclusion, the following policy recommendations are suggested:

i) Analysis of change in land resources in the study area had shown that increased settlement with mixed cropping had increased conversion of woodlands into bushland with scattered cropping while bushed grasslands changed into grassland with scattered cropping. Besides, out-migration has increased encroachment of catchmentôs areas. The use of marginal lands for annual cropping increase danger of land degradation. In order to limit land degradation there is need for agricultural extension programmes such as revival of cashew nut production in Masasi Division to be associated with development of technologies which enable use of abandoned fields. Since, fieldsô abandonment due to depletion soil fertility has induced land shortage in the study area. It is recommended that DALDO office should promote use of animal manure and cover crop production, introduce agro forestry and community woodlots that would improve soil fertility of exhausted lands. This is inevitable now as land available for further extensification and migration is limited by other competing uses such as mining and catchmentôs conservation.

ii) This study has revealed that existence of policies and institutions is not a panacea to land degradation as shown by lack of management plans, inefficient attention given to rural migration, and unconditional development of rural lands. In order to promote sustainable use of land

and other natural resources it is recommended that the village governments should set and enforce bylaws on establishment of new settlements, mark boundaries of various land uses, especially in Mchuchuma catchments.

iii) It was also observed that lack of knowledge on new areas and skills on alternative enterprises made smallholder farmers to continue stay in degraded area. In this case, there is a need for staff at District Council, especially community development officers to train smallholder farmers on alternative potentials of land apart from farming (improved livestock keeping, commercial tree planting, beekeeping, fish farming). Knowledge on alternative livelihoods would increase farmersô preparedness to respond to new situations brought by land degradation and increase capacity to take new investments. In this case, it is recommended that efforts by DALDOôs office to improve livestock in the study area should target pig husbandry which has large number of participants including women.

iv) Inadequate extension services provided in remote areas was behind increased role of farmers in distribution of new innovations like improved crop varieties. One way to enhance farmersô effectiveness in extension is for DALDO to promote seed extension and farmer field schools in areas where either extension staff or resources are limited. This would fill the technological gaps between high and low potential areas, and enhance local people participation in natural resources conservation.

v) Analysis of logistic regression showed that opportunities available for smallholder farmers to engage in various livelihoods differ due to existing socio-economic factors, and farmers should not be treated as homogenous group. In this case, it is recommended that government efforts to support farmers engaged in fish selling should target youth and single, while cassava improvement programmes should target the villages that had experienced out-migration.

6.3.2 Suggestions for further study

This study investigated the changes in smallholder farmers livelihoods associated with land degradation in selected villages of Ludewa District. Further research is required to enable lessons of this study be used in other areas with similar agro ecological conditions and environmental problems:

i) Track the changes in soil fertility for various land use/cover categories identified

ii) No attempt was made in this study to assess the costs and benefits of various livelihood strategies undertaken by smallholder farmers. It is therefore suggested that future research should assess the costs of living in area prone to land degradation.

iii) Find ways to enhance capacity of local institutions in natural resource management.

iv) As trend in land use planning in rural areas show little progress, future research should track the patterns of rural migrations in order to gain full picture of their effects on land degradation.

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APPENDICES

Appendix 1: Questionnaire for household heads

SOKOINE UNIVERSITY OF AGRICULTURE

FACULTY OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL EXTENSION AND EDUCATION

HOUSEHOLD IDENTIFCATION NUMBERé é é é é ..

WARDé é é é é é ..VILLAGEé é é é ..SUB-VILLAGEé é é é é é é ..

A. GENERAL INFORMATION

1. GENDER: 1. MALE 2. FEMALE
2. Ageé é é .
3. MARITAL STATUS:
    1. Married
    2. Divorced/separated
    3. Widowed
    4. Single
4. Educational level:
    1. Adult education
    2. No formal education
    3. Drop up of é é é é é é é é ..at which classé é é ..
    4. Finished standard four
    5. Finished standard seven or eight
    6. Finished form Two
    7. Finished form Four
    8. Finished for six
    9. College educationé é é é which oneé é é é é é ..
    10. University education, which oneé é é é é é é é é é é é .
5. Household composition

Age	Male	Female
Under 15		
16-27 years		
28-39		
40-51		
52-63		
64+		

6. What is your total average income per year?

S/N	Income category	On-farm income(Tshs)	Off-farm income(Tshs)
1	Below 400,000/=		
2.	401,000-601,000/=		
3.	602,000-802,000/=		
4.	803,000-1,003,000/=		
5.	1,004,000/=+		

B. INFORMATION ON LAND DEGRADATION AND FARMERS' LIVELIHOOD STRATEGIES

7. What is the status of soil fertility in your fields for the past five years?
   1. Increased
   2. Decreased
   3. Not changed

8. What do you think could be the reasons for the change in soil fertility?.....

9. In the past five years have you used any improve farming techniques that are being promoted by extension officers in you farm? Yes No

10. If answered yes in question 9, which techniques did you adopt?
   1. The use of chemical fertilizers
   2. The use of animal manure
   3. The use of compost
   4. The use of household wastes
   5. Soil and water conservation techniques
   6. Land preparation techniques
   7. Insecticides
   8. Herbicides
   9. Improved seeds and/or planting materials
   10. Improved farming tools
   11. Irrigation

11. Who first introduced the techniques to you?

S/N	Introducer	Type of techniques introduced
1.	Village extension worker	
2.	Neighbouring farmers	
3.	Farmer organizations	
4.	Research station	
5.	NGOs	
6.	Cooperative society	
7.	Religious organization	

12. Is the use of improved farming techniques changed the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Need to clear forest			
2.	Conservation of land			
3.	Women work load			
4.	Income			
5.	Food security			

13. In the past five years have you adopted any crop varieties or planting materials in you farm? Yes No

14. If answered yes in question 13 specify the crop varieties/planting materials introduced
é ..

15. Who first introduced the crop varieties/planting materials to you?

S/N	Introducer	Type of techniques introduced
1.	Village extension worker	
2.	Neighbouring farmers	
3.	Farmer organizations	
4.	Research station	
5.	NGOs	
6.	Cooperative society	
7.	Religious organization	

16. Do you think the introduced crop varieties/planting materials changed the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Need for more land			
2.	Women work load			
3.	Income			
4.	Food security			

17. In the last five years have you introduce any type of animals? Yes No

18. If answered yes in question 17, specify the type of animals you introduced?é é é é é é é é

19. From where did you get those animals?.....

20. What was the source of income used to get the animals?.....

21. How does the animals benefit you?.....

22. How long do you leave your farm to rest?
    1. 5 years
    2. 4 years
    3. 3 years
    4. 2 years
    5. 1 year

23. In the last five years have you changed any mode of agricultural production? Yes No

24. If answered yes in question 23, specify the mode of production you have introduced?.....

25. Do you think the introduced mod of agricultural production changed the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Need for more land			
2.	Women work load			
3.	Income			
4.	Food security			

26. What enabled you to afford/accommodate the changes you mentioned in questions 13, 17, 22, and 23?

S/N	Support	Change involved
1.	Loans/credit/subsidy from government	
2.	Training on new production techniques	
3.	Personal financial position	
4.	Farmers network	
5.	NGO financial support	
6.	Saving and credit society loan	
7.	Pilot programme materials support	
8.	Others (Specify)	

27. During the past five years did you start growing new crops? Yes No

28. If you answered yes in question 27 specify the type of crop(s) you have introduced:
    1. Cerealsé ..é é é ..
    2. Roots and tubersé ..
    3. Oil seedsé ..é é é é é
    4. Fruitsé é
    5. Vegetablesé ...é é .
    6. Legumesé é
    7. Cash cropsé .

29. What resources did you have that enabled you to afford t grow new crop(s)?
    1. Knowledge on management of that new crop(s)
    2. Enough land for additional crop(s)
    3. Market information on the new crop(s)
    4. Government support
    5. Training on the production of new crop(s)
    6. Presence of NGOs/church help

30. Do you think the introduction of new crop(s) have changed the state of the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Need for more land			
2.	Use of indusial inputs			
3.	Women work load			
4.	Income			
5.	Food security			

31. Have the amount of the following inputs used in your farms changed in the past five years?

S/N	Input	Increased	Decreased	Not changed	Never applied
1.	Chemical fertilizers				
2.	Insecticides				
3.	Herbicides				
4.	Animal manure				
5.	Compost				
6.	Household wastes				
7.	Fungicides				

32. What do you think were the reasons for the change in use of inputs in your farm? é é é é é é

33. Do you think the change in amounts of inputs used in cop production have changed the state of the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Soil fertility			
2.	Women work load			
3.	Income			
4.	Food security			

34. In the past five years have you experienced any land conflicts: Yes No

35. If answered yes in question 34, specify the sources of conflict and who resolved the conflict?

Type of land conflict	Person/institution contacted for conflict resolution					
	Neighbours	Relative meetings	Ten cell leader	Elders meetings	Court	Village land committee
Invasion of uncultivated land						
Boundary conflict						
Livestock encroachment						
Cultivating land sold to another						
Water sources						

36. In the past five years have you obliged to abandon your farm/demolish your house? Yes No
37. If answered yes in question 36 specify why was it necessary to abandon your farm?
    1. Give space for school building
    2. Give space for road construction
    3. Give space for water pipeline/irrigation canal
    4. Land conflict with neighbours

38. During the last five years have you increased the size of you farm? Yes No

39. If you answered yes in question 38 specify the crop that you have increased its area of production:
    1. Cerealsé ..é é é ..
    2. Roots and tubersé ..
    3. Oil seedsé é é é é é é é é é é é é é é é é é é ..é é é é é
    4. Fruitsé é
    5. Vegetablesé ...é é .
    6. Legumesé é
    7. Cash cropsé .

40. Where are the locations of the new farms?

S/N	Location	Cereals	Roots and tubers	Oil seeds	Fruits	Vegetables	Legumes
1.	Nearby forest						
2.	In wetlands						
3.	Near catchment forest						
4.	Neighbouring villages						
5.	River banks/flood plain						
6.	Pasture lands						
7.	Settlement prior to villagization						
8.	Farms occupied by dropped crops						
9.	Farms abandoned by migrating households						

41. Why was it necessary for you to increase the size of the farms?.....

42. How did you acquire the new land?
    1. Purchase from a villager leaving the village
    2. Given by relatives
    3. Given by village government
    4. Clear forest
    5. Rented
    6. Inherited
    7. Given by neighbours who have left the village
    8. Took over abandoned farms
43. What enabled you acquire new land?
    1. Sold properties (house, plough, bicycles)
    2. Sold crops (specify)é é é é é é é é é é é
    3. Sold animals (specify)é é é é é é é é é é é ..
    4. Savings (jewellery)
    5. Got a loan, specifyé ..
    6. Kinship links
    7. Good relations with local farmers (friendship)
    8. Money from ff-farm activities, specifyé é é é é é é é é é é é é é é
    9. Remittance, specifyé .
    10. Group membership, specifyé é é é é é é é é é é é é é é é é é é
    11. Others, specifyé é

44. Who certified the transfer of land property?.....
45. Do you have title deed/written documents for the farms you purchased or allocated by village government? Yes No

46. How many farms do you have?.....

47. Number of cultivated farms and other attribute:

S/N	Farm	A	B	C	D	F	G	H
1.	Crop grown							
2.	Acres							
3.	Distance to the farm							
4.	Time taken to the farm							

48. Do you think the increase in number of farms have changed the state of the following?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Soil fertility			
2.	Women work load			
3.	Income			
4.	Food security			

49. In the past five years have you dropped production of any crop(s)? Yes No

50. If you answered yes in question 49 specify the crop(s) that you have dropped its production:
1. Cerealsé ..é é é ..
2. Roots and tubersé ..
3. Oil seedsé é é é é é é é é é é é é é é é é é é ..é é é é é
4. Fruitsé é
5. Vegetablesé ...é é .
6. Legumesé é
7. Cash cropsé .

51. Why was it necessary to drop that crop(s)?.....

52. In your attempt to expand your farms was there any kind of laws, rules, customs, and regulations governing you access to open space, wetlands, catchment, and forest area. Yes No

53. If answered yes in question 52 show which onesé é é é é é é é é é é é é é é é é é é

54. Do you think that it is easy now for women to own land than it was five years ago? Yes No

55. If answered yes in question 54 where is the land most allocated to women?.....

56. In the five past years have production of crops dropped in your farm? Yes No

57. Do you or any members of your family work outside your farm? Yes No

58. If you answered yes in question 57 specify the activities they are doing:

S/N	Activities	Male above 18 years	Female above 18 years	Children under14 years	Children 14-17 years
1.	Ploughing				
2.	Planting				
3.	Weeding				
4.	Fertilizer application				
5.	Harvesting				

59. In the past five years have you been engaged in the following activities?

S/N	Activity	Never engaged	Time spent increased	Rank
1.	Fish selling/ fishing			
2.	Local beer brewing/selling			
3.	Mill machine			
4.	Crop/animal sale			
5.	Tailoring			
6.	Mat /basket making			
7.	Stall/Kiosk			
8.	Carpentry			
9.	Masonry			
10.	Brick making			
11.	Mining			
12.	Shop			
13.	Casual labour			
14.	Pit sawing			
15.	Grass thatching			

60. How did you manage to start new activity ranked 1-5 in question 59 above?.....

61. Do you think activities ranked 1-5 in question 59 above have changed the following trends?

S/N	Outcomes	Increased	Decreased	Not changed
1.	Soil and water conservation			
2.	Women work load			
3.	Income			
4.	Food security			
5.	Time spent on farm activities			

62. What has been the use of income generated from activities in question 59?
    1. Buying food
    2. Buying farm inputs
    3. Paying medical bills
    4. Paying school fees
    5. Buying firewood
    6. Buying family assets (livestock, bicycles, radio)
    7. Others, specifyé é é é é é é é é é é é é é é

63. Do you know any outsider investors in your area? Yesé é é é Noé é é é

64. If answered yes in question 6 specify their activities:

S/N	Activity	How many	Since when
1.	Turism		
2.	Agro-processing		
3.	Trade		
4.	Mining		

Questions for households in area that have experienced out-migration

65. How long have you lived in this village?
    1. Less than 5 years
    2. 5-10 years
    3. 10-15 years
    4. 15-20 years
    5. 20+

66. What was the place of residence before you came to this neighbourhood/hamlet?
    1. Another area within the same hamlet
    2. Another hamlet within the same village
    3. Neighbouring village
    4. Village in another District
    5. Town

67. Have any of your household members moved away in the past five years? Yes No

68. Do migrated members contribute any income to your household? Yes No

69. If you answered yes in question 68 can you specify the amount you get per yearé é é é é é é

70. Do you think that your family workload have changed due to migration of some members? Yes No

71. If you think that women workload has increased or decreased, pleas explain (what has happened?) é .

72. Have you obliged to hire labourers to compensate for the members of your household who have migrated to other places? Yesé é é .Noé é é

73. If you answered yes in question 72 specify their number per year, sources, and kind of work and mode of payment:

S/N	Type	How many	From where	For what work	Mode of payment
1.	Female labourers				
2.	Male labourers				
3.	Children				

74. Do you know any member in your hamlet that has left the area in the past five years? Yes....Noé .

75. If you answered yes in question 74 specify how many and their area of destination?

S/N	Location	Number
1.	Another hamlet within the village	
2.	Settlement inhabited before villagization	
3.	Settlement in remote area	
4.	Neighbouring village in same district	
5.	Neighbouring village in another district/region	
6.	Far away village in another district	
7.	Towns in the same district	
8.	Mining area within the same district	
9.	Unknown destination	

76. Do you have access to the farms abandoned by migrating villagers? Yesé ..é .Noé é é .

77. Will you be willing to shift to another village that has fertile land? Yesé ..é .Noé é é ..

78. If you answered no in question 77, what are the reasons for not moving?
    1. Prefer this area and Iôm used to it.
    2. Old age.
    3. I donôt like to be far from my relatives.
    4. Lack of knowledge on the conditions of the new area
    5. I donôt like to loose the off-farm activities available here

79. Do you think the out-migration from your hamlet has changed these trends?

S/N	Outcome	Increased	Decreased	Not changed
1.	Soil fertility			
2.	Income			
3.	Women work load			
4.	Food security			

Questions for households in area that have experienced in-migration

80. How long have you lived in this village?
    1. Less than 5 years
    2. 5-10 years
    3. 10-15 years
    4. 15-20 years
    5. 20+

81. What were the reasons for moving to the current village?
    1. Purchased land
    2. Rent land
    3. Use clan land
    4. Start business other than farming
    5. Moved by government
    6. Our clan original settlement
    7. Invited by relatives
    8. Found a job
    9. Escape from forced labour
    10 others, specifyé é é é é é é é é é é é é é é é é

82. What enabled you to acquire land in this new village?
    1. Income from sale of household property when left the former village
    2. Income from sales of livestock
    3. Income from off-farm activities
    4. Land allocated by village government
    5. Given by relatives/friends
    6. Member of farer/women group
    7. Work with influential organization in the village

83. Did you encounter any problems in acquiring new lands? Yes No

84. If you answered yes in question 83, specify the problemsé é é é é é é é é é é é é é .

85. Do you think is it easy acquiring land in new area than it was in the former residence? Yes...Noé

86. What happened to land you owned in the previous village?
    1. Taken by village government
    2. Taken by relatives left behind
    3. Taken by neighbours
    4. Sold
    5. Leased

87. What did you loose in the process of shifting to this new village?
    1. Farms
    2. Perennials
    3. House
    4. Livestock
    5. Membership in groups, specifyé é é é é é é é é é é é é é é
    6. Kinship links

88. How do you think the decision to migrate affected the following?

S/N	Outcome	Increased	Decreased	Not changed
1.	Need for more land			
2.	Income			
3.	Women work load			
4.	Food security			

Information on food security

89. In the past five years have you experienced the following?

S/N	State of food security	Never	Sometimes	Often
1.	Obliged to eat leafy vegetable instead of ugali			
2.	Needed to borrow food to meet social obligations (to serve a meal to guests)			
3.	Took food on credit			
4.	Worried frequently about where the next meal will come from			
5.	Needed to buy cassava often (because own production or purchased stores ran out)			
6.	The family ate few meals per day on regular basis			
7.	The adult cutback on amount of food consumed (owing to lack of food)			
8.	Needed to borrow food from relatives or neighbours to make meal [making ends meet on day to day (hand to mouth basis)]			
9.	The main working adults sometimes skipped meals (owing to an insufficiency food in the house)			
10.	There were times when food stored in the house ran out and there was no cash to buy more			
11.	Other adults (not the main working adult) personally sipped entire meals.			

Appendix 2: Checklists for FGDs and in-depth interviews

CHECKLIST FOR FOCUS GROUP DISCUSSIONS WITH FARMERS

1. Why are people cultivating their fields continuous?
2. What are reasons for location of fields?
3. Why some people are not applying animal manure in their fields?
4. What are the reasons for undertaking a particular cropping system?
5. What are the main sources of income in your area?
6. Is there any change in the sources of water supply?

CHECKLIST FOR IN-DEPTH INTERVIEWS WITH VILLAGE GOVERNMENT

1. Can you give us the history of your village?
2. Please, give information on the following:
    i) Number of hamlets in your village
    ii) Number of households
    iii) Number of inhabitants in the villages
    iv) Migration trends
3. Can you give information on the operation of following aspects related to land use:
    i) Do you have land committee?
    ii) What are the roles of land committee in your village?
    iii) Do you offer certificate for land allocated to villagers?
    iv) Are there maps for the allocated maps?
    v) Has your village been surveyed?
4. Do you have natural resource management plans?
5. What mechanisms guide the use of the following hazardous lands in your village?
    i) The use of land close to river banks
    ii) The use of wetlands
    iii) The use of land on slope areas
    iv) Cultivation in catchment areas
    v) The use of forest area
6. Do you have guidelines in the establishment of settlements?
7. Do you have any agreements on the use of natural resources between your village and the neighbouring villages?
8. Do you have any organizations/groups that deal with natural resources management in your village?

CHECKLIST FOR IN-DEPTH INTERVIEWS WITH DISTRICT AUTHORITY STAFF

1. Do you have natural resources management programmes in your district (i.e. on progress, abandoned or planned to takeoff)? How are these plans monitored?

2. How different departments are coordinated on issues related to natural resources management?

3. Do you have any by-laws on natural resources management? Who is responsible for its enforcement?

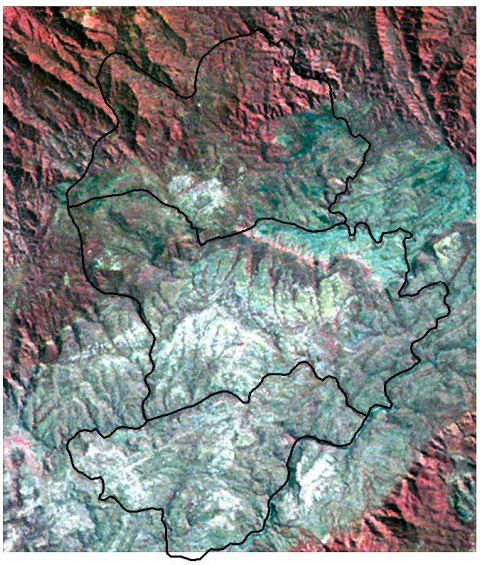
4. D you have any guidelines on the establishment of new settlements/villages?

5. Are there any plans that promote the development of off-farm activities in this district? Which organizations/ departments are responsible for its implementations?

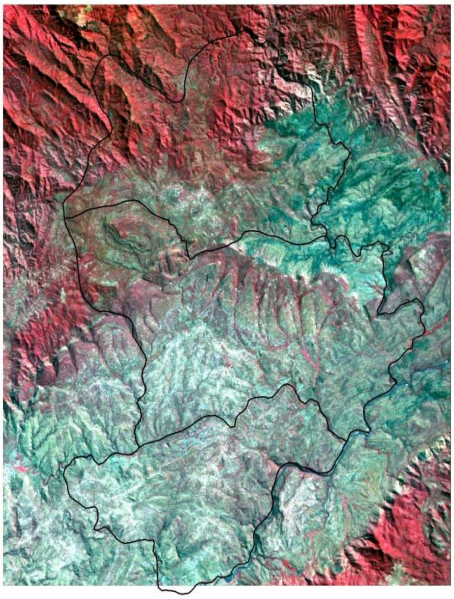
6. Do you have district action plans for implementation of various government policies?

Appendix 3: Satellite images' sub-scenes for study area

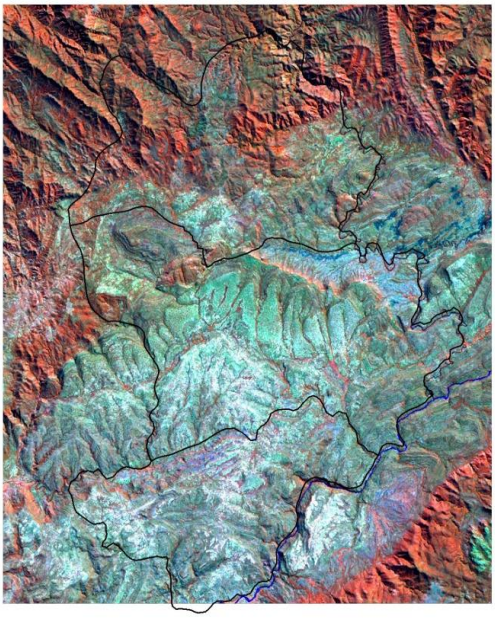
1979



1990



2002



Appendix 4: Table of specification for independent variables used in logistic regression

Variable	Description of the independent variables
GENDERT	Gender of household head (1 for Male, 2 for Female)
MARITALT	Marital status of household head (1 for married, 2 for divorced, 3 for widowed, 4 for single)
TOFSIZET	Area cultivated by a household (acres)
FSIZET	Household size (number of people in household)
FALLOWT	Number of years fields were left to rest
AGET	Age of household head (years)
FARMST	Number of fields owned by a household
DEPAGET	Number of dependents in the household
PAGET	Number of productive adults in the household
DISTFARMT	Distance walked to the fields (in km)
CASIELDT	Cassava yields (t/ha)
VITYPET	Village type (1 for those that have experienced out-migration, 0 for otherwise)
INCATT	Level of incomes (in Tanzanian shillings)
HOWNEWT	Land tenure (1 for purchase, 2 for given by relatives, 3 for village government allocation, 4 for clearance of forest, 5 for inheritance, 6 for renting)
EDUCT	Education level of household head (1 for 0 years of schooling, 2 for 1 to 4 years, 3 for 5 to 8 years, 4 for 9 to 12 years, 5 for 13+years)

Appendix 5: Bylaws in villages that had HIMA projects in Ludewa District

APPENDIX 5A: SHERIA NDOGO ZA KIJIJI CHA MANGA 22/05/2002.

1. Mtu yeyote akishinda maendeleo bila sababu yeyote atatozwa shilingi 2,000/= au jela mwezi mmoja.
2. Mtu yeyote atakayechelewa maendeleo ama vikao atatozwa shilingi 500/= au jela wiki moja.
3. Mtu yeyote anayeshinda vikao atatozwa shilingi 1,000/= au jela wiki moja.
4. Mtu yeyote atakaye tukana hadharani atatozwa shilingi 3,000/= au jela miezi mitatu.
5. Mtu yeyote atakaye piga ngoro bila sababu atatozwa shilingi 3,000/= au jela miezi mitatu.
6. Mtu yeyote atakaye kuwa anazurula ovyo atatozwa shilingi 5,000/= au jela miaka mitano.
7. Mtu yeyote asiyetunza familia atatozwa shilingi 2,000/= au jela miezi miwili.
8. Mzazi kutopima mtoto kliniki atatozwa shilingi 2,000/= au jela miezi miwili.
9. Mzazi yeyote atakayemshindisha mtoto shule atatozwa shilingi 1,000/= au jela miezi miwili.
10. Mzazi /Mlezi yeyote ambaye atashindwa kumuandikisha mtoto shule atatozwa shilingi 5,000/= au jela miezi mitatu.
11. Kaya yeyote itakayopatikana kuwa na mazingira machafu kwa mfano kutokuwa na bafu, shimo la taka au kichanja atatozwa shilingi 2,000/= au jela miezi 2.
12. Mtu yeyote atakaye kata miti ovyo ndani ya hifadhi au eneo lililohifadhiwa na kijiji atatozwa shilingi 5,000/= au jela miezi 3.
13. Mtu yeyote ambaye atafanya biashara bila kupimwa, kutovaa sare atatozwa shilingi 2,000/= au jela miezi 3.
14. Mtu yeyote atakayepatikana anaharibu vyanzo vya maji atatozwa shilingi 10,000/= au jela miezi 6.
15. Mtu yeyote atakaye choma moto bila kibali atatozwa shilingi 1,500/= au jela miezi 3 na kulipa fidia.
16. Mtu yeyote atakayevamia ardhi kwa shughuli yoyote atatozwa shilingi 10,000/= au jela miezi 6.
17. Mtu yeyote atakaye lima kwenye miteremko mikali atatozwa shilingi 2,000/= au jela mwezi mmoja.
18. Mtu yeyote atakaye kataa kuzima moto ukitoroka au kusababisha moto atatozwa shilingi 5,000/= au jela miezi 6.
19. Mtu yeyote atakaye mficha mharifu atatozwa shilingi 5,000/= au jela miezi 2.
20. Mtu yeyote atakayeacha mifugo izurure ovyo atatozwa shilingi 2,500/- au jela miezi 3 na kulipa fidia.
21. Mtu yeyote atakaye kunywa pombe wakati wa saa za kazi atatozwa shilingi 1,000/= au jela miezi 2.
22. Mzazi yeyote atakaye kaa na mtoto mdogo kilabuni zaidi ya saa 12 jioni atatozwa shilingi 1,000/= au jela miezi miwili.
23. Mtu yeyote atakaye inyanyasa jinsi nyingine ni kosa atatozwa shilingi 5,000/= au jela miezi 3.
24. Wizi mdogo mdogo kijijini atatozwa shilingi 5,000/= au jela miezi 3.
25. Mtu yeyote atakaye sababisha au kushiriki kutoa mimba atakuwa ametenda kosa. Atatozwa shilingi 10,000/= na kwenda mahakamani.

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APPENDIX 5B: SHERIA NDOGO ZA KIJIJI CHA MADILU 22/5/2002

1. Mtu yeyote atakayeshinda shughuli za maendeleo bila sababu yoyote atatozwa shilingi 1,000/= au jela mwezi mmoja.
2. Mtu yeyote atakaye chelewa kwenye kikao faini Tshs 200/= au jela wiki moja na aliyeshinda kikao atatozwa shilingi 500/= au jela wiki moja.
3. Mtu yeyote atakaye tukana matusi hadharani atatozwa shilingi 5,000/= au jela miezi mitatu.
4. Mzazi / mlezi atakaye mshindisha mtoto shule atatozwa shilingi 1,000/= au jela mwezi mmoja.
5. Kutomwandikisha mtoto shule atatozwa shilingi 5,000/= au jela miezi 6.
6. Kutorosha moto bila sababu atatozwa shilingi 5,000/= na kulipa fidia au jela mwaka mmoja.
7. Kutokwenda kuizima moto ukitoroka atatozwa shilingi 1,000/= au jela mwezi mmoja.
8. Kuacha mifugo kuzurula ovyo atatozwa shilingi 5,000/= au jela mwezi mmoja.
9. Ukataji wa miti ovyo bila kibali atatozwa shilingi 10,000/= au jela miaka miwili.
10. Kuharibu vyanzo vya maji atatozwa shilingi 10,000/= au jela miaka miwili.
11. Kufanya biashara au kuchinja mifugo bila kupimwa atatozwa shilingi 5,000/= au jela miezi 6.
12. Wenye mazingira machafu atatozwa shilingi 3,000/= au jela mwezi mmoja.
13. Uzururaji kijijini atatozwa shilingi 10,000/= au jela mwaka mmoja.
14. Kunywa pombe kabla ya wakati atatozwa shilingi 500/= au jela wiki mmoja.
15. Kaya ambayo haina shamba la zao la chakula ekari 2 na zao la biashara eka moja atatozwa shilingi 10,000/= au jela mwaka mmoja.
16. Kutotunza familia atatozwa shilingi 10,000/= au jela mwaka mmoja.
17. Mtu kulima sehemu za mwinuko bila kuchukua tahadhari ya makingamaji au sesa atatozwa shilingi 5,000/= au jela miezi 6.
18. Kutopima mimba au kutompeleka mtoto kliniki atatozwa shilingi 5,000/= au jela miezi 6.
19. Mweneza magonjwa ya zinaa atatozwa shilingi 5,000/=au jela miezi 6.
20. Kuvamia maeneo yaliyotengwa na kijiji atatozwa shilingi 10,000/= au jela mwaka mmoja.
21. Unyanyasaji wa kijinsi atatozwa shilingi 5,000/= au jela miezi 6.
22. Kutoshiriki mazishi, kubeba wagonjwa atatozwa shilingi 5,000/= au jela mwaka mmoja.
23. Kumficha mharifu kijijini atatozwa shilingi 10,000/= au jela mwaka mmoja.
24. Mtu yeyote atakaye sababisha au kushawishi kutoa mimba atakuwa ametenda kosa. Atatozwa shilingi 10,000/= au jela miaka 5.
25. Mzazi yeyote atakayekaa na mtoto mdogo kilabuni zaidi ya saa 12 jioni atatozwa shilingi 1,000/= au jela miezi miwili.

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Sahihi ya Mwenyekiti wa Halmashauri

APPENDIX 5C: SHERIA NDOGO ZA KIJIJI CHA LUPANGA 24/05/2002.

1. Kukata miti ya asili na kuharibu vyanzo vya maji atatozwa shilingi 2,000/- au jela miezi 6.
2. Kuacha mifugo izurure ovyo atatozwa shilingi 1,000/= kwa kila mfugo na kulipa fidia au jela miezi miezi mitatu.
3. Wakulima kuingia sehemu ya machungio atatozwa shilingi 800/= au jela miezi 2.
4. Kuanzisha /kuchoma moto bila kibali atatozwa shilingi 1,000/= au jela miezi 3.
5. Kushinda maendeleo bila sababu atatozwa shilingi 1,000/= au jela miezi 1.
6. Mzazi/mlezi anayemshindisha mtoto shuleni atatozwa shilingi 1,000/= au jela miezi .
7. Wazururaji (wavivu wasiopenda kazi) faini shs 2,000/= au jela miezi 3..
8. Matusi hadharani au kusababisha ugomvi faini TShs 2,000/= au jela miezi mitatu
9. Wizi mdogo mdogo faini sh 2,000/= au jela miezi 2.
10. Uzembe wa kulisha watoto (utapiamlo) faini sh 2,000/= au jela miezi 2.
11. Usafi wa mazingira (a) Vyoo vichafu faini sh 1,000/= au jela mwezi mmoja.
    (b) Kutochemsha maji faini shs 500/=
    (c) Kutokuwa nakichanja faini shs 500/=
    (d) Kutokuwa na shimo la taka faini Shs 500/=
    (e) Kutokuwa na bafu faini shs 500/=
12. Anayefanya vurugu katika mikutano faini shs 2,000/= au jela miezi 2 .
13. Kufungua na kufunga kilabu muda usiotakiwa faini shs2,000/=au jela miezi 2.
14. Kupiga yowe kuashiria hatari bila sababu faini shs 1,000/= au jela miezi 2.
15. Kutohudhuria mazishi/ au kutobeba mgonjwa faini shs 1,000/= au jela miezi 2
16. Kunywesha mifugo kwenye visima wanavyochota maji binadamu faini shs 2,000/= au jela miezi 2
17. Uzembe wa kutozingatia tiba au chanjo, kwa binadamu na mifugo faini shs 2,000/= au jela miezi 2.
18. Mfanya biashara yoyote kufanya biashara bila kupimwa faini shs 2,000/= au jela miezi 2.
19. Kaya yoyote isiyokuwa na shamba ekari 2 za zao la chakula naeka 1 zao la biashara faini shs 5,000/= au jela miezi 6.
20. Mtu yoyote asiyetoa huduma katika familia yake /watoto yatima faini shs 2,000/= au jela miezi 5.
21. Mtu yeyote anayekaa na mtoto mdogo kilabuni zaidi tya saa 12 jiono faini shs 2,000/= au jela miezi 3.
22. Kuvamia eneo lililotengwa na kijiji faini shs 2,000/- au jela miezi 6.
23. Kushinda kikao au wito wa ofisi faini shs 1,000/= au jela mwezi 1.

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Sahihi ya Mkurugenzi Mtendaji (W)

APPENDIX 5D: SHERIA NDOGO KIJIJI CHA ILININDA. 23/05/2002.

1. Mtu yeyote akishinda maendeleo atakuwa ametenda kosa faini Tshs 1,500/= au jela miezi 3.
2. Mtu yeyote akishinda kikao ni kosa faini Tshs 1,000/- au jela mwezi mmoja.
3. Mtu yeyote atukanaye matusi hadharani ni kosa faini Tshs 5,000/-a au jela miezi sita.
4. Mtu yeyote atakaye mficha mharifu ni kosa faini Tshs 50,000/= au jela miaka mitatu.
5. Mzazi yeyote asiyetunza familia yake faini Tshs 10,000/= au jela mwezi mmoja.
6. Mtu yeyote anatakiwa awe na eka 2 zao la chakula na eka 1 zao la biashara asipokuwa nazo faini sh 5,000/= au jela miezi 6.
7. Mtu yeyote asiyemshonea mtoto wake sare ya shule faini sh 2,000/= au jela mwezi mmoja.
8. Mtu yeyote anayemshindisha na kutomwandikisha mtoto shule faini Tshs 2,000/= au jela mwezi mmoja.
9. Kutowajibika kwa kiongozi ni kosa faini shs 2,000/= au jela mwezi mmoja na kulipa fidia ya kutowajibika.
10. Mtu yeyote asiyeshiriki kwenye misiba na kubeba wagonjwa ni kosa faini sh 2,000/= au jela mwezi mmoja.
11. Mzazi yeyote haruhusiwi kuwa na mtoto kilabuni baada ya saa 12 jioni, akizidisha zaidi nikosa faini Tshs 1,000/= au jela mwezi mmoja.
12. Kutopima kliniki au kumpeleka mtoto faini Tshs 5,000/= au jela miezi 6.
13. Mtu yeyote atakayepatikana anakunywa pombe kabla ya muda na baada ya muda uliopangwa faini Tshs 2,000/= au jela mwezi mmoja.
14. Ushuru kwa mfanya biashara na walanguzi lazima walipie ushuru wakikataa faini Tshs 500/= kulingana na biashara au jela mwezi mmoja na kuendelea pamoja na kulipa ushuru.
15. Kupiga ngoro bila sababu ni kosa faini shs 10,000/= au jela miezi mitatu.
16. Kuacha mifugo inazurura ni kosa faini Tshs 500/= kwa kila mifugo na kulipa fidia au jela miezi mitatu.
17. Mtu yeyote anayetishia kwa mitindo wowote ule faini Tshs 10,000/= au jela miezi 6.
18. Wanaolima kwenye vyanzo vya maji kuchungia faini shs 5,000/= au jela miezi 6.
19. Atakayepatikana /shikwa ugoni (mwanamke au mwanaume) faini shs 20,000/= au jela mwaka mmoja.
20. Ukataji wa miti ovyo faini Tshs 5,000/= au jela miezi 6.
21. Kupanda baiskeli kwenye maeneo ya vilabu faini Tshs 500/= au jela mwezi mmoja.
22. Usafi wa mazingira usioridhisha faini sh 2,000/= au jela mwezi mmoja.
23. Mtu yeyote atakaye vamia ardhi ya kijiji faini Tshs 5,000/= au jela miezi 6
24. Kutorosha moto faini sh 5,000/= au jela miezi 6
25. Kunyanyasa jinsi mmoja ni kosa faini Tshs 5,000/= au jela miezi 6.
26. Atakayekataa kuzima moto faini Tshs 5,000/= au jela miezzi sita.
27. Wanaolima kwenye miteremko mikali faini shs 2,000/- aun jela mwezi mmoja.
28. Mtu yeyote atakaye patikana na magonjwa ya zinaa faini Tshs 5,000/= au jela miezi 3
29. Mtu yeyote atakaye patikana anaiba faini shs 10,000/= au jela mwezi mmoja.

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Sahihi ya Mkurugenzi Mtendaji (W)

APPENDIX 5E: SHERIA NDOGO ZA KIJIJI CHA LIPANGARA 20/5/2002.

1. Mtu yeyote akishinda maendeleo faini Tshs 2,000/= au jela mwezi mmoja.
2. Mtu yeyote akiwa anatukana matusi hadharani faini Tshs 1,500/= au jela mwezi mmoja.
3. Kushinda vikao bila sababu yeyote faini shs 1,000/= au jela mwezi mmoja.
4. Kuchelewa kwenye vikao faini sh 200/- au jela wiki mmoja.
5. Kuanzisha/ kutorosha moto bila kibali faini shs 3,000/= au jela miezi 2 na kulipia fidia.
6. Ushuru wa shamba / kiwanja shs 1,000/=
7. Atakaye vamia eneo faini shs 5,000/= au jela miezi 6.
8. Kuchungia / kulima kwenye vyanzo vya maji faini shs 5,000/= au jela miezi 6.
9. Uzururaji kijijini faini shs 4,000/= au jela miezi 6.
10. Kushindisha mtoto shuleni faini shs 2,000/= au jela mwezi mmoja.
11. Kushindwa kumushonea sare mwanafunzi faini shs 1,000/= au jela mwezi mmoja. Na kumshonea sare.
12. Kumficha mharifu faini shs 10,000/= au jela miaka 2.
13. Kutomwandikisha mtoto shule faini sh 2,000/= au jela mwezi mmoja.
14. Usafi wa mazingira kwa ujumla faini shs 3,000/= au jela miezi miwili.
15. Uharibifu wa mazingira faini shs 3,000/= au jela miezi miwili.
16. Kutokwenda kuzima moto faini shs 5,000/= au jela mwaka mmoja.
17. Kuzaa bila kufuata mpango faini shs 5,000/= au jela mwaka mmoja.
18. Mifugo kuzurura ovyo faini shs 3,000/= au jela miezi miwili na kulipa fidia.
19. Kila mtu awe na ekari 2 za mazao ya chakula na eka 1 ya zao la biashara kama hana faini shs 5,000/= au jela mwaka mmoja.
20. Unyanyasaji wa kijinsi faini sh 3,000/= au jela miezi miwili.
21. Mtu yeyote ambaye hatahudumia familia faini shs 2,000/= au jela mwaka mmoja.
22. Mtu yeyote aenezaye ugonjwa wa zinaa, kupimwa na kwenda kutibiwa faini shs 5,000/= au jela mwaka mmoja.
23. Mwanamke yeyote asiye kwenda kupima mimba au kumpeleka mtoto kliniki faini sh 2,000/= au jela mwaka mmoja.
24. Anayefanya biashara ya kuuza vyakula na kuuza nyama isiyokaguliwa faini shs 1,000/= au jela mwaka mmoja.
25. Ushuru wa suluhu faini Tshs 3,000/=
26. Wizi mdogomdogo kijijini faini shs 3,000/= au jela miezi miwili.
27. Mtu asiyeshiriki misiba, kubeba mgonjwa na kumpeleka hospitali faini shs 2,000/= au jela mwezi 1.
28. Kutokuwa na makazi ya kuridhisha faini shs 3,000/= au jela mwaka mmoja.

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Sahihi ya Mkurugenzi Mtendaji (W)

APPENDIX 5F: SHERIA NDOGO ZA KIJIJI CHA MKONGOBAKI 21/05/2002

1. Mtu yeyote atakayeshindwa kufika kwenye maendeleo bila sababu faini shs 2,000/= au jela miezi 3.
2. Mtu yeyote atakaayeshindwa kufika kwenye kikao/ mwaliko atakuwa ametenda kosa faini shs 2,000/= au jela mwezi mmoja.
3. Mtu yeyote atakayechelewa vikao faini shs 1,000/= na kutolewa wadhifa.
4. Mtu yeyote ambaye hana shamba la chakula ekari 1 na la biashara nusu eka faini shs 3,000/= au jela miezi mitatu na kusimamiwa awe na ekari hizo zilizotajwa.
5. Mtu anayekata miti ovyo bila kupanda mingine faini shs 3,000/= au jela miezi mitatu.
6. Matusi hadharani faini shs 5,000/= au jela miezi mitatu.
7. Mtu yeyote ambaye ana mazingira machafu faini shs 3,000/= au jela mwezi mmoja na kukamilisha usafi wa mazingira.
8. Mzazi asiyemshonea mtoto sare faini shs 2,000/= au jela mwezi mmoja.
9. Mzazi kutomwandikisha mtoto shule faini shs 3,000/= au jela mwezi mmoja.
10. Kumshindisha mtoto shule faini shs 2,000/= au jela mwezi mmoja.
11. Mtu yeyote atakayemficha mhalifu faini shs 3,000/= au jela miezi 6.
12. Mifugo kuzurura ovyo faini shs 2,000/= na kulipa fidia au jela mwezi mmoja.
13. Kuanzisha moto au kutorosha faini shs 3,000/= au jela miezi mitatu.
14. Mtu akikataa kuzima moto faini shs 3,000/= au jela mwezi mmoja.
15. Kulima / kuchungia kwenye vyanzo vya maji faini shs 3,000/= au jela miezi 6.
16. Kulima kwenye kingo za barabara na kukokota jembe la ngômbe barabarani faini shs 3,000/= au jela miezi 6.
17. Kuvamia maeneo faini shs 3,000/= au jela mwezi mmoja.
18. Unyanyasaji wa kijinsi faini shs 5,000/= au jela mwezi mmoja.
19. Watu wanaolima sehemu za miteremko mikali faini shs 3,000/= au jela mwezi mmoja.
20. Kutopima wajawazito na kumpeleka mtoto kliniki faini shs 3,000/= au jela miezi miwili.
21. Kunywa pombe muda usiotakiwa faini shs 2,000/= au jela mwezi mmoja.
22. Kueneza magonjwa ya zinaa ni kosa faini shs 3,000/= au jela miezi 3 na kupata matibabu.
23. Kufanya biashara bila kupimwa /kuuza nyama bila kupimwa faini shs 5,000/= au jela miezi mitatu.
24. Kupiga kelele usiku na kutukana matusi ni kosa faini shs 5,000/= au jela mwezi mmoja.
25. Kuzurura ovyo faini shs 2,000/= au jela mwezi mmoja.
26. Mtu yeyote atakayesababisha au kushiriki kutoa mimba atakuwa ametenda kosa faini shs 10,000/= au jela miaka mitano
27. Kumuajiri mwanafunzi kabla hajamaliza masomo atakuwa ametenda kosa faini shs 5,000/= au jela miezi sita.

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Appendix 6: Perceptions of farmers on state of food insecurity in the study villages

Variable	Never	Sometimes	Often	G2	p-value
Obliged to eat leafy vegetable instead of *ugali*				5.581	0.061ns
In-migration	71(59.2)	45(37.5)	4(2.3)		
Out-migration	81(67.5)	30(25)	9(7.5)		
Borrowed food to meet social obligations				1.080	0.583ns
In-migration	54(45)	65(54.2)	1(0.8)		
Out-migration	55(45.8)	62(51.1)	3(2.5)		
Took food on credit from local store				0.961	0.327ns
In-migration	113(94.2)	7(5.8)	0(0)		
Out-migration	109(90.8)	11(9.2)	0(0)		
Worried frequently about the next meal				1.113	0.573ns
In-migration	64(53.3)	56(46.7)	0(0)		
Out-migration	66(55)	53(44.2)	1(0.8)		
Needed to purchase cassava more often				22.632	0.000**
In-migration	71(61.7)	36(30)	10(8.3)		
Out-migration	45(37.5)	38(31.7)	37(30.8)		
Family ate few meals a day on regular basis				0.776	0.678ns
In-migration	95(79.2)	24(20)	1(0.8)		
Out-migration	90(75)	28(23.3)	2(1.7)		
The adult cutback on amount of food consumed				3.261	0.196ns
In-migration	93(77.5)	27(22.5)	0(0)		
Out-migration	84(70)	34(28.3)	2(1.7)		
Borrowed food from relatives or neighbours to make a meal				1.908	0.385ns
In-migration	90(75)	29(24.2)	1(0.8)		
Out-migration	86(71.7)	30(25)	4(3.3)		
Working adults sometimes skipped meals				2.511	0.285
In-migration	97(80.8)	23(19.2)	0(0)		
Out-migration	91(75.8)	27(22.5)	2(1.7)		
Food stored in the house ran out and no cash to buy more				4.481	0.106ns
In-migration	102(85)	17(14.2)	1(0.8)		
Out-migration	89(74.2)	30(25)	1(0.8)		
Other adults personally skipped meals				3.036	0.219ns
In-migration	97(80.8)	23(19.2)	0(0)		
Out-migration	89(74.2)	29(24.2)	2(1.7)		