SUNFLOWER AS AN ALTERNATIVE TO TOBACCO AND ITS IMPLICATION TO DEFORESTATION IN SIKONGE DISTRICT, TABORA REGION, TANZANIA

BY

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ABSTRACT

Tobacco farming as an agricultural development issue, has been identified among others as an important theme to study the relationship of its production to deforestation. This study was carried out in Tutuo ward, Sikonge district in Tabora region to assess land use changes due to switch from tobacco to sunflower as an alternative cash crop; and its influence on deforestation. The villages namely Usanganya, Mole and Tutuo were involved. Household questionnaire, checklists, participant observation, PRA techniques and remote sensing were employed for data collection. Logistic regression models, linear regression analysis and geographic information system techniques were used to analyse factors influencing farmers switch from tobacco to sunflower, study the relationship between hactrage of sunflower replacing tobacco and the rate of deforestation and/ or regeneration of forest and analyse multi temporal Landsat TM and ETM+ satellite images respectively. Factors likely to significantly influence farmers switch from tobacco to sunflower cultivation in Tutuo ward included unreliable tobacco market and farm size; while farming experience significantly reduced the likelihood of shifting from tobacco to sunflower cultivation. The switch found to have no significant on reduction of deforestation and not favoured miombo woodland regeneration. The conclusion of this study is that land use changes due to switch from tobacco to sunflower, shows a trend of reducing deforestation and favouring regeneration of miombo woodlands. The study recommends farmers to introduce sunflower as an alternative to tobacco. The effect of the switch to poverty alleviation in terms of income from tobacco when compared to alternative crops which is less lucrative, is to be studied to have a base for the decision to before the switch. Farmers also have to reduce the volume of fuelwood consumption by establishing household woodlots, community based forest management system and construct efficient barns the efforts that contributes to reduction of deforestation.

DECLARATION

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

_____ _____

Erasto Anyandwile Konga Date

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The above declaration is confirmed by

_____ _____

Dr. E. F. Nzunda Date

(Supervisor)

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DEDICATION

This project is dedicated to God and my loving, caring and industrious mother Atwingisyaghe Ngajilo whose effort and sacrifice has Made my dream of having this degree a reality. Dear mother, words cannot adequately express my deep gratitude to you. I pray that you live long enough to reap the fruits of your labour.

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LIST OF ABBREVIATIONS AND ACRONYMS

ATTT	Association of Tanzania Tobacco Traders
CBFM	Community Based Forest Management
DALDO	District Agriculture and Livestock Development Officer
DFO	District Forest Officer
FAO	Food and Agriculture Organization
FGD	Focused Group Discussion
GIS	Geographical Information System
GPS	Global Positioning System
GTOS	Global Terrestrial Observing System
IFAD	International Fund for Agriculture Development
IPCC	Intergovernmental Panel on Climate Change
IRA	Institute of Resource Assessment
ISODATA	Iterative Self-Organizing Data Analysis technique
LUCC	Land Use Cover Change
LUCID	Land Use Change Impacts and Dynamics
MIRIS	Michigan Resource Information System
MNRT	Ministry of Natural Resources and Tourism
NGO	Non Governmental Organization
PRA	Participatory Rural Appraisal
SDC	Sikonge District Council
SNAL	Sokoine National Agriculture Library
TLC	Total Land Care
TTCF	Tanzania Tobacco Control Forum
UCCP	Ugalla Community Conservation Project
URT	United Republic of Tanzania
UTM	Universal Transverse Mercator
WHO	World Health Organization
WWF	World Wide Fund for Nature

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Worldwide natural resources are the foundation from which rural poor people can overcome poverty because it is still very much a rural problem. One in five of the world's inhabitants live in extreme poverty and their livelihoods depend on natural resources (IFAD, 2006). Land as major holder of resources is becoming a scarce resource due to immense agricultural and demographic pressure (Opeyemi, 2006). Agricultural land use, particularly tobacco has become one of the world's most controversial crops (Geist *et al.*, 2009). Tobacco farming has been identified as a development issue with regard to environmental sustainability, especially in growing areas of the developing world (WHO, 2004a). Against these background, World Health Organization identified among other themes as a part of world agenda for tobacco control research, those were the relationship of tobacco production to the destruction of the ecosystem, particularly deforestation. The other were to find opportunities for alternative crops and alternative livelihood (WHO, 2004b).

History in sub-Saharan Africa shows that effectively combating and reducing poverty is not easy task without the link between rural livelihoods and natural resource management as a fundamental importance to effective poverty reduction strategies (Kallonga *et al.*, 2003). Over 75% of Tanzania's population residing in rural areas is dependent on agriculture and other natural resource uses for livelihoods and survival (*ibid*). For example, over 90% of Tanzanians rely on wood fuel from trees and other vegetation for their domestic energy supplies (URT, 1998; Mariki *et al.*, 2003). Widespread poverty in rural areas compels people to over-exploit their surrounding natural resources in order to

survive. Activities such as extensive agricultural practices are reducing the vegetal capital stock and the water retention capacity of land, and increasing erosion. Protected areas have been encroached upon for farming and settlement. Overgrazing, ground fires and felling of trees for various uses are reducing the regeneration of plants and animals (URT, 2001).

1.2 Problem Statement and Justification

Deforestation caused by tobacco cultivation is one of the threats that have to be addressed in order to improve conservation of miombo woodlands (Kajembe *et al.*, 2004) where 90% of all tobacco in Tanzania is produced (Monela and Abdallah, 2007). Environmental functions of the woodlands are especially threatened by the production of flue-cured tobacco, which relies heavily on the availability of fuel wood for curing tobacco leaves, requires virgin land to support shifting cultivation and poles and sticks for barn construction (Geist, 1999; Mackay and Erikisen, 2000; Mangora, 2002; Mangora, 2005). In Tabora region, tobacco cultivation has decimated miombo forests to the point that the region now faces reduced honey production and general environmental degradation (Waluye, 1994). The Tanzania Tobacco Control Forum (TTCF) started to organize among tobacco farmers in Tanzania, encouraging them rather to grow food and alternative cash crops to tobacco such as simsim (sesame seeds), sunflower and groundnuts by pointing out that at least they could eat their crops when they faced hard times (Cullinan, 2008). The intention of establishment of alternative cash crops among tobacco farmers is to slow the expansion of tobacco production and thereby reduce the fuelwood needed for tobacco curing and hence conserve forest resources (Kajembe *et al*., 2004). One of the major critisism of tobacco industry is its impact on ecology and environment of miombo woodland due to deforestation which relates to tobacco farming in Tabora region (Waluye, 1994, Geist *et al*., 1999, Mangora, 2005).

Incidentally, no research of switching from tobacco to sunflower and its impacts to deforestation has been done in the region. The few studies conducted in Amazon (Bittner and Laurance 2009), Tanzania and Kenya (Ngailo *et al*., 2001) shows that there were land use changes due to crop switch, but the studies not involved tobacco and sunflower.

Regarding these land use changes due to crop switch, biophysical factors such as soil (i.e. texture and fertility) and climate change documented to cause crop switch in China (Verburg *et al.,* 1997) and Latin America (Wehbe *et al.,* 2005). Laws, policies and market are socio-economic factors studied to influence crop switch in East African countries (William, 2003; MNRT, 2007; Olson *et al.*, 2008). Some research documents that crop switch caused deforestation in Latin America (Panichelli 2007), Amazon (Bittner and Laurence 2009) and favoured forest regeneration in Nigeria, Ghana, Cameroon, Costa Rica and Panama (WWF, 2006; Oke and Odebiyi 2007; Sonwa 2008).

So far there has been no study that has attempted to assess the biophysical and socio-economic factors which influences the switch, the implications of the switch from tobacco to sunflower cultivation to deforestation and miombo woodland regeneration in Sikonge district. This study aims to fill this information gap.

1.3 Objectives

1.3.1 General objectives

To assess land use changes due to switch from tobacco to sunflower and assess the influence of the switch on deforestation.

1.3.2 Specific objectives

i) To determine the extent of land use change from tobacco to sunflower cultivation.

ii) To evaluate bio-physical and social economic factors that influence land use change from tobacco to sunflower cultivation.

iii) To identify and quantify land use/cover changes in the study area.

iv) To examine the influence of land use change from tobacco to sunflower cultivation on deforestation and regeneration of miombo woodlands.

1.4 Study Questions

i) To what extent has sunflower cultivation replaced tobacco cultivation?

ii) What is the role of age, level of education of respondents, household size, farm size, drought, unreliable tobacco market, price of tobacco and farmers experience in influencing land use change from tobacco to sunflower cultivation?

iii) What are the main land uses/covers in the study area for the years 1995, 2000, 2005 and 2009?

iv) What land use/cover changes occurred between the years 1995 and 2000, 2000 and 2005, and 2005 and 2009?

v) What is the trend in deforestation, forest degradation and area used for sunflower and tobacco cultivation?

vi) Does land use change from tobacco to sunflower significantly reduce deforestation and forest degradation?

vii) Does land use change from tobacco to sunflower significantly favour regeneration of miombo woodlands?

1.5 Conceptual Framework

In this study, it is assumed that tobacco land use can be switched to sunflower land use. This crop switch is influenced by several bio-physical and socio-economic factors. When land use is switched in either direction; it has got an implication to deforestation or

regeneration of natural forest. When land use switches from tobacco to sunflower cultivation, the implication is reduction in deforestation or regeneration of miombo woodlands (Fig. 1).

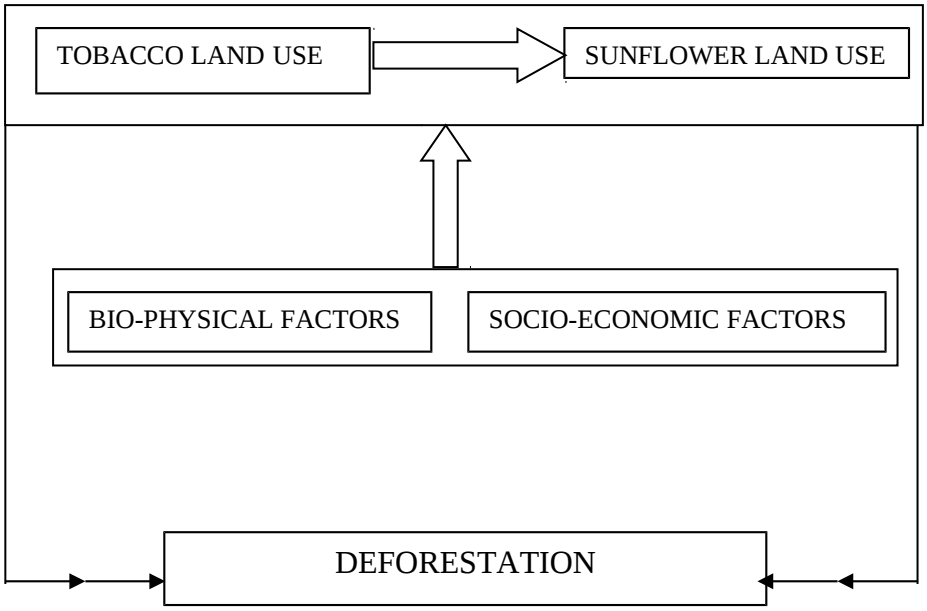

Figure 1: Conceptual framework of the study of sunflower as an alternative to tobacco and its implication to deforestation in Sikonge District, Tabora Region, Tanzania

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Alternative Crops

Alternative crops are the one newly included in production to help diversify and stabilize income and/or to solve crop production problems in the existing cropping systems (Fiese and Platt, 2001). Alternative crops are categorized as cereals and pseudo cereals; grain legumes; oilseeds; industrial crops; and fibre crops (Sauer and Sullivan, 2000). The alternative crops establishment bases on different factors which are climate, soil conditions, pests and diseases, which occurs naturally (Wehbe *et al.,* 2005). The environmental protection and nature conservation can also limit the production of some alternative crops (Bittner and Laurence, 2009).

2.2 Bio-physical and Socio-Economic Factors that Influence Crop Switch

Both bio-physical and social-economic factors are needed to explain crop switch. For instance, in China soil texture and fertility influenced farmers of the lowlands to switch to rice farming which requires poorly drained and fertile soils instead of upland crops (Verburg *et al.,* 1997). In Latin America farmers switch from peanut to soybean as peanut crop yield and production was affected by rise or fall of temperature, drought and hail (Wehbe *et al.,* 2005). During colonial time, farmers in East Africa and other parts of the world were forced to establish cash crops for export market in place of food crops (Olson *et al.,* 2008). Presently in Tanzania there are laws and policies that encourage farmers to reduce cultivation of crops that depend heavily on natural forest resources such as tobacco (MNRT, 2007). The high demand for vegetables, fruits and flowers in foreign market has resulted in increased cultivation of these crops in place of traditional cash crops such as coffee especially in Kenya and Tanzania (Ngailo *et al.,* 2001). The switch was further

more caused by removal of subsidies on inputs and decline in prices of traditional cash crops.

2.3 Land Use and Cover

Land cover defined as observed physical cover including the vegetation (natural and planted), human construction and other features that cover earth's surface; such as water, ice, bare rock, and sand surfaces (Herold, 2009; Di Gregoio, 2005). Land use is described as a human activities or action on land (Anderson *et al.*, 2001; Di Gregoio, 2005).

2.3.1 Land Use and Cover Change

Land cover change refers to the complete replacement of one cover type by another, for example deforestation. Land use change includes the modification of land cover types, for example intensification of agricultural management or other changes in the farming system (Vose *et al*, 2004). Land use and land cover changes are a result of interplay between socio-economic, institutional and environmental factors (Lesschen *et al*., 2005; Anderson *et al.,* 2001). Land use/cover change (LUCC) has important impacts on the functioning of socio-economic and environmental systems with important tradeoffs for sustainability, food security, biodiversity and the vulnerability of people and ecosystems to global change impacts (Lesschen *et al*., 2005).

Every parcel of land on the earth's surface is unique in the cover it possesses. Land use and land cover are distinct, yet closely linked characteristics of the Earth's surface (Meyer, 1995). The use to which we put land could be grazing, agriculture, urban development, logging, and mining among many others (Anderson *et al.*, 2001). While land cover categories could be cropland, forest, wetland, pasture, roads, urban areas among others, the term land cover originally referred to the kind and state of vegetation, such as forest or

grass cover but it has broadened in subsequent usage to include other things such as human structures, soil type, biodiversity, surface and ground water (Meyer, 1995).

Land use affects land cover and changes in land cover affect land use. A change in either is however not necessarily the product of the other. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affect biodiversity, water and radiation budgets, gas emissions and other processes that come together to affect climate and biosphere (Riebsame *et al.,* 1994). Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations, and ecosystem dynamics may also initiate modifications upon land cover. Globally, land cover today is altered principally by direct human use: by agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development. There are also incidental impacts on land cover change from other human activities such as forests and lakes damaged by acid rain emanating from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (Meyer, 1995). Hence in order to use land optimally, it is not only necessary to have the information on existing land use land cover but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape

2.3.2 Land Use Change due to Crop Switch

Globally land is facing increasing pressure from competing uses, of which crop production is one (Opeyemi, 2006). Types of crops grown on various regions of the world have been recognized for long time to have effects on land use of the region. The establishment of permanent crops such as coffee, banana and tea mixed with woody perennials on slopes of

east African mountains of Kilimanjaro and Kenya substituted annual crops (Ngailo *et al.*, 2001). This led to changes from seasonal crops to homegardens land use (Olson *et al.*, 2008). This forced the upland increased population to expand into the low lands converting grazing areas to farm land, switching from the seasonal rain fed crops grown at the lowlands, mainly maize, to irrigated rice and sugarcane (Mbonile *et al.*, 2003).

2.4 Forest and Forest Cover

Forest/Forest cover is a land on which trees form the dominant vegetation type (FAO, 2001b). Forest is defined as a land with the tree crown cover of more than 10 percent of the ground, should be an area of more than 0.5 and the tree should reach a minimum height of 5 metre at maturity (FAO, 2001a).

2.4.1 Deforestation

In the context of the Kyoto, protocol deforestation is defined as a direct human induced conversion of forested land to non-forested land (Moulinho and Schwartzman, 2005). IPCC (2001) stated that deforestation refers to change of land cover with depletion of crown cover to less than 10%. So conversion of forest to pastures, cropland, or other managed uses are referred as deforestation.

2.4.2 Deforestation Drivers in Tropical Forests

The study on deforestation drivers in tropical forests, classified the causes of deforestation into proximate and underlying (Geist and Lambin, 2002; Rademakers *et al.*, 2010). Agriculture expansion, wood extraction and infrastructure extension which are caused directly by human are said to be proximate causes. Underlying causes are economic factors, policy, institutional, technological, cultural and demographic. Other factors are land characteristics (e.g. slope, water and vegetation), biophysical triggers (soil, water and

vegetation related) and social triggers (civil war, economic crisis and refugee movement) (Geist and Lambin, 2002). But agriculture is said to be the dominant causes and driver of deforestation in boreal, temperate and tropical dry/rain forests (Gorte and Sheikh, 2010).

Most tropical deforestation results from clearing of space for agricultural land. This reflects the fact that it is normally more profitable to clear forest and grow crops, than it is to harvest timber and other forest products sustainably (Chomitz *et al.*, 2007). Currently, tropical deforestation is largely caused by demand for subsistence food crops, especially in Africa; but in Latin America commercial cattle ranching and soya cultivation are significant drivers (FAO, 2005). A typical sequence of deforestation in a Amazon rainforest might start with new access due to a road being built, followed by selective logging of the valuable timber species and some small scale farmers being evicted by commercial interests, such as cattle ranchers or soy cultivators (Bittner and Laurance, 2009). In Southeast Asia, palm oil and wood pulp production, along with large scale timber extraction are also important. However, underlying these direct causes of deforestation are issues of economic development, land ownership and governance that have prevented previous international efforts to reduce deforestation (Fitzherbert *et al.*, 2008).

2.5 Influence of Crop Switch on Deforestation and Regeneration of Natural Forest

Crop switch may either result in increased deforestation or enhance forest regeneration. For instance, when food crops are replaced by plantations for biofuel production, the displaced farmers move to deforestation frontiers and cause new deforestation (Panichelli, 2007; Bittner and Laurance, 2009). On the other hand, switching from cocoa monocultures to cocoa agroforestry land use in Cameroon, favoured forest regeneration (Sonwa *et al*, 2008). The cocoa-based agroforestry systems in Nigeria have the capacity to conserve

many of the forest species under improved management practices and that the natural forests around this farming system are rapidly regenerating giving way to cocoa farms (Oke and Odebiyi, 2007). In Ghana, cocoa farmers manage the regeneration of forest species in their farms for the ecological, economic, or cultural value (Amanor, 1996). In Costa Rica and Panama the diverse cocoa agroforestry farms have high conservation value as buffer zones for the natural forest reserve (WWF, 2006) and the spread of it in the North of Yaoundé offers opportunity for reforestation (Sonwa *et al.*, 2008).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location

Tutuo ward, which is part of Sikonge district of southern Tabora, is located between 5˚19´ and 5˚33´ south of the equator and 32˚27´ and 32˚42´ east of the Greenwich line. The ward lies on western central Tanzania plateau (URT, 2005). The ward borders Urambo district on its west and Pangale, Igigwa and Sikonge wards on its north, east and south respectively. This study was conducted in Usanganya, Mole and Tutuo villages in the ward (Fig. 2).

3.1.2 Demography

In accordance with the 2002 population and housing census, the ward had a population of 18 953, of which 9406 were males and 9547 were females, all accommodated in 3150 households (URT, 2003). However, based on the documented information on the population and the growth rate of 4.8% (*ibid*) the population data obtained from village registers was 27 577 by the year 2010. The main ethnic groups in the ward are the Nyamwezi and Sukuma. Other minor ethnic groups are the Konongo, Tongwe, Mbungu, Ha, Nyaturu, Fipa, Gogo, Kurya and Tutsi.

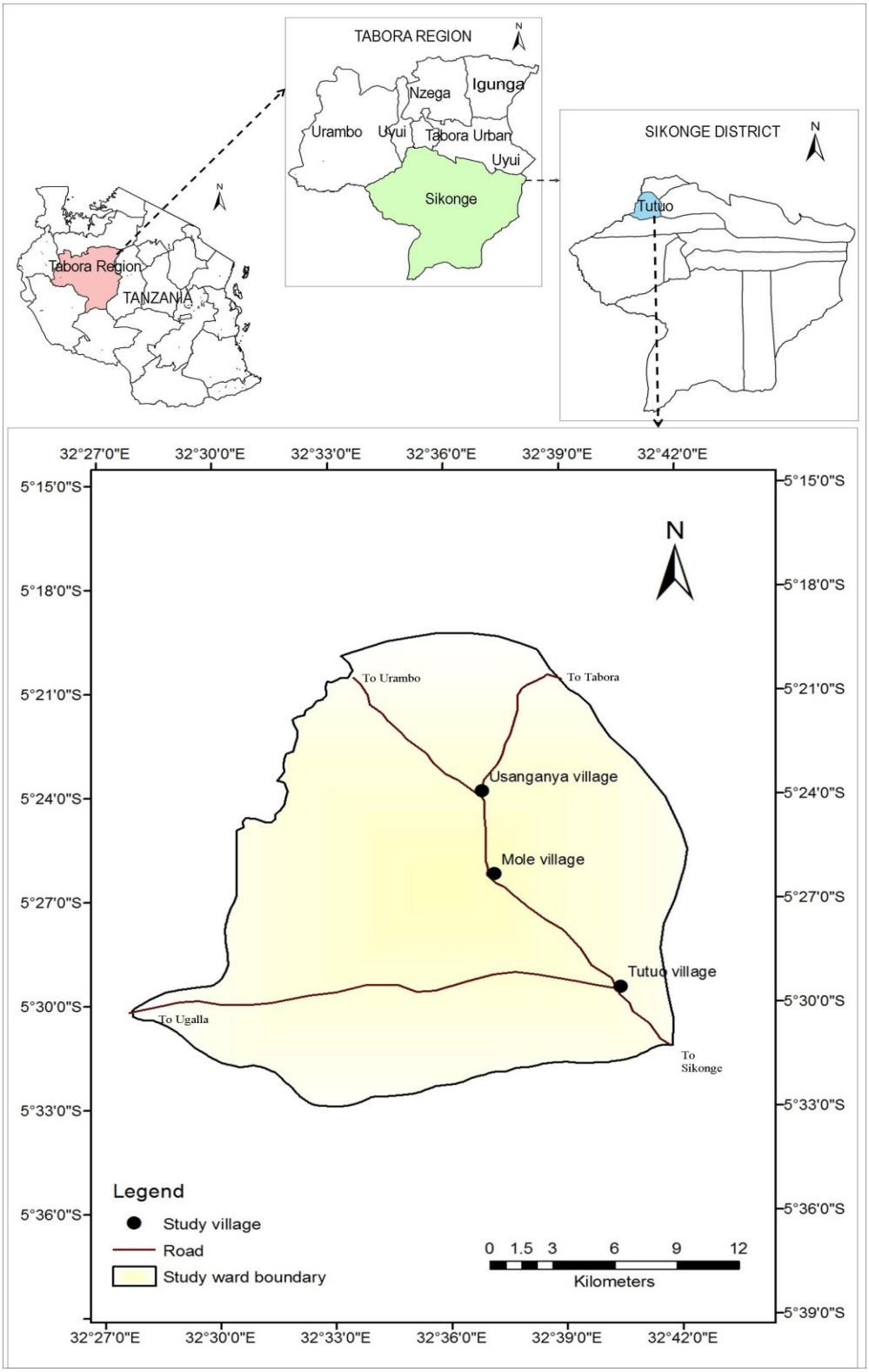

Figure 2: Map of study area, Tutuo ward in Sikonge district

3.1.3 Geomorphology, Soils and Vegetation

The average altitude of Tutuo ward is 1000 m above sea level, which comprises gently undulating plains of low relief with extensive mbugas. These flat plains are seasonally inundated or become permanent swaps (SDC, 2009). The ward has an infertile deep sandy loam soils with little graduations of clay and red soils (Kauzeni *et al.,* 1993). The natural vegetation includes miombo forest and wooded grasslands (SDC, 2009).

3.1.4 Climate and socio-economic activities

Tutuo ward has an average temperature ranging between 23˚C and 30˚C and receives an annual rainfall ranging from 600mm to 900mm. The rain starts in early November and end in early May followed by dry season between May and October (URT, 2005). Agriculture is the main land use in the ward, employing about 85% of the total manpower. Others are pasture and construction land uses. Pasture lands are used for livestock grazing, while construction land is used for settlements and other infrastructures.

3.1.5 Hydrology

The main water bodies in the ward are seasonal rivers which demarcates the boundaries of the ward on its north, west and south. Underground water is obtained through shallow wells and ponds excavated locally in the ward. The only charcoal dam in the ward is constructed in Mole village at Utyatya sub village (SDC, 2009).

3.2 Methodology

3.2.1 Collection of research materials

The available Landsat satellite images covering the study area, acquired in 1995, 2000, 2005 and 2009 were obtained from the Institute of Resource Assessment (IRA),

University of Dar es Salaam. The details of the characteristics of these images are shown in Table 1.

Table 1: Characteristics of remote sensing data used for the study

Landsat Scene	Date of Acquisition	Path/Row	Spatial Resolution*
Thematic Mapper (TM)	31/06/1995	170/64	28.5 m × 28.5 m
Enhanced TM Plus (ETM+)	14/06/2000	170/64	30 m × 30 m
Landsat 7 ETM+	09/06/2005	170/64	15 m ×15 m
Landsat 7 ETM+	17/06/2009	170/64	30 x 29.96m

**Source: Spatial resolution is obtained from header files of the image data*

ERDAS 9.1 and Arc GIS 9 were used for analysis of satellite images, GPS receiver (GPSMAP 76CSx) for point mapping in the field and digital maps for wards of Sikonge district for obtaining an area of interest.

3.2.2 Preparation of research materials

3.2.2.1 Questionnaire for Socio-economic Survey

Semi structured questionnaires were prepared for intention of capturing information on the extent sunflower replaced tobacco and the percentage of farmers' households switched from tobacco to sunflower land use. Data on factors that influenced farmers to switch from tobacco to sunflower cultivation was obtained through this instrument where respondents mentioned the most influencing factors. Other social economic factors which influenced the crop switch also captured using the questionnaire.

3.2.2.2 Participatory Rural Appraisal Guidelines and Checklist

Guidelines for Participatory rural appraisal (PRA) methodology to get primary and / or secondary data were prepared. The PRA team and focused group discussion (FGD) had to provide data on number of households, hactrage grown tobacco and /or sunflower with

their respective seasons focusing to which extent area grown sunflower replaced that of tobacco in the villages. Checklist prepared for key informants enabled to capture tobacco issues such as areas dominated by tobacco production, years in which the crop were grown at the maximum and the effects of tobacco to environment. The checklist enabled to identify and get elaboration on the existed bio-physical and socio-economic factors that influenced a change from tobacco to sunflower cultivation.

3.2.2.3 Satellite images

The preparation of Landsat satellite images involved sub setting and other pre-processing steps including georeferencing or image registration, colour composite and unsupervised classification (Lillesand and Kiefer, 2008). Sub setting consisted mainly in selecting and extracting the study area from the full scene images. The images were georeferenced to the Universal Transverse Mercator (UTM) map coordinate system so as to be able to use other print outs of land use map for ground truthing. Colour composite and unsupervised classification of 2009 Landsat 7 ETM+ image was done (Appendix 1). Unsupervised classification adopted because it allows spectral clusters to be identified with high objectivity. The Iterative Self-Organizing Data Analysis technique (ISODATA) algorithm in ERDAS 9.1 Imagine was used to identify spectral clusters. The most important clustering parameter is number of classes which affects the performance of the classifier in computing most of the land surface variability for the image data being analysed (Yang and Lo, 2002). In their study, Mundia *et al.* (2000) found that 40 classes for TM and ETM+ data was optimum for the reasons that too small numbers produces relatively broad clusters which may not produce true results and too big number produces very pure clusters but very high demanding for computational resources and time. ERDAS 9.1 imagine and Arc GIS 3.2 software enabled to establish a map of major land cover classes before ground truthing to match the reality in the field with the classified image. The

available satellite images had already been corrected for radiometric distortions; the developed sub-scenes were only subjected to geometric correction. According to Lillesand and Kiefer (2008), the geometric correction allows for compensation for various errors introduced by several factors including curvature of the earth, earth rotation effects, atmospheric refractions, relief displacement, variation in platform altitude, panoramic distortions (wide field of view of some sensors), altitude and velocity and panoramic effects related to the imaging geometry.

3.2.3 Preliminary Survey

Preliminary survey was conducted to familiarize with the study area and to check the validity and reliability of the research instruments. The pre-testing of the research instruments was done in Usanganya village. Ten households from the village were interviewed and information gathered was used to modify research questionnaire to fit the actual situation of society and area under research (Goldman and McDonald, 1987).

3.2.4 Research Design and Sampling

The selection of this ward based on existing production systems, with the purpose of capturing a wide range of land uses and land covers. However, using simple random sampling three villages in the ward were selected. A sampling unit for this study was a household growing tobacco. Each household was randomly selected in all villages (Table 2). The sampling intensity for this study was 5% of households growing tobacco in each village (Bailey, 1994).

Table 2: Distribution of sampled tobacco growing households in surveyed villages of Tutuo ward, Sikonge district

Village	Number of households growing tobacco	Sample size	Percentage

Usanganya	603	30	5
Mole	550	30	5
Tutuo	632	30	5
Total	1 785	90	5

3.3 Data Collection

Both primary and secondary data were collected for the accomplishment of this study. The data focused mainly on agricultural activities (specifically on tobacco and sunflower), geographical positioning of existing land uses and forest cover.

3.3.1 Primary Data

The data were collected in three villages namely; Usanganya, Mole and Tutuo. Combination of techniques which were structured questionnaire (with both closed and open-ended questions), participatory rural appraisal (PRA) methods, key informants and GPS mapping were used to collect the data. This combination of methods was used to compliment limitations by one technique and allows cross checking and verification (Olsen, 2004).

3.3.1.1 Socio - economic data

(a) Questionnaire Survey

Questionnaire was administered to a sample of 90 households involve in tobacco cultivation for the purpose of collecting both quantitative and qualitative data (Appendix 2). Information collected focused mainly on number of farmers growing sunflower among sampled households for the purpose of getting the extent farmers changed land use from tobacco to sunflower cultivation. The instrument was also used to collect data on various factors that influenced land use change from tobacco to sunflower cultivation focusing to evaluate the most bio-physical and / or socio-economic factors that influenced the change. Other socio-economic information such as background information

and other activities of respondents were collected during the administration of questionnaire for the purpose of knowing its contribution to factors that influenced a crop switching from tobacco to sunflower cultivation.

(b) Participant observation

Participant observation tool was employed during data collection in order to link the discrete elements of data collected by other methods. According to Kajembe and Luoga (1996), this method as its name implies, is distinguished by the fact that the observer forms part of the situation which he or she is studying. In this study, the method enriches the understanding of the collected information. Additionally, the researcher gained the confidence on the persons being studied, so that his presence did not interfere with the natural course of events. Observing operations in the field gives an opportunity to discuss with the respondents what, how and why things are done and to check what you are told against what you see (Kessy, 1998). In this study, participant observation involved own assessment on various environmental related socio-economic activities, different land uses, farming practices, identification of agricultural crops, agriculture practices and status of forests around Tutuo ward. The observation enabled to highlight the inter linkage between socio-economic activities and environmental effect in relation to forests use.

(c) Participatory rural appraisal

Participatory Rural Appraisal (PRA) was employed to learn about rural conditions in an intensive and interactive manner. The focus group discussions, resource mapping and participant observation were the main tools used in PRA. Focus group discussion was deliberately selected in order to explore information from people of different ages, sex and occupation. As a research tool, PRA guidelines (Appendix 3) served the purpose of opening up discussions with villagers particularly on land use changes due to crop switch

from tobacco to sunflower and its influence on forest resources (Kessy, 1998). Resource mapping were used because it was easily handled by the villagers with minimum level of education to provide useful information. Moreover, in this study this PRA tools were used to identify and locate different Land Uses (LUs) in the study area focusing an examination of the influences of land use change from tobacco to sunflower cultivation on deforestation and regeneration of miombo woodland. The main LUs identified were agricultural, pastoral and construction land uses.

(d) Checklists

Through use of checklist the researcher had information from key informants and focus groups that would have expected to have greater depth of knowledge about issue in question. A key informant for that matter is an individual who is accessible, willing to talk and has great knowledge about issue in question (Mettrick, 1993). This included such people as village elders, village environmental committee members, village natural resource committee members, District Forest Officer (DFO), Non Governmental Organizations (NGOs) representatives and District Agriculture Livestock Development Officer (DALDO).

Information collected from the key informants oriented the researcher to understand the current forest management regime, stakeholders and their common activities or land uses for the purpose of knowing to which extent crop cultivated areas had been replacing forests or other crops. The key informants provided information on conservation strategies, rules, regulations, policies, price of agricultural crops and activities of people that depends on natural resources. This information were important for evaluating the bio-physical and socio-economic factors that influenced land use change from tobacco to sunflower cultivation. Lastly, key informants mentioned the causes of deforestation,

impacts of natural forest depletion and mechanism used to solve the problem. The information were used to examine how different land uses including change from tobacco to sunflower cultivation significantly reduce deforestation and favour regeneration of miombo woodland. Checklist (Appendix 4), were used to obtain information which would supplement formal questionnaire.

3.3.1.2 Geographic data

Ground truthing based on the coordinates introduced on classes of unsupervised classified Landsat 7 ETM+ satellite image of 2009, which gave a general scope of the area by visually observing different land cover type signatures represented in different colours. (Lillesand and Kiefer, 2008). On the unsupervised classified image, the distinct spectral classes present in the imagery data were determined and their information utility were defined. The identification of features was done through first locating easily observable features such as roads, rivers, plantation, forest, woodlands, regenerating vegetation, cultivated (agriculture areas) and bare land; thereafter were related to other features such as vegetation types. The features were georeferenced using GPS receiver. The local community members provided the onsite local knowledge including administrative locations (names of village and sub village), type of present land cover and use, and land cover changes. Additional information on landscape and soil features (texture and relief) was also recorded. The modified signature derived from unsupervised classification were used to derive seven land use / cover classes namely forest, agriculture, grassland, woodland, shrubs, bare land and water as described in T3.

Table 3: Description of land cover /uses classes found in the study area in periods between 1995 and 2000, 2000 and 2005 and between 2005 and 2009

Classes	Description

Forest	This comprises deciduous trees with canopy touching each other dominated with genera *Brachystegia, Isoberlinia* and *Julbernadia* all the family of leguminosae.
Agriculture	This land primarily used for farming and production of food and cash crops. Food crops produced are maize, rice, cassava, sweet potatoes and pulses
Woodland	This comprises trees at least 5 m tall, with most of their crowns not touching each other, but covering at least 30% of the surface. Used as a source of woods and other vegetal needs.
Grassland	This is an open area mostly covered by grasses or sedges, but other herbs and low shurbs are olso present. This vegetation save as grazing land for livestock (cattle, goats and sheep).
Shrub land	This composed of woody plants 0.5-5 m tall. Individual shrubs not touching each other, often with a grass and fast growing shrubs, occurring as pioneers on river beds and near flooded plains. Used as range land for livestock.
Bare land	These areas are not covered with vegetation or water bodies. This comprises the river beds, roads, residential areas, bare exposed rocks and sandy plain.
Wooded grassland seasonally inundated	Wooded grassland comprise an assessed ground cover percent of trees below 10 percent of total. When these grassland areas become covered with large amount of water seasonally then referred to as Wooded grassland seasonally inundated.

Source: Mundia et al., 2000; Evelyne and Camirand, 2003; URT, 2010.

3.3.2 Secondary data

Both qualitative and quantitative secondary data were collected from Sikonge district agriculture and livestock development office, NGOs – (Total Land Care [TLC] and Africare), Sokoine National Agricultural Library (SNAL) and Internet were the major sources of information. Association of Tanzania Tobacco Traders (ATTT) an important source of secondary data concerning tobacco in Tutuo ward.

3.3.3 Data analysis

The quantitative and qualitative information collected through structured questionnaire was coded to facilitate data entry and statistical analysis using Statistical Package for Social Sciences (SPSS) and MS Excel.

3.3.3.1 Descriptive statistics

This was employed to analyze qualitative data and summarize them into percentage and frequency count of households grows tobacco, sunflower and those shifted from tobacco to sunflower cultivation. Bar and pie charts were used to present the extent sunflower replaces tobacco cultivated areas and proportional areas of different land use/cover as existed in different periods in years selected for study. Graphs used to present the trend of land use/cover change for the whole period of study.

3.3.3.2 Inferential statistics

The function of inferential statistics was to provide an idea about whether the pattern described in samples were likely to apply in the population from which the sample were drawn. In this regard therefore, logistic regression was developed to show the shift from tobacco to sunflower land use as dependent variable and factors influences change from tobacco to sunflower as independent variables. The analysis assessed the bio-physical and socio-economic factors influenced changes from tobacco to sunflower land use. A simple correlation was developed to measure the degree of linear relationship between two variables; the area grown sunflower as dependent variable and reduction of deforestation and vegetation regeneration as independent variables.

(a) Analysis of bio-physical and socio-economic factors influencing change from tobacco to sunflower land use

Analytical model adopted is regression. A discrete variable logit assessment of the choice to shift from tobacco to sunflower land use or not was carried out. In this study, 100% sample was included in the model because it was a reasonable first choice for any farmer. The choice of farmer to shift from tobacco to sunflower land use or not was framed as a binary choice which assumed that individual farmers were faced with a choice between two alternatives and the choice depended on identifiable characteristics. The probability of shift choice Pr ($T_i = 1$), was cumulative density function F evaluated at $X_i \beta$, where X_i is a vector of explanatory variables and β is a vector of unknown parameter (Maddala, 1983). This kind of cumulative density function can be modelled using logistic probability function, which has the following form: -

Choice to shift from tobacco to sunflower land use =

$$Pr(T_i = 1) = \exp^{\dagger}((X_i \beta))/\exp^{\dagger}((X_i \beta)) \quad \text{..... (1)}$$

Factors that influences shift of farmers from tobacco to sunflower was discussed by FDG, key informants during PRA and then extracted from questionnaires were the household size, farm size, drought, unreliable tobacco market, low price of tobacco crop per kilogram, farming experience, level of education and age of respondents. The SPSS Version 16 program for windows was used for the analysis.

The estimated model was $SHIFT = b_0 + b_1 HHSZ + b_2 FMSZ + b_3 DROUGHT + b_4 UNRMAKT + b_5 LOPPKGS + b_6 FARMEXP + b_7 LEVEDU + b_8 AGE + \xi$; ..... (2)

where

Dependent variable (Y)

SHIFT	=	Is a qualitative dependent variable which takes a value of 1 if the farmer shifted from tobacco to sunflower and 0 if no shift
Independent variable (X)		
HHSZ	=	Household size
FMSZ	=	Farm size
DROUGHT	=	Drought
UNRMAKT	=	Unreliable tobacco market
LOPPKGS	=	Low price of crop per kilogram
FARMEXP	=	Low price of crop per kilogram
LEVEDU	=	Respondents level of education
AGE	=	Respondent's age
ξ	=	Error term

(b) Analyzing the implication of land use changes due to crop switch from tobacco to sunflower cultivation on deforestation and regeneration

The linear regression coefficient of determinant R^2 used as a measure of the strength of association between increase in area grown sunflower and the reduction of deforestation and / or miombo forest regeneration (Kothari, 2004). The value of R^2 near or equal to 0 implies little or no relationship between x and y. The closer is R^2 to - 1 or 1, the stronger the linear association between x and y. The statistic significance of relationship between x and y was tested by the t - test at a significance level of P (< 0.05). The linear regression was applied to investigate the following association: the relative reduction of deforestation and increment of regenerating forests as tobacco farmers switch to sunflower as an alternative to tobacco.

3.3.3.3 Analysis of satellite image data

Since the GPS points contain information from the field, they were used to train the remote-sensing software to conduct a supervised classification. The GPS points were used

as key to interpret spectral signatures on the images. The signatures which appeared as undefined clusters in unsupervised classification before field work could now be defined in supervised classification to generate specific view on the study area.

The features which were covered by clouds and its shadow were counted whenever observed. Multiple polygons were created for each land cover category to help and ensure that Erdas has sufficient information to create the spectral signatures. Once the training sites developed, Erdas used this information along with the various images of different band width to create spectral signatures from the specified areas. These signatures then used to classify all pixels in the scene. Hard classifiers assigned each pixel in the scene a discrete value or category based on the training sites in the vector layer. Land use/ cover change detection analysis was conducted by using overlays generated from ArcGIS land cover maps produced using Erdas 9.1 imagine software. Land cover change detection matrix tables were developed and used for quantification of land use/ cover changes (Table 7), Maps produced might be contained some errors, therefore accuracy assessment was done. The basic idea in thematic accuracy assessment was to compare the mapped category of each pixel with the actual cover as discovered by ancillary data. Generally, linking remote sensing and socio-economic data achieved by combining information from household survey and time series with remote sensing data. The survey focused on changes in land use and land cover type, which were related to time series of Landsat satellite data to produce maps of land use/ cover change trajectories using change detection techniques (Lambin, 2003).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 The Extent of Replacement of Tobacco Cultivation by Sunflower Cultivation

In Tutuo ward, 44.4 % of sampled households (n = 90) shifted from tobacco to sunflower cultivation (Table 4).

Table 4: Percentage of households shifted from tobacco to sunflower cultivation in 2009/2010 season in Tutuo ward, Sikonge district (n = 90)

Name of Village	Number of tobacco producing households surveyed	Households shifted to Sunflower production	Percentage
Usanganya	30	13	43.3
Mole	30	12	40.0
Tutuo	30	15	50.0

The study showed that, 24.1% of 99.5 ha in Usanganya, 65.6% of 30.5 ha in Tutuo and 23.9% of 71 ha in Mole villages which were under tobacco shifted to sunflower cultivation in the season 2009/10. The former tobacco growers switched from tobacco to sunflower cultivation increasingly from 3.8% in 2000/01 to maximum of 35.3% in 2004/05, then dropped to 3.1% in 2009/10 season. The replacement of areas under tobacco by sunflower increased to noticeable scale by 4.4 % in 2000/01 to maximum of 26 % in 2004/05 season, which then dropped to 2.8% in 2009/10 season (Table 5). Sunflower was introduced in Tutuo ward as an alternative cash crop to tobacco following the Ugalla Community Conservation Project (UCCP) which was initiated in 1998 to address problems related to natural resources conservation, environment and poverty issues in villages around Ugalla conservation area (Kajembe *et al.*, 2004). In the season 1999/2000 sunflower started to be grown intensively in the villages of this ward following unreliable

tobacco market since early 1990s (Yanda, 2010). The replacement of tobacco area by sunflower went up to maximum in 2004/05 season as a result of problems in marketing of tobacco, which was unfair classification according to farmers. This resulted into being offered low prices for their produce and gross inefficiency in the production-marketing system of tobacco.

Table 5: The extent sunflower replaced tobacco from 2000/01 to 2009/10 season in Tutuo ward, Sikonge district

Season	Farmers formerly grew tobacco	Area formerly under tobacco (ha)	Tobacco farmers shifted to sunflower cultivation	Area replaced by sunflower (ha)	Tobacco farmers shifted to sunflower (%)	Area replaced by sunflower (%)
2000/01	291	355	11	15	3.8	4.2
2001/02	250	318	14	17.0	5.6	5.3
2002/03	165	240	35	42.5	21.0	17.7
2003/04	169	254	42	51.0	24.9	20.1
2004/05	241	392	85	102.0	35.3	26.0
2005/06	285	439	81	97.0	28.4	22.1
2006/07	363	529	77	93	21.2	17.6
2007/08	522	703	62	75.0	11.9	10.7
2008/09	591	772	41	49.0	6.9	6.3
2009/10	666	908	21	25.0	3.1	2.8

These problems increased costs and reduced revenues in the input/output markets and prevented the realisation of potential income gains by tobacco growers which led them to change cropping patterns and allocated their resource to alternative crop enterprises (Rweyemamu and Kimaro, 2006, WHO, 2008).

4.2 Bio-physical and Socio-economic Factors that Influence Change from Tobacco to Sunflower Cultivation

Summary of results of logistic regression analysis for Tutuo ward is shown in Table 6. The results showed that unreliable tobacco market and farm size were significantly

influenced farmers to change positively from tobacco to sunflower cultivation. Farming experience significantly influenced farmers negatively i.e. to be reluctant to change from tobacco to sunflower cultivation. Respondents age, drought, level of education, low tobacco price, and household size were non-significant factors. The significance of unreliable tobacco market experienced in villages with tobacco cooperative societies in the ward; which drops a large number of farmers from growing tobacco to sunflower cultivation when tobacco market became unreliable.

Table 6: Bio-physical and socio-economic factors that influence change from tobacco to sunflower land use. Bold type indicates statistically significant factors

	B	S.E.	Wald	df	Sig.	Exp(B)
AGE	0.691	0.401	2.979	1	0.084	1.996
HHSZ	0.181	0.355	0.261	1	0.610	1.199
LEVEDU	1.189	0.970	1.503	1	0.220	3.284
FAMSZ	0.891	0.438	4.143	1	**0.042**	2.438
DROUGHT	0.941	0.556	2.870	1	0.090	2.563
UNRMAKT	2.484	0.682	13.280	1	**<0.001**	11.995
LOPPKGS	0.410	0.596	0.474	1	0.491	1.507
FARMEXP	-0.582	0.186	9.753	1	**0.002**	0.559
Constant	-9.182	4.492	4.179	1	**0.041**	0.000

Model summary: Overall percentage = 81.1 %, Model Chi-square = 4.95, (P < 0. 042), 2 Log Likelihood = 88.70, Nagelkerke R squared = 53.1%.

As long as labour remains relatively scarce, tobacco production a labour-intensive activity, will not remain profitable to farmers holding large size farms (Wichern *et al.*, 1999). Shortage of funds, high price of tobacco inputs and credit is the most limiting factors which influences tobacco farmers with large areas to shift to sunflower cultivation (Jha and Hojjati 1993; Kimhi and Chiwele, 2002).

Farmers who have been growing tobacco for many years are reluctant to shift from tobacco to sunflower production as they compare a higher gross margin of flue-cured

tobacco per kilogram with other alternative cash crops (Monela and Abdallah, 2007). The investments made by the tobacco companies in production by providing loan of inputs discourage experienced farmers to switch from tobacco to sunflower cultivation, where there is a minimal or no support to farmers who shifts from tobacco (Rweyemamu and Kimaro, 2006).

4.3 Land Use / Cover Change on the Study Area between 1995 and 2009

The land use / cover distribution for each study year as derived from the maps in Fig. 3 – 6 and are presented in figures 7 – 10 below. The results from Fig. 3 shows that in 1995 the agriculture land use concentrated on the southern east of the ward near Tutuo village. In figure 7, forest covered 51.55% of the total area of the interpreted area in the ward. Woodland covered 24.48% of the area in the ward. The area left 6.19%, 6.49% and 6.19% covered by grassland, agriculture and wooded grassland seasonally inundated respectively. Wooded grassland seasonally inundated found to contain ponds, swamps, season rivers and flood plains during rain seasons.

In 2000, the results from Fig. 7 and 8 shows that the area under agriculture land use increased by 2.39% between 1995 and 2000. The forest and woodland covers decreased by 24.66% and 6.3% respectively. Grasslands increased by 6.92%. Agriculture land use found to cluster on upper areas and extended from south to north of the study area. Grasslands were found to spread around agricultural areas and around degraded forests or woodland (Fig. 4). Wooded grassland seasonally inundated and shrubs areas were found to increase by 7.02% and 5.29 respectively. Bare land found to appear in this year of study occupying 9.35% of the total interpreted area.

The results for 2005 are shown by Fig. 8 and 9. The agriculture land uses found to decrease by 0.9% between 2000 and 2005. The forest cover found to decrease by 11.66%. Woodland cover decreased by 2.05%. Grassland increased slightly at this period by 1.51%. Wooded grassland seasonally inundated, shrubs and bareland areas increased by 6.28%, 4.52% and 2.3% respectively. Results from Fig. 5 shows that, agriculture activities shifted from north towards the south of the ward. Deforestation shifted towards the west of the ward and wooded grassland seasonally inundated found to spread on degraded low land parts of the ward.

The results from Fig. 9 and 10 shows that in 2009 agriculture land use, bareland, woodland, and grassland covers increased by 2.74%, 4.09%, 0.95% and 0.85% respectively. Forest, shrubs and wooded grassland seasonally inundated covers found to decrease by 1.17%, 1.20% and 6.25% respectively. The map in Fig 6 shows that, agriculture land use concentrated on the central part of the ward at this year of study. Forest cover shows a slight decrease and its degradation increased towards the west of the ward. There was slight increase in grassland which spread almost the whole area of study. Woodlands increased slightly as regeneration of miombo woodlands that appears on the eastern part of the ward. Wooded grassland seasonally inundated and shrub areas observed to decrease. Bareland found to increase and spread on the central part of the ward.

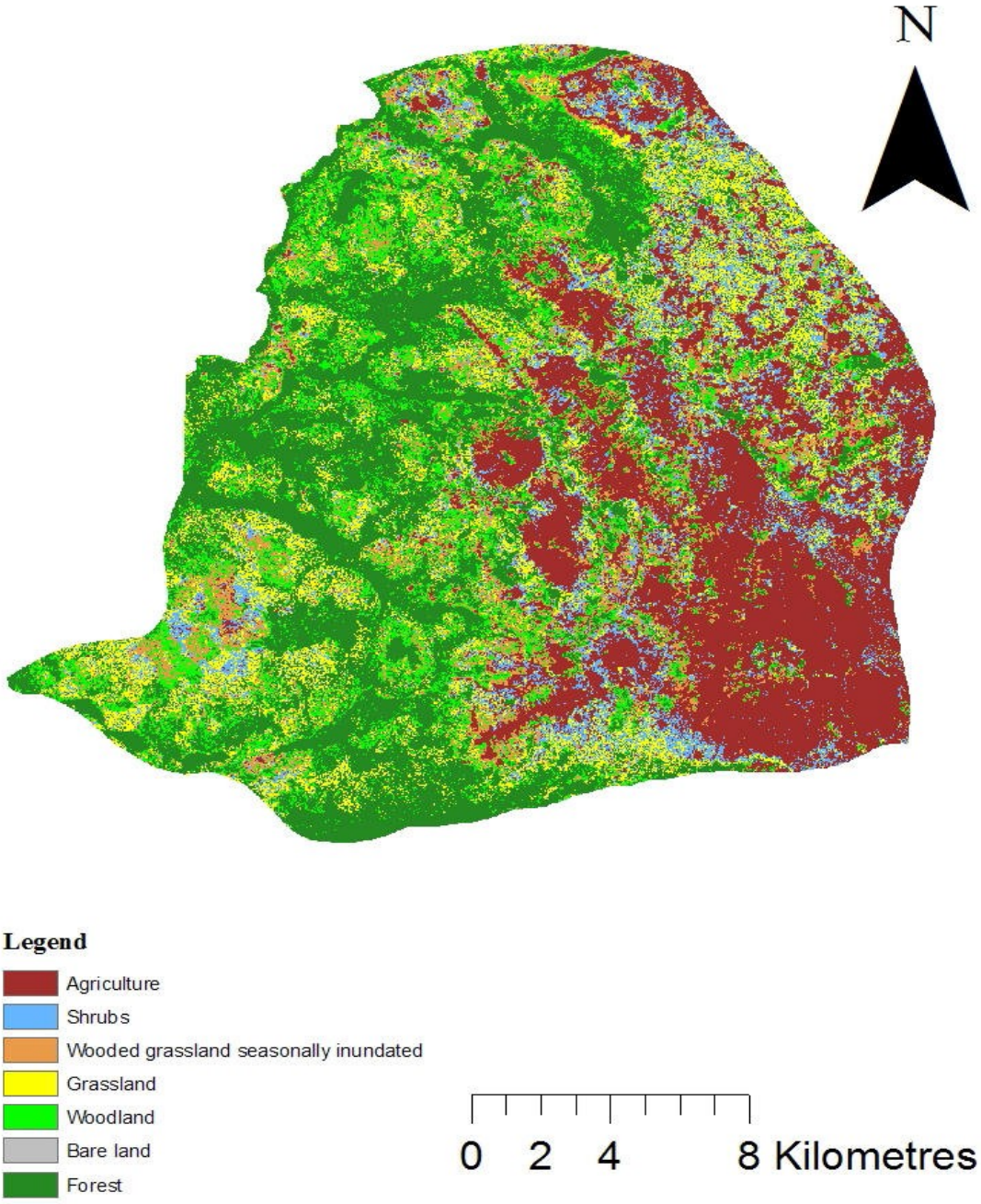

Figure 3: Map of Tutuo ward showing forest cover and other land use/cover in 1995

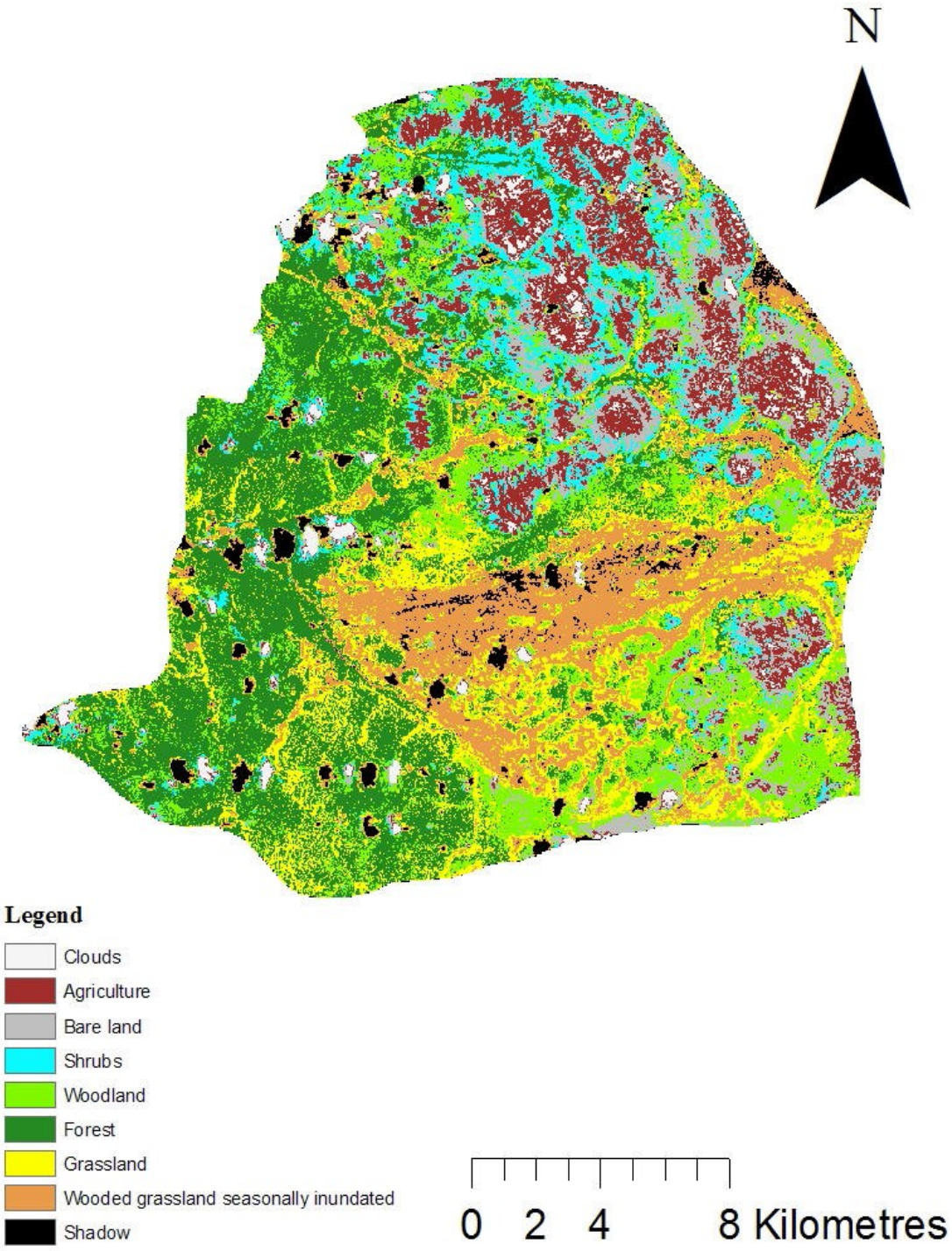

Figure 4: Map of Tutuo ward showing forest cover and other land use / cover in 2000

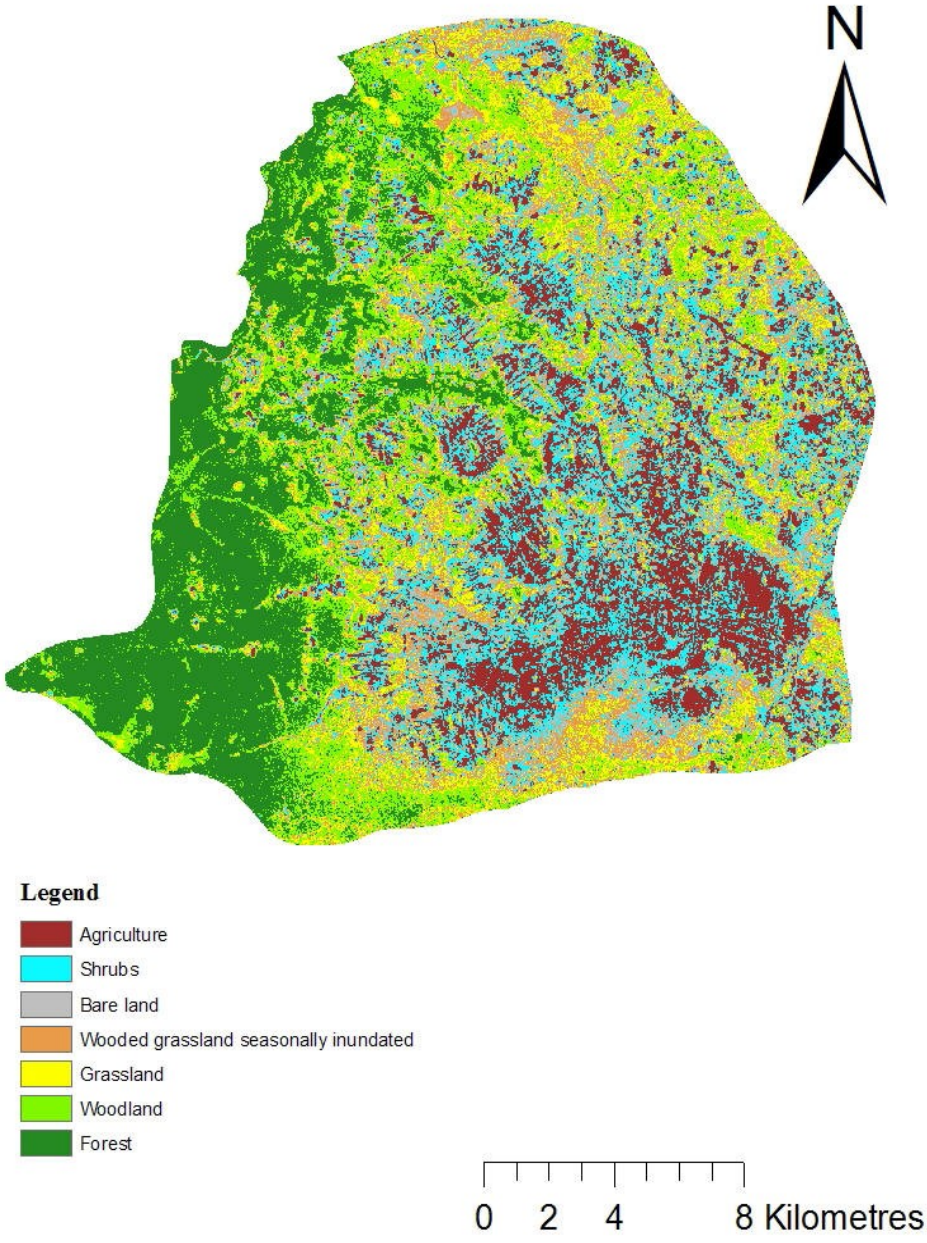

Figure 5: Map of Tutuo ward showing forest cover and other land use / cover in 2005

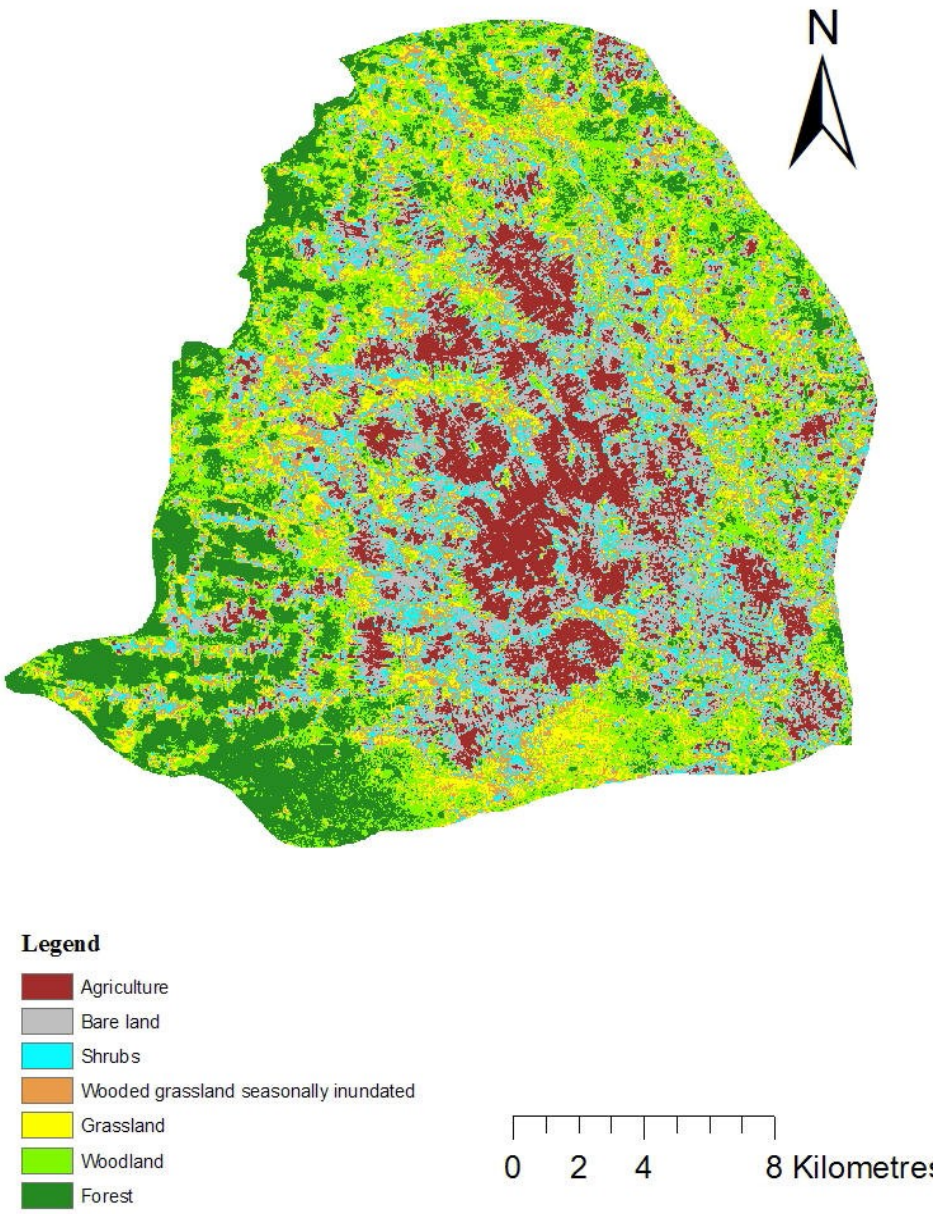

Figure 6: Map of Tutuo ward showing forest cover and other land use/cover in 2009

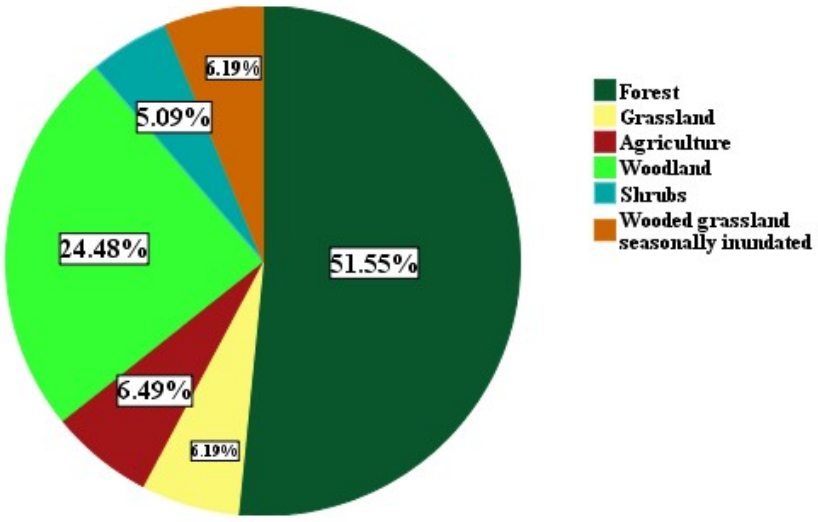

Figure 7: Land use / cover types in Tutuo ward, Sikonge district 1995

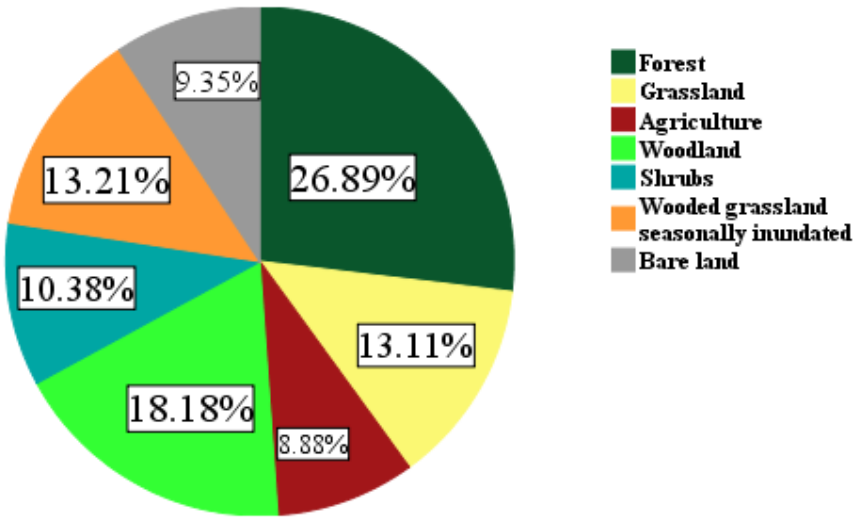

Figure 8:Land use / cover types in Tutuo ward, Sikonge district 2000

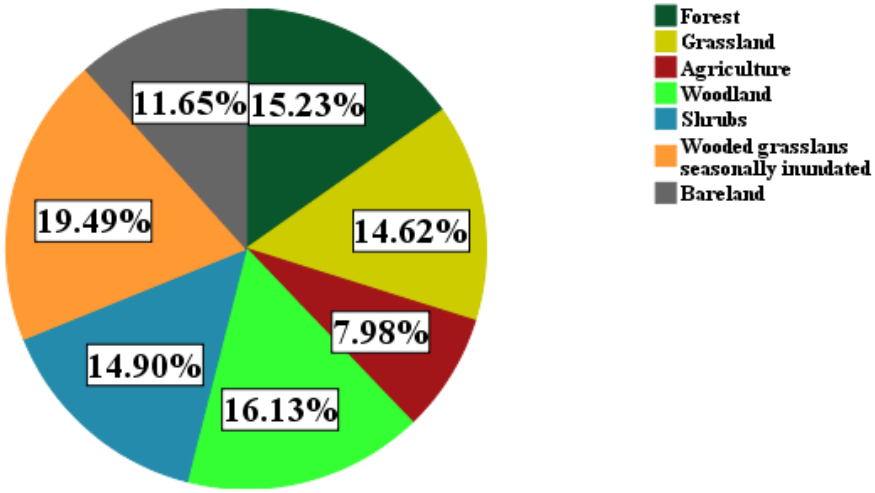

Figure 9: Land use / cover types in Tutuo ward, Sikonge district 2005

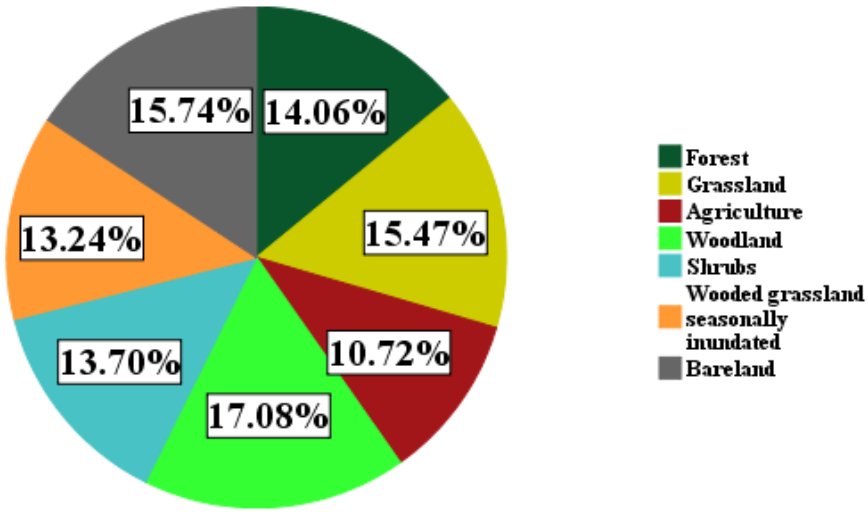

Figure 10:Land use / cover types in Tutuo ward, Sikonge district 2009

4.4 Trend of Change of Land Use/ Cover from 1995 to 2009

There has been a remarkable land use/ cover change in Tutuo ward from 1995 to 2009. Fig. 11 and Table 7 below, show a trend of change and quantity of each class of land use/ cover types in different periods of study.

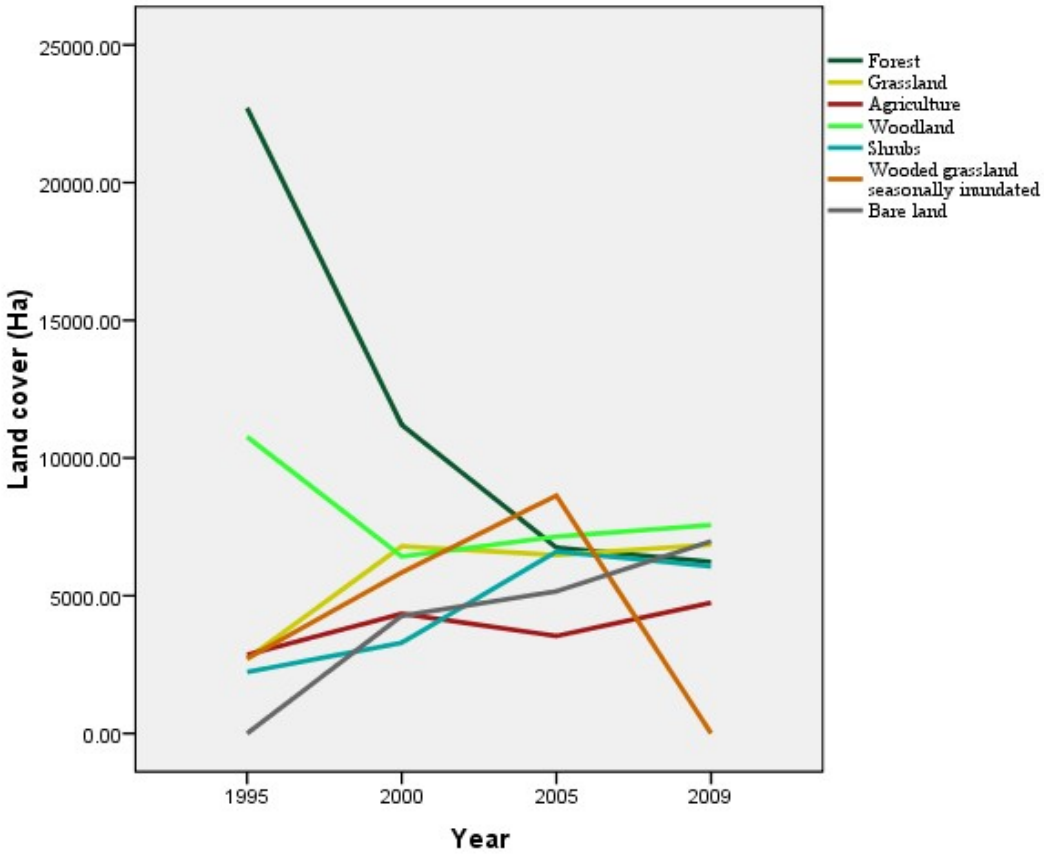

Figure 11: Trend of change of land use/ cover types in Tutuo ward, Sikonge district between 1995 and 2000, 2000 and 2005 and between 2005 and 2009

Table 7: Change in land use/ cover area from 1995 to 2000 in Tutuo ward, Sikonge district

LAND USE/COVER	1995 (ha)	2000 (ha)	2005 (ha)	2009 (ha)	Difference between 1995 and 2000		Difference between 2000 and 2005		Difference between 2005 and 2009	
					ha	%	ha	%	ha	%
Forest	22711.72	11201.76	6748.09	6230.83	-11509.96	-50.7	-4453.67	-39.76	-517.26	-7.67
Grassland	2712.26	6795.63	6478.51	6853.49	4083.37	150.6	-317.12	-4.67	374.98	5.79
Agriculture	2858.25	4348.62	3537.82	4749.59	1490.37	52.1	-810.80	-18.64	1211.77	34.25
Woodland	10771.90	6324.84	7148.69	7566.78	-4447.06	-41.3	823.85	13.03	418.09	5.85
Shrubs	2228.33	3294.41	6602.07	6069.07	1066.08	47.8	3307.66	100.40	-533.00	-8.07
Wooded grassland	2717.71	5845.68	8636.55	5868.98	3127.97	115.1	2790.87	47.74	-2767.57	-32.04
seasonally inundated										
Bare land	0.00	4271.06	5160.44	6973.43	4271.06	-	889.38	20.82	1812.99	35.13
Un- interpreted cover	312.00	2230.17	0.00	0.00	1918.17	614.8	-2230.17	-100.00	0.00	0.00
Total	44312.17	44312.17	44312.17	44312.17	-	-	-	-	-	-

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The results indicate that there was a decrease in forest cover by 11 509.96 ha (rate of-10.14% per year) between 1995 and 2000, 4 453.67 ha (rate of -7.95% per year) between 2000 and 2005; and 517.26 ha (rate of -0.92% per year) between 2005 and 2009. The trend shows that the forest cover generally decreased between 1995 and 2009, while its rate of decrease per year also decreased. The rate was higher between 1995 and 2000. This situation was attributed to fluctuation of agriculture land use for crop production especially tobacco cultivation, a crop which has been associated with nearly 96% of all deforestation cases in miombo ecosystems (Abdallah *et al.*, 2007). The rate of forest depletion decreased between 2000 and 2009 because of lowering of price and unreliable market of tobacco crop between seasons 1999/2000 and 2003/2004 which led the majority of tobacco farmers to neglect tobacco cultivation and some of them to shift for alternative crops including sunflower.

The woodland decreased by 4 447.06 ha (rate of -8.26% per year) between 1995 and 2000, increased by 823.85 ha (rate of 2.61% per year) between 2000 and 2005; and 418.09 ha (rate of 1.46% per year) between 2005 and 2009. Woodland cover change started by high rate of decrease between 1995 and 2000 because of the increase of clearing of land for cultivation and wood extraction for fuelwood. The cover found to increase between 2000 and 2009; because of degradation of miombo forest converted into woodlands (Panigrahy *et al.*, 2010) and regeneration of miombo woodlands occurred in southern east and eastern part of the ward. The reasons for this regeneration was the shifting of agriculture activities from one point to another in the ward (as shown in Fig. 3 to 6 above) following newly-cleared land and fuel wood for tobacco curing (Mangora, 2005).

Agriculture land increased by 1 490.37 ha (rate of 10.42% per year) between 1995 and 2000, decreased by 810.80 ha (rate of -3.73% per year) between 2000 and 2005 and then

increased by 211.77 ha (rate of 8.56% per year) from 2005 to 2009. The fluctuations in agriculture production were due to unreliable climate such as too much rainfall and/or drought (Mwamsamali, 1997). The agriculture land use in the study area dominated by tobacco; a cash crop which requires extensive virgin land to support shifting cultivation and the need for sufficient forest areas to supply fuel wood for tobacco curing (Temu, 1980). The period between 2000 and 2005, some of the farmers in the ward started to change land use from tobacco to sunflower cultivation which contributed to forest improvement.

Grassland increased by 4 083.37 ha (rate of 30.12% per year) between 1995 and 2000, decreased by 317.12 ha (rate of -0.93% per year) between 2000 and 2005, and again increased by 374.98 ha (rate of 1.45% per year) between 2005 and 2009. The increase of grassland stemmed obviously from the agricultural lands left to fallow (IPCC, 2001) and intense precipitation events which accelerate nutrient cycling and germination of grass (Sutherst, 2000).On other hand, the decrease in grassland cover was due to its conversion into agricultural production which weaken native grass, and lead to the loss of it (Dale *et al*., 2000); also livestock grazing diminished grassland by compacting soils which may increased vulnerability to drought and accelerated desertification (Robertson, 1996).

Shrubland increased by 1 066.08 ha (rate of 9.57% per year) between 1995 and 2000, 3 307.66 ha (rate of 20.08% per year) between 2000 and 2005 and decreased by 533.0 ha (rate of -2.02% per year) between 2005 and 2009.The shrubland increased as the agriculture land left under fallow, as learned in 2009/10 survey that 73% of households in the study village practised land fallow. The land was found to be left under fallow for 1 year, 2 to 3 years and 4 to 5 years. Majority of farmers in the study area found to let their lands to fallow between 2 to 3 years.

Bareland observed to appear and increased up to 4 271.06 ha between 1995 and 2000, increased by 889.38 ha (rate of 4.16% per year) between 2000 and 2005; and 1 812.99 ha (rate of 8.78% per year) between 2005 and 2009. Bare land increases because of human activities such as agriculture, settlement establishment and construction of infrastructures such as roads (Diallo and Bao, 2010). The sand plains and seasonal river beds left after floods are also bare land observed (MIRIS, 1980).

Wooded grassland seasonally inundated increased by 3 127.97 ha (rate of 23.02% per year) between 1995 and 2000, 2 767.57 ha (rate of 9.55% per year) between 2000 and 2005; and decreased by 2 767.57 ha (rate of -8.01% per year) between 2005 and 2009. The wooded grassland seasonally inundated area increased at the period between years 1995 and 2000 was a result of floods caused by El-Niño rainfalls these heavy rainfall on the study area added ground water resources which found to caused flooding of wooded grasslands and seasonal rivers added water on the plains in the period between 2000 and 2005 (Barrena *et al.*, 2007). Wooded grassland seasonally inundated area found to decrease at the period between 2005 and 2009 because of drought during this period (Wilhite, 2005), the reason which led some areas of wooded grassland flood plains to be converted into agricultural land use (Fig. 5 and 6).

4.5 Implication of Land Use Change from Tobacco to Sunflower Cultivation to Deforestation and Woodland Regeneration

The trend in Fig. 12 shows that deforestation rate decreases as the area replaced by sunflower increases although the result from linear regression show that there is no significant relation between deforestation rate and increase of area under tobacco replaced by sunflower in Tutuo ward ($R^2 = 0.22$; $F_{1,1} = 0.29$; $P = 0.686$).

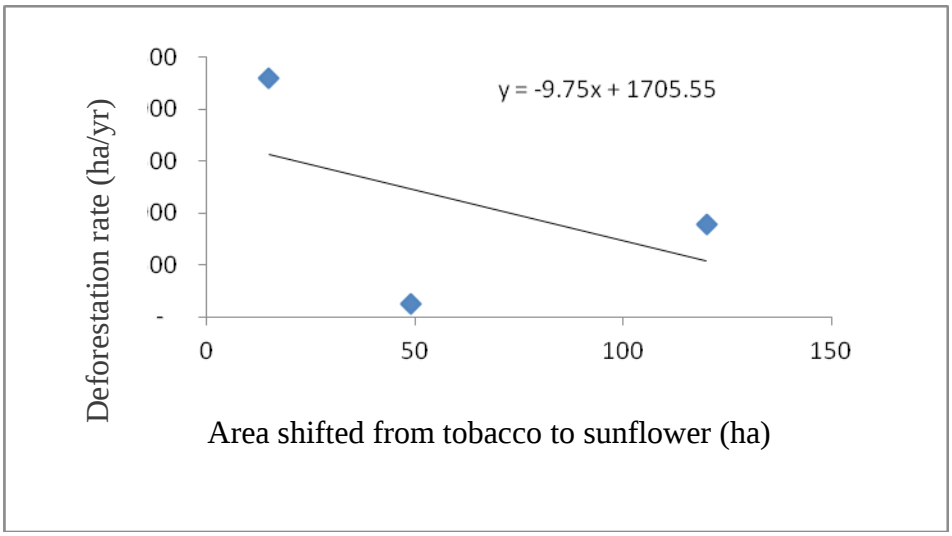

Figure 12: Relationship between rate of deforestation (ha/yr) and area shifted from tobacco to sunflower (ha)

On the other hand, the trend in Fig. 13 shows that there is an increase of regeneration rate of miombo woodland as the area replaced by sunflower increases but the result from linear regression shows that there is no significant relation between regeneration rate of miombo woodland and an increase of the tobacco area replaced by sunflower in Tutuo ward ($R^2 = 0.61$; $F_{1,1} = 1.55$; $P = 0.430$).

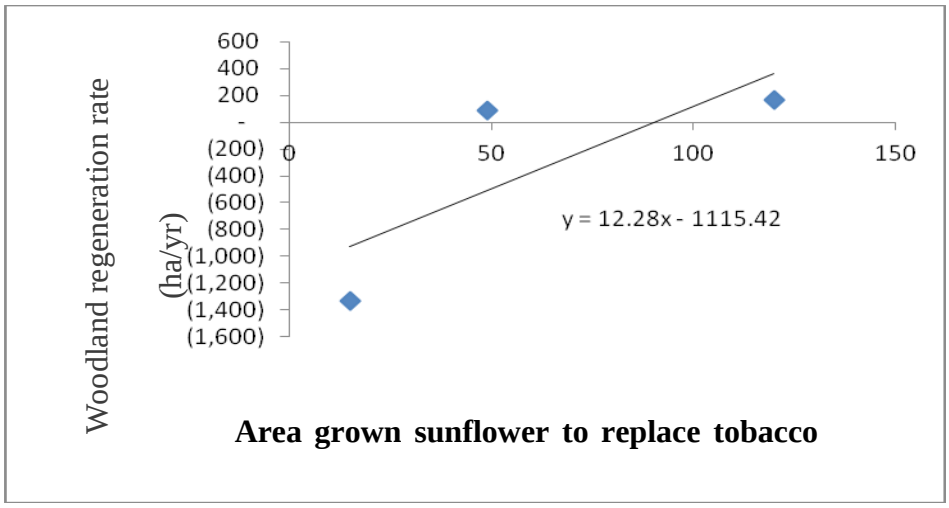

Figure 13: Relationship between rate of regeneration of miombo woodland (ha/yr) and area shifted from tobacco to sunflower (ha)

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 The Extent of Land Use Change from Tobacco to Sunflower Cultivation

This study revealed that, there was a change in agriculture land use when farmers switched from tobacco to sunflower cultivation in Tutuo ward. Tobacco farmers in the ward have started to shift from tobacco towards sunflower cultivation. The sunflower cultivation has replaced tobacco to an extent that 44.4%. of farmers under survey found to shift from tobacco to sunflower in 2009/10 season and study from secondary data revealed that up to 35.3% of tobacco farmers' households switched from tobacco to sunflower, and an area up to 26% of tobacco were replaced by sunflower in the period between 2000/01 and 2009/10 seasons.

5.1.2 Bio-physical and social economic factors that influence land use change from tobacco to sunflower cultivation

The factors which significantly influenced the land use change from tobacco to sunflower cultivation were unreliable tobacco market and farm size. The tobacco market fluctuation seems to govern the farmers' decision either to grow tobacco or not. The differing in classification between farmers and buyers leads to lowering of price of tobacco leaves per kilogram; the situation which led to negative attitude towards tobacco cultivation. Another social concern associated with the farm size which led to the positive shift from tobacco to sunflower cultivation as labour is relatively scarce, shortage of funds, high price of tobacco inputs and lack of credit are the most limiting factors which influences tobacco farmers with large size farms to replace some or whole parts of their farms with alternative cash crops. The factor that was likely to weaken significantly the switching from tobacco

to sunflower cultivation in the ward was the farming experience (i.e. being a tobacco farmer for a many years). In fact those farmers with experience in growing tobacco resist shifting for sunflower when they compare difference of gross income between the two crops.

5.1.3 The land use/cover changes in the study area

The study reveals that the land use/ cover types found in the study area at the period between 1995 and 2009 were forests, woodlands, grasslands, shrubs, agriculture, bareland and wooded grassland seasonally inundated areas. The changes were obvious to all land use/ cover in the study area at this period. Generally forests and woodland were found to cover almost half and one third of the total area of the ward respectively in 1995. Forests and woodland covers were found to decrease between 1995 and 2009; although the rate of deforestation decreased at this period. Agriculture, grassland, shrubs, bareland and wooded grassland seasonally inundated were found to increase between 1995 and 2009.

5.1.4 The Influence of land use change from tobacco to sunflower on deforestation and regeneration of miombo woodlands

The finding from the study reveals that, there is no significant evidence that the agricultural land use changed by switching from tobacco to sunflower to have an influence on deforestation and regeneration of miombo woodland. But the introduction of sunflower as an alternative cash crop to tobacco in the ward found to have a hopeful trend that observed to reduce deforestation rate and had every sign of favouring forest regeneration.

5.2 Recommendations

Tobacco farmers in villages are insisted to take more measures against deforestation. Among them are the introduction of more alternative cash crops, improvement of

household woodlots, and construction of efficient curing barns and strengthening of community based forest management.

5.2.1 The need for more alternative cash crops

Besides the fact that the introduction of sunflower as an alternative to tobacco, has shown a hopeful performance to the expectations, the ward should continue to work towards providing farmers with more alternative cash crops such as groundnuts and palm oil trees. Although switching from tobacco to alternative crops saves forest but crops such as sunflower is less lucrative, what should the government or interested parties do to save the forest while alleviating poverty at the same time?

5.2.2 Improvement of household woodlots

Woodfuel is the main source of energy for tobacco curing in this area. Lack of alternative and affordable source of energy has contributed to the degradation of natural forest due to uncontrolled harvest that exists in this ward. Farmers should be required to establish woodlots on their farms as among of the conditions required for a farmer to produce tobacco.

5.2.3 Construction of efficient curing barns

In this ward there were less than 1% of improved tobacco curing barns, this implies that majority of tobacco farmers are still using large volume of fuelwood to cure tobacco leaves from one hectare. The volume of fuel wood extracted from the natural forests situated on village open lands is still high because majority of farmers are unable to afford costs of constructing improved barns. Therefore construction of improved curing burns such as rocket and Brazilian barns should be under subsidy in order to enable all tobacco farmers to have the structures which will use the fuel wood efficiently.

5.2.4 Strengthening of community based forest management

Building of community based forest management (CBFM) institutions that are representative of the different interests among the local actors and sensitive to the dynamics of power relations in the communities is an intensive and time consuming process. The villages of this ward should be advised to reduce uncontrolled use of forest by establishing village reserves. These should originate from participatory land use management of villages.

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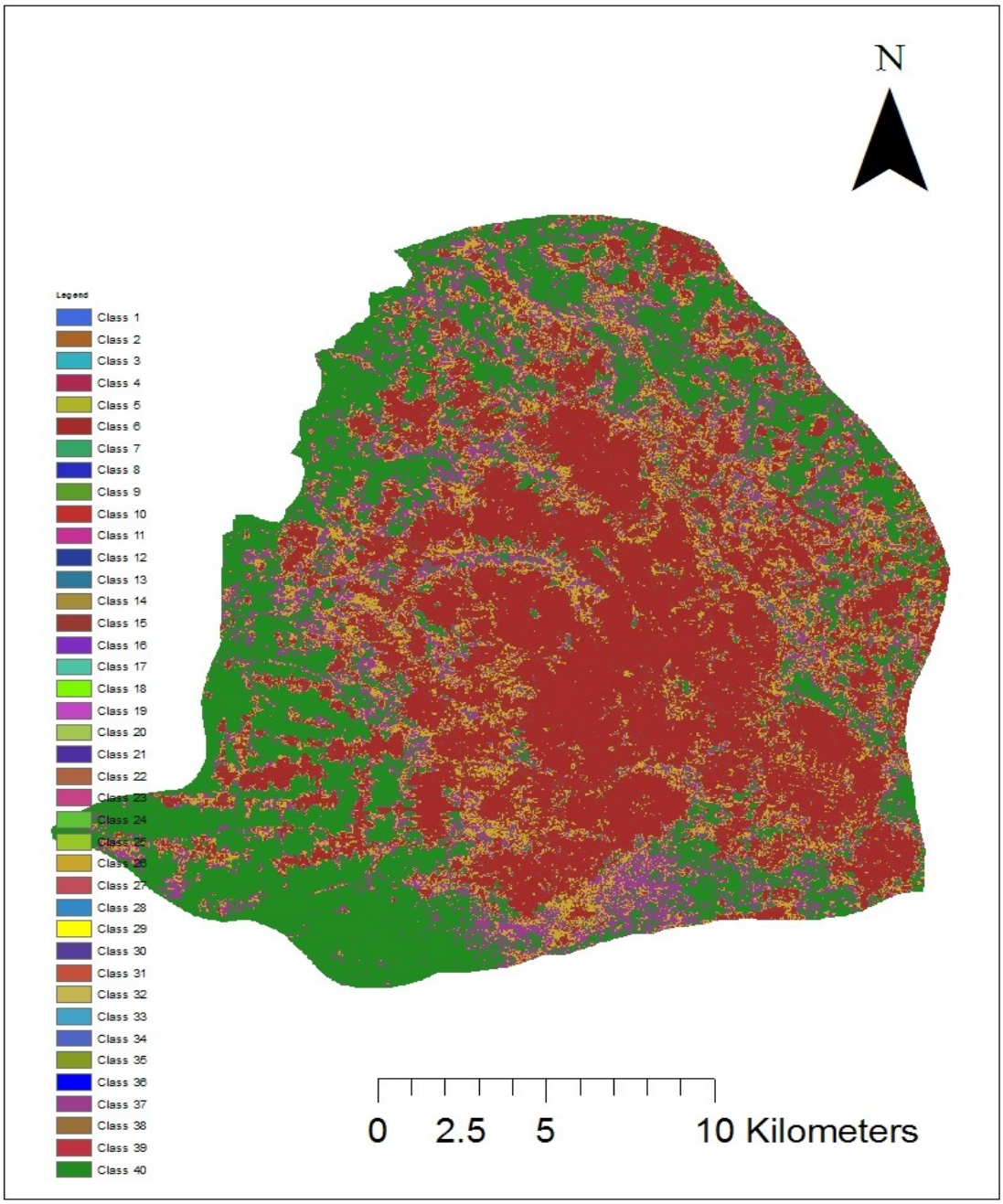
APPENDICES

Appendix 1: Out print of unsupervised classification of Landsat EMT+ acquired in 2009



Appendix 2: Household questionnaire for socio-economic data

SUNFLOWER AS AN ALTERNATIVE TO TOBACCO AND ITS IMPLICATION TO DEFORESTATION IN SIKONGE DISTRICT, TABORA REGION

1. Background information

Questionnaire No. …….…….

Date of interview ……

District ……

Ward …….....…….

Village ……..…….

Sub – village ……..……...……..

Name of Interviewer ……..…….……

1.1 Name of respondent (Head of household) …….....…….…….

1.2 Sex of respondent …….....…….

1.) Yes

2.) No

1.3 Age …….....……..,……years

1.4 Marital status …….…….…….....……..

1.5 Tribe …….…….....…….

1.6 Place of birth ……...…..…….……

1.7 Years of residence in this village ……...…...…….…….……years

1.8 Place of usual residence ……..…...…….…….

1.9 Did you shift to this village? …….....……..……..

1.) Yes

2.) No

1.10 If YES in 1.9, what are the reasons for shifting? …….……...…….

1.11 What is your main occupation?....……...……...…….

1.) Farming

2.) Business

3.)Government worker (specify .....)

4.) Politician

5.) No occupation

6.) Other (specify .....)

1.12 Household composition in number

No	Category of members	Number	How contribute on farm
1	**Adult**		
	Male		
	Female		
2	**Children**		
	Male		
	Female		
3	**Dependants**		
	Male		
	Female		
	Total		

1.13 What is your belief (religion)?

1.) Pagan

2.) Christian

3.) Islamic

4.) Others (specify .....)

2.0 Farmers socio-economic status

2.1 What is your highest level of education?

1.) No formal education

2.) Adult education

3.) Primary education

4.) Secondary education

5.) College

6.) Others (specify .....)

2.2 What is your social position?

1.) Peasant/ small scale farms

2.) Political leader

3.) Traditional leader

4.) Employee (specify .....)

2.3 What is the major source of income?

1.) Farming activity

2.) Non-farm activity

3.) Both 1.) & 2.)

4.) Others (specify .....)

3.0 Land use and land tenure

3.1 Does your household own land for agriculture use? ……...…….….

1.) Yes

2.) No

3.2 If 3.1 is Yes how did you acquire land? .....

1.) Purchase

2.) Rented

3.) Inherited

4.) Both 1.) & 2.)

5.) Both 2.) & 3.)

6.) Offered by Village government

7.) Others (specify .....)

3.3 How long have you owned the land? …….....……...…years

3.4 How large is your land area (acres)? …….....…….…..……

3.5 Which type of crops do you grow on your land?

FOOD CROPS			**CASH CROPS**		
No	**Crop**	**Acres**	**No**	**Crop**	**Acres**
1			1		
2			2		
3			3		
4			4		
5			5		

3.6 Have you ever grown tobacco on your farm?.....

1.) Yes

2.) No

3.7 How many acres have you cultivated tobacco this season? …….....……

3.8 For how long have you been growing tobacco? ……....….. years

3.9 How many acres of tobacco have you cultivated in the following seasons

Season	**Acre**	**Kilograms of tobacco harvested**
2006/2007		

2007/2008		
2008/2009		

3.10 Did you shift from tobacco to sunflower as an alternative cash crop to tobacco? .....

1.) Yes

2.) No

3.11 How many acres have you cultivated sunflower this season? ……...……

3.12 For how long have you been growing sunflower? …….....…….……years

How do you plant sunflower?

1.) Pure stand

2.) Mixed with other crops

3.) Other ways (specify .....)

3.13 How many acres of sunflower have you cultivated in the following seasons

Season	**Acres**	**Kilograms of sunflower harvested**
2006/2007		
2007/2008		
2008/2009		

3.14 Do you practice land fallow? …….....…….……..

1.) Yes

2.) No

3.15 If 'Yes' how many years do you allow your field to fallow? ……...…….…… years

3.16 Have you abandoned the tobacco farm? …….....…….……

1.) Yes

1.) No.

3.17 If 'Yes', why? ……..……..……..

3.18 Do you keep any livestock? ……....…….

3.19 If 'Yes' in 3.19, which type of breed, quantity and type of feeding system?

Type of Livestock	Number kept	Year when started to rise	Livestock raising system 1 = zero grazing 2 = Private pasture 3 = Communal pasture 4 = On farm livestock	Breed 1 = local 2 = Pure 3 = Cross

4.0 Household energy supply

4.1 What is primary source of energy in your household for : -

4.1.1 Source of energy for cooking

1.) Electricity

2.) Charcoal

3.) Wood

4.) Others (specify .....)

4.1.2 Source for lightning?

1) Electricity

2) Kerosene

3) Others (specify.....)

4.1.3 Source for tobacco curing? (if tobacco grown by household)

1.) Wood

2.) Crop residue

3.) Charcoal

4.) Others (specify .....)

4.1.4 If in 4.1.1 is(2)& (3) and in 4.1.3is (1) & (3), where normally is its source?

1.) Household woodlot/ Ngitiri

2.) Natural forest (village open land)

3.) Natural forest (reserve)

4.) Others (specify .....)

5.0 Factors influencing land use change from tobacco to sunflower

5.1 Why did you decide to shift from tobacco growing to sunflower?

5.1.1 Bio-physical influencing factor

No	Factor	Rank
1	Soil borne tobacco diseases	
2	Soil fertility	
3	Drought	
4	Others (specify)	

5.1.2 Socio-economic influencing factors

No	Factor	Rank
1	Unreliable crop market	
2	Conservation policy	
3	High price of tobacco inputs	
4	Low price of crop per kg	
5	Fuel scarcity	
6	Lab our scarcity	
7	Farming experience	
8	Lack of cash loan	
9	Others (specify)……..	

6.0 Natural resource conservation

6.1 Do you perceive environmental destruction in your field?

1.) Yes

2.) No

6.2 If YES in 6.1 above, what features lead you to believe that such a problem exists

1.) .....

2.) .....

6.3 What kind of destruction occurs?

1.) .....

2.) .....

6.4 Do you take any measures to control environmental destruction?.....

1.) Yes

2.) No

6.5 If YES in 6.4, which measures do you take?

1.) .....

2.) .....

3.) .....

6.6 Are you planting trees for tobacco curing and / or domestic use?

1.) Yes

2.) No

6.7 If ‘Yes’ in 6.6 above, are trees planted in use?

1.) Yes

2.) No

6.8 If ‘No’ in 6.7 above, why?

1.) Trees are still young

2.) Trees did not survive

3.) Others (specify .....)

6.9 If you grow tobacco, what type of curing burn do you use?

1.) Local barn

2.) Brazilian barn type

3.) Rocket barn type

4.) Others (specify .....)

THANK YOU

Appendix 3: Checklist for participatory rural appraisal (PRA)

PRA group members (two members from each group)

1. Members from the village government for the selected villages
2. Members of the Village Natural Resource Committee
3. Prominent people in the village (preferably old people)
4. Women representatives
5. Youth

Issues to be discussed in PRA

6. Resource mapping
7. Identification of land uses which is existing in village and how it affects natural resources.
8. Identification of agricultural land use in the village.
9. Identifying the areas dominated by tobacco land use for long time.
10. Identifying years in which tobacco was grown at the peak.
11. Identifying the effects of tobacco to environment especially forest.
12. Identify the source of fuelwood and volume used per acre of tobacco.
13. Identifying the measure taken to reduce deforestation.
14. Identify the year when sunflower were introduced.
15. Identifying factors influencing the change of tobacco land use to sunflower.
16. Identify other types of alternative crops / activities.
17. Identification of regenerating areas.

THANK YOU

Appendix 4: Checklist of questions for key informants

Key informants

18. **Village leaders**
19. **Representatives of NGOs and CBOs working in** Sikonge district
20. District Forest Officers
21. District Agriculture and Livestock Development Officer - Sikonge
22. Field Officer from Ugalla Community Conservation Project in Sikonge District

Issues to be discussed and collected

23. General information
    1. Date……Place of interview…….
    2. Name …….Sex…….……
    3. Position……..……
24. What types of the land uses which is existing in the district and how it affects its natural resources?
25. What are the agriculture land use commonly practised in the district and Tutuo ward?
26. What are the types of food and cash crops grown in the district?
27. Which areas are dominated by tobacco production in the district?
28. What are problems associated with tobacco as a cash crop?
29. What are indicators which show that tobacco causes natural forest resource degradation
30. What are the effects of tobacco to the environment specifically forest resources.
31. What are the potential mechanisms that are used to solve the problem?
32. What types of alternative crops are grown in the district?
33. When did sunflower introduced in the district?
34. To which extend do farmers shift from tobacco to sunflower in Tutuo ward?
35. What were the trend of switching from tobacco to sunflower between 2000/01 and 2009/10 seasons? (Number of farmers and area replaced hectare)
36. Which factors influences the crop switch from tobacco to sunflower
37. What are current strategies that are used to solve the natural forest depletion in the district villages?

THANK YOU