ASSESSING THE LAND USE FIRE TRADEOFFS AND IMPLICATIONS TO LIVELIHOODS IN REDD+ PILOT AREA OF KILOSA DISTRICT, TANZANIA

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

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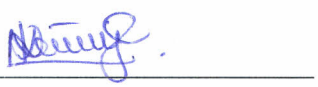
ABSTRACT

The current study was conducted in Kilosa REDD+ pilot area to determine the land use-fire tradeoffs and implication to livelihoods. In this study, fire regimes, uses of fire in land-use practices as a management tool were assessed and the opportunity cost of fire as a land-use management tool was determined. Data were collected through the use of household questionnaire survey, focus group discussions and in-depth interviews. The collected data were analysed using SPSS and inferential statistics. Net Present Value was used to determine profitability of land use practices with a discount rate of 10%. The findings showed that fire usually occurred twice a year specifically in late August and early November and these fires were reported as severe causing great loss of ecosystem. On average, approximately 4ha of forest land was reported to be destroyed in each fire incidence. Most fires were caused during farm preparations or hunting and there were no reported cases of fire originating from pastoralists although they have been implicated in other studies. Regular and intense fire in the area could impact some livelihood strategies such as farming and grazing. Economic assessment showed that some land-use practices such as agriculture, livestock keeping, pit sawing, charcoal making and hunting can be profitable without using fire as a management tool. On the contrary, profitability from honey gathering increased with fire. It is recommended that communities have to be encouraged to engage in modern land use practices that are sustainable and abandon the conventional practices that demand an input of fire in operation. However, there is a need of more emphasis on conservation education particularly fire suppression strategies at community level but also communities in collaboration with the District government should implement sustainable land management practises and lastly further economic valuation of environmental aspects in relation to livelihood strategies is necessary.

DECLARATION

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



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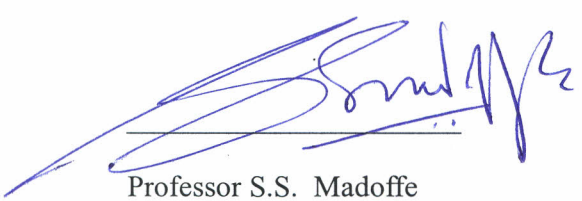

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DEDICATION

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LIST OF ABBREVIATIONS AND SYMBOLS

CFM	Community Forest Management
CFR	Catchment Forest Reserve
COP	Conference Of Parties
FBD	Forest and Beekeeping Division
GFMC	Global Fire Monitoring Centre
HH	Household
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NBS	National Bureau of Statistics
NetMBA	Internet centre for Management and Business Administration
NPV	Net Present Value
PES	Payments for Ecosystem Services
PFM	Participatory Forest Management programme
REDD	Reducing Emission from Deforestation and forest Degradation
SPSS	Statistical Package for Social Sciences
TFCG	Tanzania Forest Conservation Group
TSh	Tanzanian Shillings
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
WWF	World Wildlife Fund for nature

CHAPTER ONE

1.0 INTRODUCTION

Reducing Emission from Deforestation and Forest Degradation (REDD) is an international scheme that aims to reduce emissions from deforestation and forest degradation in developing countries by preserving the existing natural forests through incentive provisions to communities (IPCC, 2007). The central idea of REDD is to develop a multilevel system of payments for ecosystem services (PES), this involves performance-based financial compensation to forest adjacent communities to protect forest, use less forest land, favour the forest management and hence improve people's livelihoods (Angelsen *et al.*, 2009). REDD+ is the addition of sustainable management of forests, conservation and enhancement of forest carbon stocks to the original concept of REDD. While REDD+ recognizes the importance of forests as an asset for rural livelihoods and survival, a clear opportunity exists to further improve the contribution of forests to rural livelihoods and the national economy but forest destruction, poor management, and environmental degradation continue and, with it, negative impacts on communities that depend on forests and forest products emerges (Mariki, 2001).

For the implementation of the general REDD concept, the National REDD+ Task Force and the National Carbon Monitoring Centre in Tanzania has been re-established, the draft National REDD Strategy and the Action Plan are in place. The REDD+ initiative intended to provide incentives for local communities participating in forest management (Mukama *et al.*, 2011). This stands on the objective of reducing emissions related to deforestation and forest degradation as well as reducing poverty of forest dependent communities. Its strategy is closely linked to the current National Growth and Development strategies such as the National Growth and Poverty Reduction Strategies as reported in COP 17 Durban.

Majority of the primary causes for deforestation and forest degradation were population growth, poverty, environmentally harmful government subsidies, 'elite capture', debts owed to developed countries leading to environmentally unsustainable exports, failure to value and understand the ecology of the systems, and as a consequence failure to value the ecological services provided by forest and woodlands (Mark and Cochrane, 2009). The secondary causes included physically removed or altered vegetation and initiating processes of degradation, e.g. charcoal making, grazing, logging and wildfires (WWF, 2006). This implies that REDD+ might provide strong incentives for forest management if it can generate an income of the same order of magnitude as the socio-economic drivers do.

World-wide, fires are problems and uncontrolled fire often cause destruction on society and the environment, destroying property and natural capital, depleting nutrient pools, polluting water supplies, reducing biodiversity, increasing emission of greenhouse gases, disrupting communities, decimating livestock and even killing people (Sarre and Goldammer, 1996). Furthermore, fire contributes in changing the landscape structure and species composition including grasslands, savannahs, closed forests and woodlands (Tylor, 1995). Wildfire in the tropics is implicated as one of the main source secondary driver of deforestation but also contribute to carbon emission but despite years of regulation and attempts to control, wildfire in many tropical countries has increased and communities are continuing using it in various ways.

Global records show that approximately 3.9 Gt of carbon (Gt C) are released annually into the atmosphere through biomass burning equivalent to over 70% of the annual anthropogenic fossil fuel emissions (Goldammer, 1992). Of the total land in Tanzania,

38% is covered by forest while deforestation takes place at a rate of between 130 000 and 500 000 hectares per year (URT, 2001).

Tradeoff is a situation involving a loss of one thing with a gain in another due to competition (Net MBA, 2005), that is as one desirable element goes up in value another comes down leading to extinction of one or reduce the disadvantages of one over the other but eliminate neither. Win-lose situation are tradeoffs (Gill *et al.,* 2003). The relationship between maintaining forest for carbon and use of fire as management tool to get higher crop yields and or other goods like charcoal, honey and protecting livestock within different land uses is an example of tradeoff. A distinctive example of tradeoffs exist between profitability and biodiversity conservation (White and Minang, 2010), on the other hand efforts to increase crop productivity and other related land use activities decreases biodiversity.

Fire in some cases is one of the management tool used to minimize costs of production as it is said to be less expensive but this results to deforestation due to the fact that it could break to wildfire destroying large areas of forests therefore loss of relative services (Harrison *et al.,* 2009). Opportunity costs are used to evaluate tradeoffs (White and Minang, 2010) hence determining the costs of engaging in fire use as land management tool is necessary to depict these tradeoffs. REDD+ discourages such measures in land uses that are associated to destruction of biodiversity particularly forest biodiversity by providing other livelihood options which are better for the sake of forest existence but on the other side they have implications to people's livelihood both economically and socially. This study discusses the scope for resolving the trade-offs between the communities' perceived benefits of fire use and national and global environmental concerns arising from land burning.

1.1 Problem Statement and Justification

It is estimated that fires destroy about 65 000 ha of forests and other wooded areas annually in Tanzania thus increasing the rate of deforestation (Aloo, 2001). To curb the problem of deforestation the Government of Tanzania begun to promote village and community forestry with the aim of producing sufficient amount of forest products and services to meet both local demands and enhance forests contribution to global environmental conservation. Despite these efforts, forest and environmental degradation at large is still a problem in many parts of the country.

Fire in many communities is regarded as a major tool used for land management (FBD, 2006). For instance fire for many years has been used for hunting, chasing marauding animals (Kate *et al.*, 2010), fighting against tsetse flies and to others it is used for cultural activities (Chokkalingam *et al.,* 2006). To pastoralists fire is used to stimulate sprouting of pasture in rangelands (Kate *et al.*, 2010), whereas to farmers fire is reported to be an important tool for land clearing during preparation of farms for cultivation. Therefore some of these forest changes and degradation are affected by the communities' activities which often make them better off (Chomitz, 2007).

In Kilosa district Tanzania Forest Conservation Group (TFCG) has reported fire as a big conservation challenge occurring every year and causing great destruction in forests (Kate *et al.*, 2010). Various land uses cause fires, including hunters, farmers, livestock keepers, honey gatherers, and timber sawyers. Effective implementation of REDD+ limits drivers of deforestation by prevention of shifting cultivation particularly the fire in land clearing, wildfires control that may be meant for pasture creation and delimit charcoal and timber production. Land use and management choices by local community members for forest carbon storage, provision of fuelwood, timber and for agriculture would therefore

need a balanced trade-offs economically, socially, and environmentally (Milledge, 2009). Tanzania has one of the REDD+ project *('Making REDD Work for Communities and Forest Conservation in Tanzania'*) in place, introduced as mitigation strategy to deforestation in Kilosa district. It is reported to have potentials to improve rural livelihoods and the local communities' well-being (Kate *et al.*, 2010). Moreover the project '*Developing Fire reduction strategy for Miombo woodlands as a Potential tool for Carbon storage and Sequestration'* provide a foundation for the design and prioritization of future wildfire management activities in the country, of which one of the study site is Kilosa District (Madoffe *et al.*, 2012). All these are efforts towards minimising land use fires.

Since fire seems to complicate efforts towards forest sustainability and biodiversity conservation and causing great concerns among government authorities, local and international researchers and conservation agents, understanding of the cause-effect relationship of fire among local community would help to ease the conservation task. Within the land use practises and land management little is known on which means is of economic efficient and would not lead to forest destruction that instead of using fire in different livelihood strategies what else can people use? What are the costs of using fire for land management compared to other options? And how does the land use fire tradeoffs impact livelihoods? This study aimed at answering these questions and estimated land use fires tradeoffs to the alternatives and its implications to livelihoods to various land users. The study is expected to add value to the REDD+ project strategies as well as giving possible alternatives to communities on management of livelihood options because by conserving forest the livelihoods could be improved as people will have more livelihood opportunities and getting ecosystem goods and services adequately in a longer term.

1.2 Objectives

1.2.1 Overall Objective

To assess the land use fire tradeoffs and its implications to livelihood in REDD+ pilot area of Kilosa District.

1.2.2 Specific objectives

i. To determine different fire regimes in Kilosa District.

ii. To assess uses of fire in land use practises as a management tool in Kilosa District,

iii. To determine the opportunity cost of fire as a land use management tool in relation to REDD+ in Kilosa District.

1.2.3 Research Questions

1) What are the fire regimes in Kilosa District?
2) What are the uses of fire in land use management in Kilosa?
3) What is the opportunity cost of using fire as land management tool in relation to REDD+ in Kilosa?
4) What are the implications of the fire tradeoffs to livelihoods in Kilosa?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 REDD+ and Livelihood Improvement

Reducing emission from deforestation and forest degradation (REDD) is one of the climate change mitigation strategy. There are three scales under which REDD works: national level that support programmes and activities implemented via government; subnational, and fusion or 'nested' approach combining the national and subnational approach (Angelsen *et al.*, 2008b). Due to agreement on the scope of the activities under the Bali Action Plan, REDD has evolved to REDD+ where plus represents conservation, sustainable forest management and enhancement of forest carbon stocks (Decision 2/CP.13) (UNFCCC, 2008).

Burgess *et al.* (2010) reported that for REDD+ to succeed, current users of forest resources must adopt new practices, including equitable sharing of benefits accrued from REDD+ implementation. These challenges are being addressed by combined donor support to implement a national forest inventory, remote sensing of forest cover, enhanced capacity for measuring, reporting and verification, and pilot projects to test REDD+ implementation linked to the existing Participatory Forest Management Programme (PFM).

REDD+ payments contribute to the reduction of poverty in different ways. First, they can enhance or protect forests so to become a long-term sustainable source of timber and non timber forest products. Second, they provide economic incentives which can be saved, invested, or spent for household needs, as well as other collective goods. And third, they bring about new livelihood opportunities through employment and forest management training (Sunderlin *et al.* 2003, 2005).

Angelsen *et al.* (2009) reported that effective implementation of REDD+ calls for a broader set of policies. These include institutional reforms in the areas of governance, tenure, decentralization, and Community Forest Management (CFM). Agricultural policies can limit the demand for new agricultural land. Energy policies can limit the pressure on forest degradation caused by woodfuel harvesting, while reduced impact logging practices can limit the harmful impacts of timber extraction.

2.2 Global Fires

Forest ecosystems capture and store carbon dioxide (CO_2), making a major contribution to the mitigation of climate change but when forests are destroyed, over-harvested or burned can become a source of CO_2 emissions (Bodegom *et al.*, 2009). It has been estimated that annually fires burn across up to 500 million hectares of woodland, open forests, tropical and sub-tropical savannahs, 10- 15 million hectares of boreal and temperate forest and 20-40 million hectares of tropical forests (Rowell and Moore, 1998). Hansen *et al.* (2010) found that there are higher rates of forest loss in boreal and temperate regions than in the tropical forest biome between 2000 and 2005. Werf *et al.* (2010) reported that more than half of the global carbon emissions between the year 1997 and 2009 were from Africa (Fig. 1). Forest fires occur either because of anthropological or natural causes but majority of fires around the globe are caused by human activities.

The Global Fire Monitoring Centre (GFMC) reports that fire occurs every year destroying hundred million hectares of forests and other vegetation types worldwide. Forest fires and open vegetation (woodlands, bushland, grasslands, savannahs, and steppes) are commonly designated as wildland fires or vegetation fires. Wildfires can have both positive and negative effects on nature. In some ecosystems fires play an ecologically significant role in maintaining biogeochemical cycles, for instance, many savannahs in the tropics and

subtropics burn annually or in intervals of several years (short fire cycles of 1 to 3 years). These fires are important to regenerate and stimulate the growth of grass and maintain the habitat structures of important wildlife species and domestic animals. Useful fires that improve the conditions for sustainable growing of crops are also set by experienced agriculturalists, herdsmen and hunters all over the world.

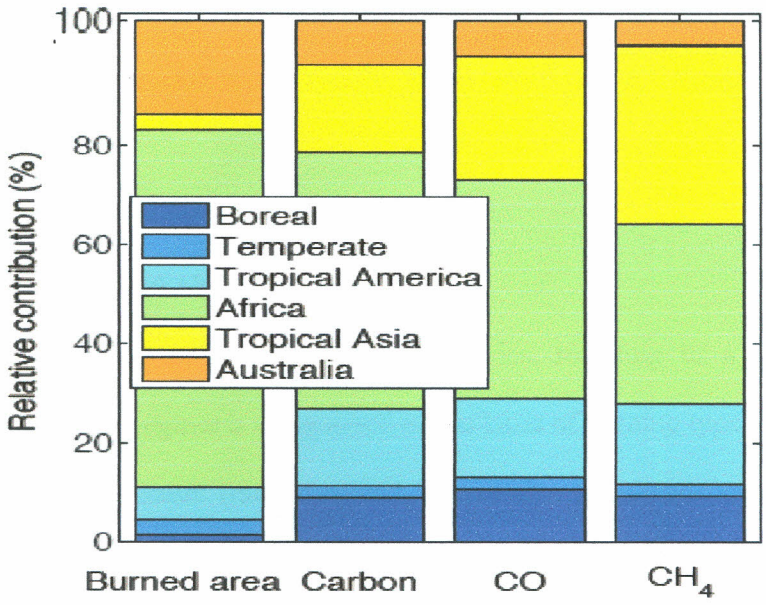

Figure 1: Relative contribution (%) from different regions to average global total burned area and fire emissions of carbon, CO and CH4 (1997-2009).

Source; van Werf *et al.*(2010)

2.3 Deforestation and Fire in the Tropics

Deforestation/degradation is measured as the loss of Catchment Forest Reserve area (CFR) (URT, 2003). Most fire sensitive ecosystems are located in the tropics as reported by Shlisky *et al.* (2007) and this is increased by the expansion of human activities such as forest change to agriculture and grazing fields (Mark and Cochrane, 2009). Fire used for land clearing and land use changes are the commonest in tropics (Ashwini and Agrawal, 2009) and it is widely used as a management tool.

In the past decade from 80 500 km^2 to 95 000 km^2 per year of forests were converted to other land uses in tropical regions through deforestation by fire, (Archad *et al.*, 2004). For instance a study by Eriksen (2007) showed that in Zambia local communities use fire to obtain desired natural resources and to shape the natural environment to advance their agricultural and other objectives, such as bush clearance, firebreak creation, charcoal production, hunting, weed and disease control, caterpillar breeding, honey collection and pasture regeneration. In Tanzania it is estimated that fires destroy about 65 000ha of forests and other wooded areas annually (Aloo, 2001) thus increasing the rate of deforestation.

2.4 Fire Regimes and Alteration

Fire burns with different intensities and frequencies, resulting in a wide variety of ecological effects. Fire regime is categorized on the basis of burning type (ground, surface, and crown), temporal nature (rate of spread, seasonality, and frequency), spatial pattern (size and patchiness and consequences to ecosystem and human (Bowman *et al.,* 2009)

Human activities which lead to changed vegetation are the primary cause of altered fire regimes. For instance, in fire-adapted forests, human exclusion of small periodic fires over the past 100 years has greatly increased the amount of wood fuel available for current wildland fires. In fire-sensitive forests like the tropical, logging activity that opens the forest canopy can dry out moist forests, hence more susceptibility to ignitions. People can also alter fire regimes through deliberate or careless ignitions. The UN Environment Program (UNEP) estimates 90% of fires globally to be caused by human activities (Levine *et al.,* 1999). Agriculture practices (such as slash-and burn), mechanical timber harvest, and recreational visitors all can serve as accidental ignition sources for wildfire.

Alteration of fire regimes in forests pose problems as they threaten human safety, endanger ecosystems and species, damage communities adjacent to the forest, and contribute to global change by releasing stored carbon into the atmosphere. These effects are being felt in every region of the world. For example in Central America, altered fire regimes are increasingly causing severe fires that disrupt the pine forest and savannah ecosystems and negatively affect neotropical migratory birds, In Brazil, forest clearing for conversion to agriculture is drying out the tropical forest, which allows fires for land-clearing to expand into wildfires. In central Africa, forestland is being cleared at a rapid rate through slash-and-burn agriculture and escaped fires. Results include a profound impact on communities that rely on the forest for food and economic development and considerable damage to the remaining forested ecosystems of the Congo Basin (USDA Forest Service, 2007).

2.5 Fire Tradeoffs and Conservation

The productivity of the economy is threatened by land use changes and unsustainable land management practices which impact seriously the country's biodiversity, crop production and livestock grazing lands (Hamza and Lyela, 2012). Some communities consider fire to the catalyst for high yield in farms and protection against animals plus other related land uses. This is contrary to conservation agents, government authorities and researchers who consider fire to be disastrous to the environment. On the other hand are apparent valued assets like increased crop productivity, livestock and several goods while on the other are assets like rare species, biodiversity and aesthetics which are harder to fix (Gill *et al.,* 2003).

Several researchers have examined tradeoffs in species conservation and cost, but few have applied their work to existing conservation areas, and examined tradeoffs among

biodiversity, vulnerability and cost (Polasky *et al.*, 2005). Chokkalingam *et al.* (2005) argued that community involvement in burning as a significant factor and they benefit from fire use has major management and policy implications therefore a need of balancing the trade-offs between immediate local livelihood needs and national to global environmental concerns arising from the land use management.

Livelihood benefits shows that both win–win and trade-off outcomes are possible in forest commons (Ashwini and Agrawal, 2009). In addition to their widely recognized contributions to rural livelihoods in developing countries (Wunder, 2001). It is unclear, however, whether forests that contribute more to livelihoods store more carbon or less, or if carbon storage and livelihood contributions of forests are unrelated (Smith, 2003).

2.6 Costs Estimation

The costs of REDD+ are categorized into three levels as opportunity, implementation and transaction costs.

Opportunity costs are regarded as the costs of foregone benefits. Apart from the negative impacts of deforestation, it can also bring benefits to local community. Construction materials like timber can be obtained and cleared land can be used for crops or as pasture however, reducing deforestation means foregoing these benefits. Estimating these opportunity costs is thus the central problem in estimating the costs of REDD+ (Pagiola and Bosquet, 2009). Opportunity costs estimation is also critical to understanding the causes and extent of deforestation and hence the types of interventions needed to actually reduce deforestation and the potential need for mechanisms to avoid adverse social consequences. Mostly opportunity costs include the foregone benefits of the alternative land uses as direct costs, socio-cultural costs associated with changes in livelihoods and

third are the indirect costs (White and Minang, 2010). This study aimed at assessing the direct costs associated to land management practices and hence telling the tradeoffs as they can be expressed in terms of money and physical units in accordance with White and Minang (2010).

Implementation costs are costs involved in implementation of the REDD+ programme. They are directly related to reducing deforestation and emissions for example paying compensations to communities near forest areas/reserves to avoid deforestation, developing alternative livelihoods opportunities such as capacity building or equipments to communities and employing human capital in safeguarding forest to prevent illegal activities like logging.

Transaction costs are REDD+ costs that are necessary for the parties to a transaction involving payment (the buyer and seller, or donor and recipient), as well as external parties such as a market regulator or payment system administrator (Pagiola and Bosquet, 2009). The costs are incurred in the process of identifying the REDD+ program, negotiating the transaction, and monitoring, reporting, and verifying the emissions reduction. These costs are separate from implementation costs, as by themselves they do not reduce deforestation or forest degradation.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Site

3.1.1 Location

Kilosa District is one of the six districts in Morogoro Region with a total area of 14 918 km^2. It is located in East central Tanzania 300 km west of Dar es Salaam and in the Northwestern part of Mororgoro Region (Fig. 1). It lies between latitude 5°55' and 7°53' South and longitude 36°30' and 37°30 East, with altitude ranging from 200 to 700m asl. Kilosa bouders Mvomero District to the East, Kilombero and Kilolo Districts to the South, Kiteto (Manyara Region) and Kilindi (Tanga Region) to the North; and Mpwapwa District (Dodoma Region) to the West. The district is divided administratively into 9 divisions, with 36 wards, 164 villages and 1010 hamlets.

3.1.2 Climate

The climate varies depending on the agro-ecological zones. Rainfall distribution is bimodal, short rains starts from October to December while long term rain fall between end of February and May. The highest parts of the district get annual rainfall ranging from 1000 mm –1600 mm whereas central and southern parts experience an average rainfall of 800 mm to 1400 mm. The temperature varies between 15°C to 32°C with mean annual temperature of 25°C. Therefore the climate in the area support significantly an extensive land cover and uses which are in one way or another influenced by fire occurrence.

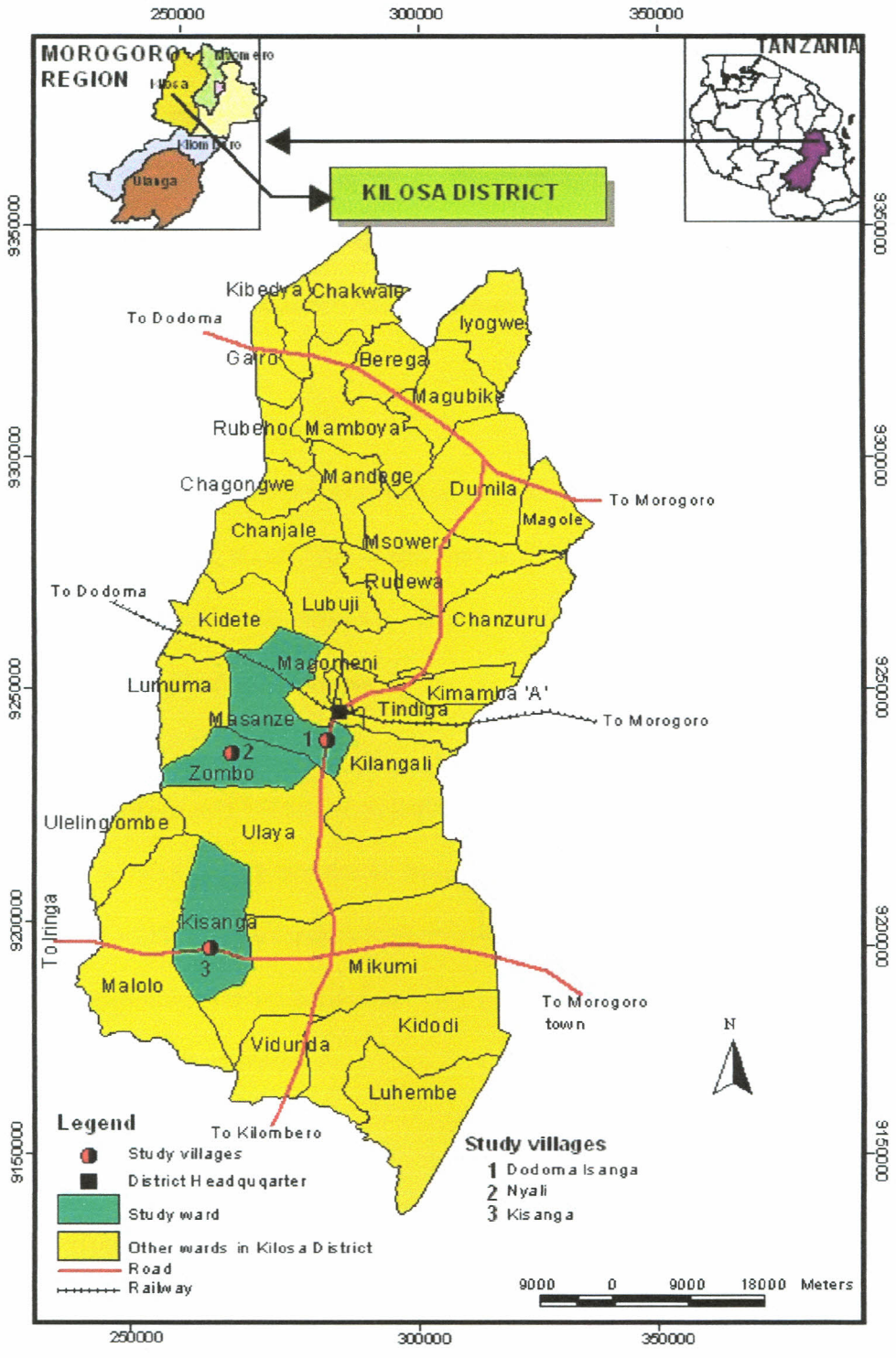

Figure 2: Map of Tanzania showing the geographical location of Kilosa District

3.1.3 Vegetation

Different soil types support different land covers and uses. However, Miombo woodlands and savannah grasslands are the main dominant vegetation in the district and are widely susceptible to fires. Forest covers about 71.6% of the total area in Kilosa District (Shishira *et al.,* 1997). Most forest reserves are closed Miombo forests which constitute catchment forests in the ranges of the Eastern Arc Mountains forest (Msemwa, 2007).

3.1.4 Land use distribution

According to URT (2003), the distribution of land use in Kilosa District is as follows: 71.6% is general land, about 19% of the land is under Mikumi National Park and Selous Game Reserve, 4.9% is settlement and urban areas while 4.5% of the land area is allocated of catchment and plantation forests.

3.1.5 Population and economic activities

According to NBS (2012) the district has a population of 438 175 people where 218 378 are males and 219 797 are females with an average of 4.2 people per family. Agriculture is the main economic activity carried and this includes crop farming and livestock keeping plus other non-farm activities.

3.2 Research Design

A cross sectional research design was used in this study which involved collecting data at a single point in time as recommended by Kothari (2004). This design was considered appropriate due to limitations of finance and time.

3.3 Sampling Procedure, Sample unit and Sample size

From thirteen villages that are involved in REDD+ project only three villages relatively adjacent to the forest reserves were selected namely DodomaIsanga, Nyali and Kisanga (Appendix 3). The sample size was systematically determined by employing the probability proportional to size (PPS) sampling method which considers simple random selection (Nyariki, 2009).

In this context a reconnaissance survey was carried and pretested the questionnaire to at least 10 households. This enabled determination of the population in each village and therefore sample size of 96 households was preferred as shown below. Snowball sampling was used to get charcoal makers, hunters, honey gathers and pit sawyers with the reason that it would be difficult to get them as majority perform their activities illegally. The first respondent from this group was obtained with the help of village leaders and each selected respondent proposing the next respondent.

Sample size determination

$$N = \frac{z2\,(pq)}{d2} \quad \text{.....(1)}$$

Where:

N = sample size

z = statistical certainty usually chosen at 95% confidence level, that is, $z = 1.96$

p = estimated level/coverage to be investigated usually 0.5 is preferable,

$q = 1\text{-}p$

d = precision level desired given to be 0.1

$N= (1.96^2*0.25)/0.1^2$

Therefore, N (sample size)= 96

Since only three villages were studied sampling interval was obtained as follows with link from the above equation

$$\sum_{i-1}^{n} Xi = X1 + X2 + X3 \quad \text{.....(2)}$$

Where: Xi = Population in sub-area i

n = number of sub-areas (villages)

X1; (household population for Dodoma Isanga) = 421

X2; (hh population for Nyali) =450

X3 ;(hh population for Kisanga) = 1511

The total population derived as shown in formula 2 is divided by the sample size to determine the SI, as follows

$$SI = {}^{\Sigma_{i-1}^{n} Xi}/_{N} \quad \text{.....(3)}$$

Where

SI=sampling interval which is number of households to be taken in each village

N = sample size

SI= 2382/ 96

= 25 households

However, in addition to taking into consideration the statistical requirement to have a minimum size of 30 sample units is vital as recommended by Nyariki (2009). Therefore, from two villages (Dodoma Isanga and Nyali) 30 households were taken each while in Kisanga village a total of 36 households were chosen as this village had greater hh population.

3.4 Data Collection

Both primary and secondary data were collected during the study. Primary data were gathered through structured questionnaires, semi structured interviews and focus group discussion with help of a checklist. Secondary data were obtained from relevant literatures from Library and websites. However, participant observation was also necessary to supplement the information from respondents and link the real situation of land practises.

3.4.1 Assessing uses of fire in different land-use practises and determining the fire regimes in the study area

The information on uses of fire as a land use management tool was captured through structured questionnaires to heads of households (Appendix 1) and checklists (Appendix 2) to charcoal makers, pit sawyers, honey gatherers and hunters. Focus group discussions of three groups containing 8 to 10 people both males and females were conducted considering different social groups taking various economic activities. The checklist in Appendix 2 was used as a guide for discussions on issues related to fire use in land management and options that exist in land preparation as well as fire frequency, seasonality and intensity in the study area.

3.4.2 Opportunity cost of Fire as a Land use Management tool in relation to REDD+ in Kilosa district

The opportunity cost of fire as land management tool refers to the net income per year or Net Present Value (NPV) that is sacrificed as a result of not using fire in land management. Checklists (Appendix 2) was used to determine the opportunity cost of fire as a land management tool in relation to REDD+ from different socio-economic groups of villagers that perform forest related land use activities. The groups involved crop farmers, livestock keepers, hunters, charcoal makers, pit sawyers and bee-keepers.

3.5 Data Analysis

Descriptive and inferential statistical analyses were carried out. Statistical Package for Social Sciences (SPSS) software version 16.0 and Ms. Excel were employed for the analysis.

3.5.1 Descriptive statistics

This analysis involved calculation of distributions such as percentages and frequencies, central tendencies of the household responses on age, marital status, sex, level of education, household size and income sources together with various uses of fire in different land use practises, fire occurrences and status as well as benefits and costs of production.

3.5.2 Economic analysis

A cost benefit analysis was performed to obtain the opportunity cost whereby profits from different land uses when fire is not used as management tool were compared with the profit from land when fire is used as a management tool. To the selected land use practises that are likely to cause forest fire in their management two scenarios were examined 1) operations with the use of fire as management tool and 2b) operation without using fire as a management tool. The decision criteria used was the Net Present Value whereby profits were captured using NPV estimates. This criterion is widely relied upon as a guide to economic efficiency (Kessy and O'kting'ati, 1993). The time horizon was set at 3 years when the fire fighting strategy project was established.

The NPV was calculated using the following formula.

$$NPV = \sum_{t=0}^{n} \frac{(Benefits - Costs)t}{(1 + r)t} \quad \text{.....(4)}$$

Where:

Benefits= yearly income accrued from land uses

Costs= production costs in land use activities

r = discount rate;

t = number of years projection is being run for, and

n = number of years at end year of the NPV calculation.

A discount rate of 10% was used in the computation of the NPV in this study. This is recommended for development projects evaluation by the World Bank (Kessy *et al.,* 1993; Grieg-Gran, 2006).

Finally a t-test was performed to find out if the profitability differences between the two scenarios when (1) using fire and (2) not using fire in production were significant at a level of 95%. The protection of forest involves opportunity cost of not using fire in land management.

3.5.3 Costs and benefit components

The cost components involved were capital costs (accounts all costs of equipments necessary for the activities) and variable costs involved in each land use practise in the course of production. Benefit component included all revenues accrued from each land use production, that is for farmers the crop yields as well as other associated benefits like fodder if any, livestock keepers from sale of animals and animal products, charcoal makers from sale of charcoal produced, hunters from sale of meat and other products from animals hunted, honey gatherers from sale of honey collected plus beeswax and finally pit sawyers on sale of timber harvested. All these values were calculated based on the responses from interviews.

3.5.4 The time horizon and running assumptions

The time horizon for the analysis was considered to be three years. This was based on the time of the project of the fire reduction strategy and establishing of the REDD+ project too.

Other assumptions in the analysis were;

i. All land use practices assessed were considered at their conventional operations and not modern.

ii. A zero price of land as an input was assumed because majority of the households acquired land through inheritance.

iii. Prices of all parameters involved in the study were based on year 2012 and currency used was Tsh and are assumed not to change for the three years of analysis.

iv. Yields were assumed to be constant throughout the three years regardless of any uncertainty due to weather.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Demographic Characteristics of the Communities in the Study Area

Consideration was taken on the characteristics of the household such as the household size, household composition, gender, marital status, education level, and age of the respondents due to its potentiality in influencing the land uses practices, utilization and management of different forest resources.

Out of 167 village members from DodomaIsanga, Nyali and Kisanga who contributed to household questionnaires, interviews and focus group discussion, 138 were males while 29 were females as shown in Table 1. Majority of the respondents were aged between 30 and 49 years and these on average accounted for 78.5% (113) from all three villages. Age is a very important variable in economic production and its evidently known that young people (30-49 years) are more energetic and productive than old people (Monela *et al.*, 2000).

4.1.1 Household size

The study area had an average household size of 4.8 people. However, a dependent average number was revealed to be 2.2 persons per household. Household size revealed an extent of resources demand and therefore engagement in more land use practices to cater for their livelihood. An increase in the household size will likely result to high engagement to different land use practices to sustain the family in terms of their needs therefore will imply an over-exploitation of forest and environment as well. Such implications have been confirmed by Nduwamungu (2001) and also reported by Giliba *et al.* (2011). Mahinya (2005) pointed out that large household tends to over-exploit their resources in order to meet their needs while undermining their livelihood resource.

4.1.2 Marital status

Findings from this study showed that 70.8% of the respondents interviewed were married, 9.4% single while 19.8% were widowed and divorced as shown in Table 1. These results expose the exact characteristics of rural households whereby the majority get married at early ages particularly soon after completing primary school education. Moreover, results also illustrated the existence of mature families that were potential in increasing the population which will hence have an implication to nature and forest conservation. The later has also been reported by Msemwa (2007) and Lusambo (2002).

4.1.3 Education level

Education is an important aspect to development in any nation. Results from the current study indicated that 75% of the respondents had primary education (6-7 school years) while the rest (7%) had acquired secondary and post secondary education. The remaining portions i.e. 18% did not attend any formal education. Management of forest and natural resources at large depends much on education with the fact that better understanding is achieved by literacy. However, more and skilful production in agriculture, livestock and any land related practice is associated with education. The education status of the area therefore reveals that most land use practices managed by fire are likely done because of the level of illiteracy. Low level of education refrain most people to use modern land husbandry contrary to traditional practises. This also blocks various alternatives that were suitable in conducting agricultural and forest related activities other than using fire. Similar arguments were put forward by Giliba *et al.* (2011).

Table 1: Characteristics of the respondents in Kilosa district

Characteristics	Frequency	Percentage (%)
Sex		
Females	29	17.4
Males	138	82.6
Marital status		
Married	68	71
Single	9	9
Divorced	14	15
Widowed	5	5
Education level		
Primary school	72	75
Secondary	7	7
None	17	18

4.1.4 Land ownershipand farming intensity

Kilosa communities obtain their needs from various land activities therefore holding of land was very important to them. In this study 83% of the surveyed households were reported to own land for different uses but mainly for agricultural production. The remaining had no land of their own therefore depended on renting and borrowing. The average occupation of land was 2.6 ha for agricultural practices in agreement to a study done by Lusambo (2002).

In this study 41.7% of the respondents had their land near forest areas whereas 58.3% owned land far away from the forest. This implied that the forest was exposed to fire outbreak hence risk due to the fact that most farmers in the area used fire in land clearing after and before planting. Moreover, close proximity to a forest gives easy intrusion to the forest for any illegal activity that could contribute to degradation. Most of the forest fire

experienced in the area erupted from farms, as it was reported in the focus group discussion.

4.1.5 Sources of income

A number of income generating activities to household were mentioned and these included agriculture, livestock keeping and other non-farm sources such as selling charcoal and petty business. The results showed that agriculture contributed highly to household annual income by approximately 96% of the total income while other sources accounted below that (Table 2). It was also noted that the agricultural crops grown were maize, simsim, paddy, cassava, beans, cow peas, pigeon peas, sorghum and sunflower. The same findings were reported by Msemwa (2007), Lusambo (2002) and Ngasongwa (2006). Implication of these findings was that the high contribution of agriculture to income in the study area may result to more pressure on forest clearing for the purpose of obtaining agricultural land not forgetting the rigorous use of fire for clearing the land.

The other sources of income had strong ties with the forests and if they are not done legally and sustainably could lead to forest degradation. For instance if charcoal making is continuously relied for income then perhaps more degradation will happen in forests as the study done by Lusambo *et al.* (2007) in the same study area who reported charcoal making to contributes 37.5% of miombo deforestation. Nevertheless, livestock keeping was reported to be the second source of income by 37.5% of the respondents. In the whole country, 60% of rural households earn income from livestock husbandry (Covarrubias *et al.,* 2012). This perhaps implies a threat to forests since open grazing in the forest is the conventional rearing practice for forest bordering communities and this has adverse impact on growing stock as well as regeneration capacity of forest when there is over grazing due to more livestock.

Table 2: Percentage distribution of household income from different activities in the study area

Income generating activity	Percentage
Agriculture	96
Livestock keeping	37.5
Charcoal making	18.3
Hunting	9.4
Petty business	4.2
Timber harvesting	4.2

4.2 Uses of Fire in Different Land-use Practices

Most forest fires in the study area were caused by different human activities. The human-induced causes included land clearing for cultivation purposes and other agricultural activities, maintenance of grasslands for livestock management, extraction of non-wood forest products such as honey, resettlement, hunting, traditional outreach *'orpul'*, and charcoal making (Table 3). This was also reported in other developing countries by Lourenco *et al.,* (2013).

Table 3: Causes of forest fire in the study area

Land user	Percentage
Farmers	68
Hunter	45.8
Neighbourhoods	16.7
Honey gathers	16.7
Charcoal makers	8.3

4.2.1 Agriculture

Many incidences of forest fire are caused by farmers specifically during land preparation followed by chasing away animals. About 79% of the respondents interviewed stated that

farmers use fire in their production and therefore causes most forest fires (68%). During land preparation fire is used to clear land whereby majority of the respondents 66% conduct slash and burn in farm preparation, 32% use hand hoe while the remaining 2% use tractor. Famers were also reported by pastoralists to cause fire due to conflict of interest "so*metimes they burn our grazing areas so that we take our herds to their shambas and from there we are fined ..... they do this several times especially during dry season*". Occasionally fire from farms get out of hand and spread to the adjacent forests. This situation is likely to occur due to the fact that 42% of the farmers have fields adjacent or very close to the forest. Use of fire in land preparation has been implicated as one of the main cause of forest fires (Saigal, 1990). Despite fire menace to the forests, it is widely used as farm management tool in production with reason that it is the cheapest, easiest and fastest method as compared to for instance mechanical methods and there is no monetary incentive to use alternative methods, This is a common practice not only in the study area but also in other developing countries (Heikkila *et al.,* 1993; Harrison *et al.,* 2009; Lourenco *et al.,* 2013). This was also argued similarly by Hoffmann *et al.* (1999) and Vayda (1999). Suyanto *et al.* (2004) reported that the use of fire as a management tool is attributed by low capital of investment into agriculture.

4.2.2 Charcoal making

Charcoal making in Kilosa District is practiced as a supplementary activity to major income generating activities. Only about 9% of the respondents were actively making charcoal. Most of charcoal produced is reported to be from forest (64%) and the remaining 36% is produced from farms. This implies that forests are in great danger of accidental fires especially when fire is not well controlled after collecting charcoal from kiln. About 48% of all interviewed households identified charcoal making as one of the economic activities conducted in the forest. Majority of the charcoal makers take their

products to Kilosa and Mikumi township. Nevertheless illegal production of charcoal was reported from focus group discussion and key informants and neither tax nor fees are paid to any district authority. The species preferred are *Acacia spp*, *Terminalia spp* and *Brachystegia spp.* Msemwa (2007) reported that similar species were widely used for charcoal making and that they were in great threat of extinction.

4.2.3 Hunting

Hunting in the study area contributed only to 9.4% of the household income. From the study hunting was reported as second main cause of forest fire by 45.8% of the respondents after agriculture. Fire is used to confine the targeted animals from escaping and in the course fire can spread to the forest. It was argue by Lourenco *et al.* (2013) that hunting is a negligent action that cause fire by their course of improving access to hunting. Some forest fires are set by hunters and poachers to clear vegetation for a better sight of the prey (IFFN, 2006). Most animals hunted in the study area are cane rat (*ndezi*), bushbuck (*mbawala*) and wild pigs (*nguruwe mwitu*).

4.2.4 Honey gatherers

Results from the study showed that 23% of the respondents interviewed identified honey collection as one of the economic activities conducted by forest adjacent communities in Kilosa. Statistics indicate that Kilosa District is one of the leading area in honey production in Morogoro region (NBS, 2002). Most honey producers construct traditional beehives using either dug logs or tree backs. Ngasongwa (2007) reported that Kilosa District had 19 189 traditional beehives and 705 modern beehives. Very few people use modern beehives. During honey harvesting people use local smokers such as pieces of clothes or splinters and sometimes this can lead to fires. The findings showed inability of household to afford modern beehives and associated equipments for collecting honey that

are more friendly to the environment but also increase yield. As a result of using fire in collection process a greater risk to the forest on fire is expected.

4.2.5 Pit sawing

Pit sawing was another land use practice conducted in the study area. Findings of the survey showed that 53% of the respondents reported pit sawing as one of the economic activities conducted in the forest and the main trees logged were *Terminalia sp, Ptercarpus angolensis, Burkea africana* and others as it was also observed by Lusambo (2002). The pit sawyers cook their meals in the forest or occasionally use fire to clear paths and occasionally unextinguished fire could fall out of hand and cause forest fire as reported in other developing countries by IFFN (2006). According to village leaders, pit sawing is conducted illegally in the forest and this is due to very bureaucratic procedures involved in acquiring legal logging permit. Similarly pit sawyers are adamant in paying the necessary logging fees in the fear of getting small profit from the sales of timber. Similar scenario was reported by Lusambo (2002) in the same study area. The sawn timber was finally transported to Kilosa town centre for sale but also some were used in the villages for construction purposes.

4.2.6 Livestock keeping

According to the research findings no reports were found on livestock keepers having caused fire neither use fire in managing their pasture land. On the contrary the neighbouring villagers of Changarawe who had larger number of livestock were implicated for causing forest fires. Small number of pastoralists in the study villages could perhaps explain as to why they don't cause fire and due to the fact that they are nomads. This does not solely mean that this group do not cause fire in the forest, since a study done by Kate *et al.* (2010) in the same study area reported that livestock keepers caused forest

fire among other groups, similarly a report by TAFORI, (unpublished) also shows pastoralists as one of the group causing forest fire in some areas of Morogoro Districts. Grass usually sprout promptly soon after fire incidences (Plate 1 and 2) giving enough and palatable feed to the livestock. This was as well reported by Douglas *et al.* (2011) who indicated that livestock keepers ignite fire during dry season of the year in order to promote the production of nutritious re-growth pasture.

Plate 1: Herds of cattle grazing on sprouting grass from a recently burnt area

Plate 2: Picture showing burnt stem of a shrub with new grass growing around

4.3 Different Fire Regimes

Pechony and Shindell (2010) reported on the importance of fire regimes in understanding and describing the effects of land use change on fire patterns and characterizing their combined impacts on vegetation and the carbon cycle. Changing fire regimes also impact efforts to manage and suppress fire (Lutz *et al.*, 2011). The findings showed that fire regimes were driven more vitally by land use practices among other factors like climate.

4.3.1 Fire patterns

Results from the study showed that there were mainly two fire seasons in the study area; early burning in the months of early August to September as reported by 8% of the respondents and late burning (29%) in late September to early November seasons (Fig. 3) and to some extent an intermediate period of fire outbreaks occurred particularly in the months of January and February which are usually dry period. Most of the fire reported are anthropogenic however, few cases of natural and/or unknown sources have been reported. This was associated with the response from the respondents that agricultural land

is cleared and prepared in late September to early October where farmers extensively use fire to reduce costs of farm preparation. Burning also saves time which could perhaps be used in other useful economic activities (Chokkalingam *et al.,* 2007). The timing of burning is clearly linked to particular livelihood activities. However, the time at which fires burn during the year has a strong effect on vegetation response to fire (Taylor, 2001). A study by Madoffe *et al.* (2012) indicated that early burning was better for carbon storage than late burning or no burning at all.

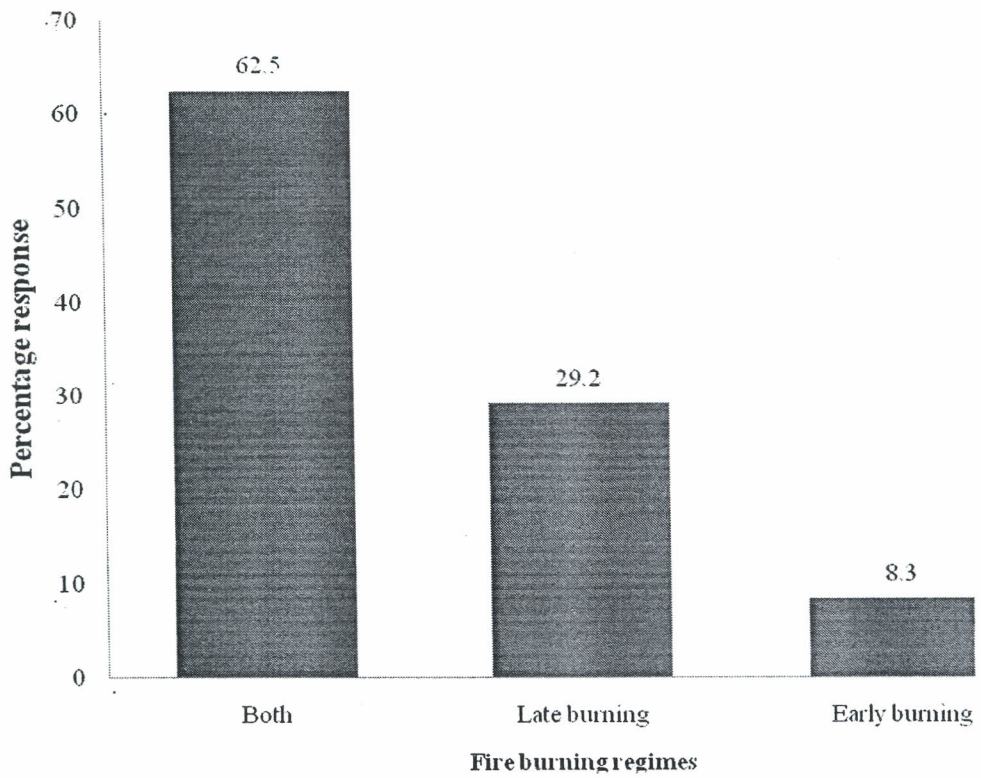

Figure 3: Forest fire burning regimes in the study area

4.3.2 Fire Intensity and severity

About 76% of the respondents reported that when fire occurs in the forest it destroys large areas giving an estimate of more than 4ha (respondents' estimate) and this was based on their observation and involvement in fire fighting. Severe fires were reported to occur during the late dry season (October) and some of these fires could dare serious consequences to the ecosystem. Generally there was no fire management in most areas and extensive long-lasting fires were common phenomena. Some negative effects of fire outbreaks reported in the study area were destruction of houses, loss of ecosystem, inadequate pasture, loss of thatching material, loss of crops, honey loss and less firewood (Fig. 4). Most residential houses are grass thatched and are highly prone to fire. Similarly due to severity of fire it is possible to loose the entire ecosystem especially if there are frequent and hot fires. Grasses/pastures are usually resistant to fire but they can easily be destroyed by severe fires due to killing of the buds as a result of devastating the scales.

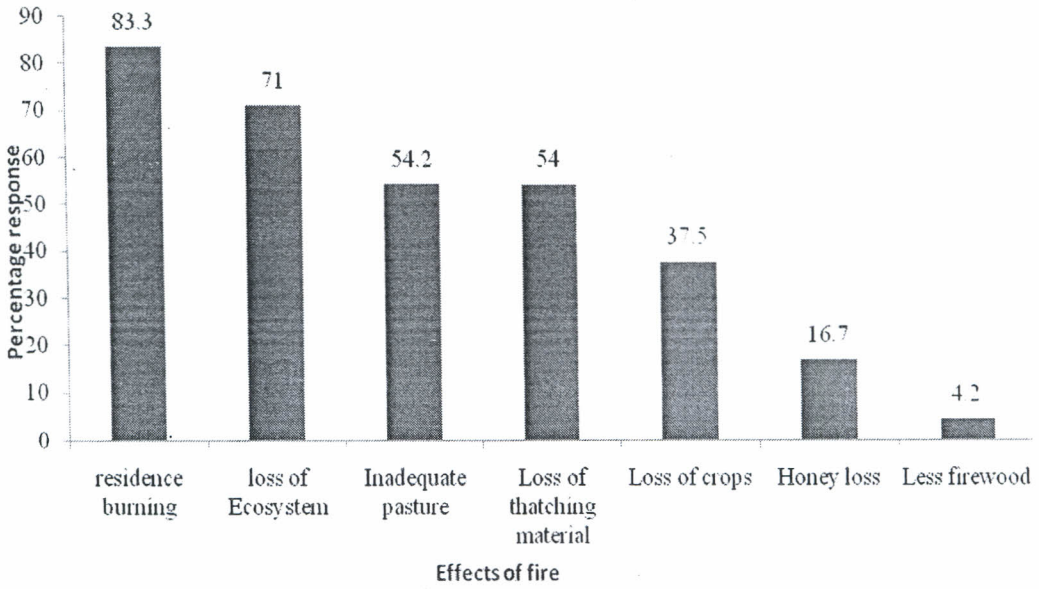

Figure 4: Percentage distribution of the effects of fire in the study area

4.3.3 Fire frequencies

About 66.7% of the respondents reported that fire occurred once a year, while 25% said twice a year, and 8.3% said more than two times in a year. If fire recurs repeatedly at an interval of less than that for plant species to flower and fruit then its effect to flora and fauna could be very serious. Single annual burn at the beginning of the dry season could have less effects to the vegetation (Chokkalingam *et al.,* 2007) and can facilitate shaping the general landscape of the forest area and regulating the accumulation of biomass as well as helping the miombo woodland to re-grow.

4.4 Opportunity cost of Fire in Different Land Use Practices

The land use practices that were assessed during the study were farming, livestock keeping, charcoal making, hunting, honey collection and pit sawing. These activities were as well mentioned during the survey as drivers to forest fire occurrences. Communities use fire to increase productivity particularly in agriculture and livestock sectors. In so doing they could destroy some ecosystem goods and services which would indirectly or directly affect their livelihood. Foregoing the use of fire to facilitate productivity could be very expensive and therefore the community have to look for alternative economic options.

During the household survey, respondents mentioned other alternatives to fire managing their land use practices as mechanical means of land preparation, for example using tractors in tilling the land and search of market for fodder (maize straws), hunters suggested building ability to own riffles and minimising the level of bureaucracy in obtaining the permission, honey gathers indicated introduction of modern beehives and provision of honey extraction equipment.

Considering costs and revenues in each land use practice, the NPV was calculated using the discount rate of 10% in comparing two scenarios of either using fire or without using fire (Table 4).

Table 4: The opportunity cost of land use practices under the two alternative scenarios

Land use Practise	NPV-scenario 1	NPV-scenario 2	opportunity cost
Farming	3 243 204.36	3 392 415.48	-149 211.12
Livestock keeping	11 076 276.48	11 076 276.48	0
Charcoal making	1 010 465.82	1 010 465.82	0
Honey gathering	732 667.17	609 030.8	123 636.37
Hunting	218 797.9	231 525.17	-12 727.27
Pit sawing	473 420.96	473 420.96	0

Results revealed that in agriculture the opportunity cost of using fire was negative Tsh 149 211 per year indicating that it was more paying when fire was not used than when fire was used in production. Possibly this could be explained by higher costs involved in land clearing specifically slashing and then gathering the trashes all together followed by burning. The practise could be even more costly in case if fire gets out of hand and destroying the adjacent forest goods and services. The local communities however practice slash and burn without considering the cost implication of the practise. In spite of problems associated with slashing, fire hastens grass growth which is important for the livestock. From this observation more knowledge is required to reach the community so as to avoid the incidences of forest fire and degradation.

Livestock keeping had higher profitability from the rest of land use practices under both scenarios therefore had an opportunity cost of zero. This situation appears to be influenced by invisible costs associated with the use of fire as a result of difficulty in determining the

cost of nutrients added to the new growth. This could be used as an entry point for persuading the communities to refrain from deforestation through fire due to the benefits obtained in maintaining the forest.

Honey collection showed decline profitability when abstaining from the use of fire in production and its opportunity cost was Tsh 123 636 per year. The main reason to this result was probably due to the variation of the capital costs in both scenarios, not using fire required higher costs (capital and variable) compared to the using fire scenario. However, if all benefits accrued from the option of not using fire were calculated then it would lead to a view that modern practice should be adopted rather than the traditional one as it was also observed that majority conduct traditional ways of smoking out beehives.

Based on the findings by Lusambo *et al.* (2007) from the same study area that charcoal making contributes to forest degradation by 37.5% and in this study charcoal making caused fire by 8.3%, the practice cannot work without fire as in the above illustration but this can be done sustainably while protecting the forest from fire. Nevertheless, it was found that there were sustainable charcoal programmes that existed in some of the villages in the study area this could be the reason of charcoal making contributing smaller percent in forest fire.

However, statistically there was no significance difference ($p>0.05$) in profitability between using fire and not using fire as a management tool in the land use practises. This implied that no any added value of output in the process of using fire which was a destructive scenario to forest and therefore much emphasis on refraining from using fire as an input to the local community was vital.

4.5 Livelihood Impact and Implications

Livelihood comprises of capabilities, assets (including both material and social resources) and activities required for a means of living (DFID, 2001). The intensification of the community into fire based land management practices has influenced the status of the forest surrounding them of which about 42% of the respondents reported that the status of forest was at an average meaning that it was neither good nor bad. This has resulted into shifting to other livelihood strategies such as charcoal making and hunting but the sustainable options are limited; livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base (DFID, 2001). Much of the income in the study area was obtained from forest related activities (Table 2) showing a beneficial aspect of the forest to community and yet those income generating activities (livelihood strategies) cause fire in forest (Table 3). It is argued by Cattermoul *et al.* (2008) that the livelihood strategies/outcomes become less available when resources get degraded with time (Fig. 5).

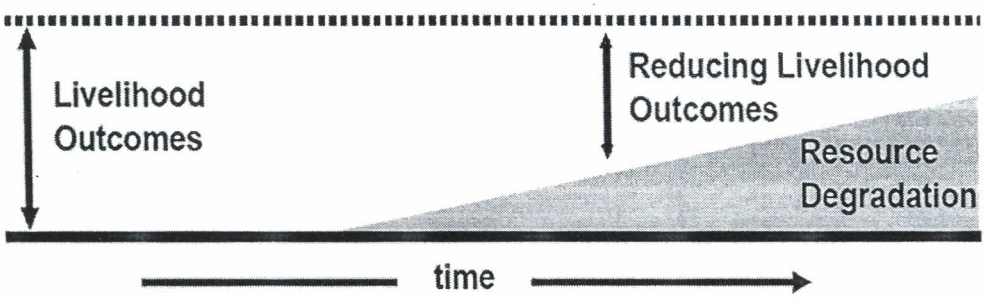

Figure 5: Illustration showing reduced livelihood outcomes as an impact of long-term resource degradation

Source; Cattermoul *et al.* (2008)

The uses of fire in land practices hence forest fire were reported to have implications such as the loss of ecosystem by 71% from the in-depth interviews and during focus group discussions. It was reported that some plant species that were useful as medicinal have vanished and some animals die due to the heat and smoke when fire happens. Moreover, 83% of the respondents reported that some houses are accidentally burnt during farm preparation.

Despite rapid adaptations and involvement into new opportunities by local communities, their income levels as reflected by livelihood options overall are overall declining. The adaptations have extended impacts beyond the local area, as some pastoralists particularly wasukuma and migratory labour have moved into the neighbouring forests to exploit resources specifically grazing land, charcoal making and logging but later has extended into grabbing land for agriculture as well as for grazing. This has particularly ended up into land conflicts in the study area. Similar findings were earlier reported by Baha *et al.* (2008).

Moreover, trading off fire as an input in production for land use practises was found to have an economic implication for instance in crop farming an opportunity cost of negative Tsh 149 211.12 per year was revealed meaning that it was profitable to operate without fire and therefore taking the mechanical method of farming is preferable, this is a forest protection choice. On the other hand some practises had a positive opportunity cost with use of fire (Table 4) indicating that it pays more when fire was used in production. This option is considered to be exploitative to the forest because of the threat of fire otherwise the communities will have to incur costs of adapting the no fire operation.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on results from this study, the following conclusions can be made;

i. Fire occurrence in Kilosa District is high and it usually occurs twice a year (early and late burning) in the months between late August and early November and these fires were reported to be severe causing great losses of the ecosystem, houses and grazing grounds.

ii. Additionally, almost all income generating activities (farming, charcoal making, honey collection, logging and hunting) were reported to use fire as a management tool, with agriculture and hunting being the main practices that caused most forest fires. These livelihood strategies contribute greatly into forest/miombo degradation.

iii. Economic assessment showed that some land-use practices such as agriculture and hunting could be profitable without using fire in management and only honey gathering indicated no profit when fire was not used. However, statistically there were no any significant differences ($p>0.05$) between using and not using fire.

iv. Fire had impacted to the livelihoods by destroying some ecosystem goods and services consequently reducing economic livelihood options.

v. REDD+ emphasizes on the alternative options to livelihood strategies that protect forests however, the options that exist in stopping people from using fire in their land-use operations seems to be limited and demanding higher investing capital in the beginning but later on all costs are distributed along production line therefore this would mean that communities need support not only financially but in knowledge too.

vi. Unless sustainable land management practices are implemented, the forests as vital source of economic life in Kilosa District will continue to be degraded thereby reducing livelihood outcomes.

5.2 Recommendations

Based on the findings from this study and experience from previous related work in Kilosa the following recommendations are put forward;

i. There is a need to impact more community conservation education particularly on fire suppression strategies.

ii. Further economic valuation of environmental aspects in relation to livelihood strategies is necessary in the study area and people should look for more viable economical options in addition to farming and livestock keeping.

iii. Communities in collaboration with the District government should implement sustainable land management practices and each village need to have operational by laws in order to safeguard village decision.

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APPENDICES

Appendix 1: Questionnaire for households

Division..... Ward.....

Village..... Village registration number.....

Date of interview..... Name of enumerator.....

A. General Information Questions

Household characteristics:

1. Household number.....
2. Name of respondent .....
3. Tribe.....
4. Age.....
5. Sex.....Male ☐ 1 Female 2

6. Marital status (Tick appropriate answer)

S/n	Marital status	Code
I	Single	1
ii	Married	2
iii	Divorced	3
iv	Widowed	4

7. Duration of residence in the village in years.....

8. Education level (Tick appropriate answer).

S/n	Education level	Years of schooling	Code
i	No formal education		1
ii	Primary education		2
iii	Secondary education		3
iv	Others (specify)		4

9. What is your religion?
    1. Christianity
    2. Islam
    3. Traditional
    4. Other, (specify)

10. What is your Household composition (Tick appropriate answer).

Age(years)	Female	Male	Total	Code
<18				
18-35				
35-60				
>60				

11. Total number of individuals in the household ☐

12. What are the major sources of household income?

S/n	Sources of household income	Code
i	Honey collection	1
ii	Crop production	2
iii	Livestock production	3
iv	Logging timber	4
v	Both crop and livestock production	5
vi	Petty business	6
vii	Others (specify)	7

13. Does your household have land close to the forest? Yes/No.....

14. If yes how many hectares.....

15. How do you prepare land for farming?

-Slash and burn

-Use hand hoe

-Use tractor

-Other methods (specify)

16. What types of crops do you cultivate?

B. Forest resource use and forest fires

1. What are the economic activities that are performed in the forest?
   a) Timber harvesting
   b) Honey gathering
   c) Hunting
   d) Charcoal making
   e) Livestock grazing
   f) Others (specify).....

2. Have you ever witnessed fire outbreak in the forest, which is related to one of the economic activities that is performed in the forest? 1. Yes 2. No
3. What activity (source of fire) did the fire result from?
4. If yes give the average frequency of forest fire occurrences per year.
5. What are the damages that fire outbreak has ever brought both social and economical?
    a) .....
    b) .....
    c) .....
    d) .....
6. Are there some efforts to alleviate the problem of fire? 1. Yes 2. No
7. If yes, what efforts?
8. Do both men and women participate in fire fighting? 1. Yes 2. No
9. What are the other groups that deal with fighting against fire in the village?
    a) Environmental village committee
    b) Village leaders
    c) Other institutions in place (mention).....
10. What is the present status of the forest fires?
11. What are the burning regimes that exist in your area?
    a) Early burning (when)
    b) Late burning (when)

Appendix 2: Checklists for households undertaking different land use practises

1.1 Charcoal makers

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

C. Research information

1. Where do you conduct your charcoal work? 1. In the forest area 2. In own land
   a) How long do you stay in the forest for charcoal work per day?
   b) What activities do you undertake?
   c) How many days does it take you to undertake all those activities?
   d) How much charcoal do you produce at once? (e.g. how many bags of charcoal do you get? of what size are they?

2. a) What equipments do you use?
   b) For how long can you use the equipment before you buy new ones?
   c) What is the price of the equipment?
   d) How many (of those equipments) do you need?
   f) Do you put off the fire after removing charcoal from the kiln? Yes/No
   g) How do you prevent fire during charcoal making?
   h) In case of fire getting out of hand how do you manage/suppress it?
   I) Have you ever caused forest fire? What did you do then?

3. a) Where do you sell charcoal you have produced?
   b) At what price do you sell charcoal you have produced?
   c) How long does it take you to transport charcoal from the field to the market place?
   d) What is the cost of transport from the forest to the market place?

4. For how long have you been undertaking this business?
5. What other socio-economic activities do you undertake?
6. How do you access charcoal in the forest? Do you have licenses/permits?
7. How much forest could you loose/have been lost when ever fire gets out of hand?

1.2 Checklist for pit-sawyers

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

C. Research information

1. a) How long do you stay in the forest for pit-sawing per day?
   b) How many pieces of timber do you produce at once and of what sizes?
   c) How long do you work in the forest to get that number of pieces of timber?

2. a) Which period or months do you undertake pit-sawing?
   b) How many times do you produce pieces of timber per month?

3. a) What equipments do you use?
   b) How many people work with you in the forest for pit-sawing?
   c) Do you employ people to assist you?
   d) How much do you pay them per day?
   e) For how long can you use the equipment before you buy new ones?
   f) What is the price of the equipment?
   g) How many (of those equipments) do you need?

4. Uses of fire
   a) Do you use fire in your work?
   b) If yes why (reason) do you use fire?

c) At which process (purpose) do you use fire?

d) Are there any other ways that you can abstain from using fire?

e) What are those alternatives?

f) Why don't you use them?

g) How do you ensure that fire does not spread to the forest?

h) Have you ever caused forest fire? Yes/No

i) If yes how did you manage it?

5. a) Where do you sell timber you have produced?

b) At what price do you sell timber you produce?

c) How long does it take you to transport timber from the field to the market place?

d) What is the cost of transport from the forest to the market place?

6. Which tree species do you usually use for timber?

7. For how long have you been undertaking this business?

8. What other socio-economic activities do you undertake?

9. How do you access timber in the forest? Do you have licenses/permits?

1.3 Checklist for livestock keepers

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

Research information

a. What are the types of livestock you own?

b. How many of them do you have?

c. Where do you send your livestock animals for grazing?

d. How long do you stay in the forest for livestock grazing in a day?

e. Where else do you send your livestock animals for grazing?

f. How long does it take you to reach to the place of grazing livestock?

g. How many people do you work with for livestock grazing in the forest?
h. Do you employ workers to take care of your livestock?
i. If yes in 1h above, how many?
j. How much do you pay them?
k. What are other cost you incur in livestock keeping?

2. Uses of fire in land management
   a. Do you use fire in any of the activities related to livestock keeping?
   b. If yes, for what purpose do you use fire?
   c. Why do you have to use fire?
   d. Are there other possible means of managing land for grazing livestock other than using fire?
   e. What are those alternatives?
   f. Have incidences of fire break to forest ever happened as you use?
   g. How did you manage the fire from spreading into the forest?
   h. How many incidences of fire in forest have you ever witnessed?
   i. Can you tell the amount of forest land that has been destroyed by fire?
3. Revenues from livestock keeping
   a) How many of the above livestock do you sell in a year?
   b) Where do you sell them?
   c) How far is the market place from where you live?
   d) What means of transport do you use while taking your livestock to market?
   e) What are other benefits do you get from your livestock?
5. What strategies do you think could help to reduce the occurrence of fire in the forest?
6. What other socio-economic activities do you undertake?

1.4 Check list for Hunters

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

C. Research information

1.Costs and mode of land practices

a) How often do you hunt in year? (Seasonally)
b) What types of animal do you hunt?
c) How many of them do you hunt?
d) Do you do the work alone?
e) If no, how many people do you involve?
f) How much do you pay them?
g) How many times do you go for hunting in a month?
h) What equipments do you use for hunting?
i) How much do they cost?

2. Uses of fire

a) Is fire one of the tools you use for hunting?
b) What are the reasons for using fire as a hunting tool?
c) Which activity in your production uses fire?
d) Are there other options/alternatives to using fire? Mention them
e) What is the cost of each option?
f) If the options were made available do you think it would help to reduce fire incidences in the forest?
g) How do you ensure that fire does not spread to the forest after hunting?
h) How do you manage fire if it gets out of hand?
i) Have you or any other hunter caused forest fire? Yes/No
j) If yes how many hectares were burnt?

3. Revenues from hunting

a) Do you sell the meat you get from hunting?
b) Where do you get the market?
c) What is the price of each unit?
d) What are other revenues you get from hunting?

4. What other socio economic activities do you do?

5. How do you do hunting in the forest? Do you have licenses/permits?

1.5 Check list for Honey gatherers

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

C. Research information

1. Costs and mode of land practices
   a) Where do you collect honey?
   b) How many times in a month do you harvest honey?
   c) What types of bee hives do you use?
   d) Do you purchase the beehives or you make alone?
   e) If you purchase, how much does it cost each?
   f) What equipments do you use in collecting honey?
   g) How much do they cost?
   h) How many people do you work with?
   i) How much do you pay them in a month?
2. Uses of fire
   a) Is fire one of the tool you use for honey gathering?
   b) If yes, for what purpose do you use fire?
   c) What is the reason that you use fire?
   d) Are there other options/alternatives rather than using fire? Mention
   e) What are their costs in each?
   f) If the options were made available do you think it would help reduce fire incidences in forest?
3. Revenues from honey gathering
   a) How many liters of honey do you collect in a year?
   b) Where do you sell the honey?
   c) How far is the market place from where you live?
   d) What means of transport do you use?
   e) How much do you sell per unit?

f) What other product from honey do you sell?

4. What other socio economic activities do you do?

5. How do you obtain honey in the forest? Do you have licenses/permits?

1.6 Check list for crop farmers

A. General information

Date..... Region..... District.....

Village name..... Ward..... Division.....

B. Interviewee particulars

Name..... Age..... Sex..... Marital Status.....

Number of household members.....

C. Research information

1. Costs and mode of land use practise

a. How did you obtain the land for cultivation?

-bought

-inherited

-rented

-Given by village committee

b. How much did you pay to obtain the land?

c. What is the size of your farm (ha)?

d. How many seasons of production do you practise in a year? (specify months)

e. How do you prepare land for cultivation?

-Slash and burn

-Use hand hoe

-Use tractor

-Other methods (specify)

f. What costs do you incur for farm preparation?

g. What other inputs do you use in production?

h. For each input what is the quantity and cost?

i. Do you own a tractor or you hire?

j. If you hire how much does it cost?

2. Revenues
   a. What types of crops do you cultivate in a year?
   b. For each crop mentioned above, how many bags/units do you produce?
   c. Do you sell all crops that you produce?
   d. If what amount do you sell?
   e. What is the price of each unit crop?
   f. Where do you sell?
   g. How far is the market place from where you live?
   h. What other benefits do you get from crop production?
3. Fire uses
   a. Do you use fire as land management tool in any part of production?
   b. If yes, which activities and when do you use fire?
   c. What are the reasons of using fire in production?
   d. Are there other options/alternatives rather than using fire? Mention them
   e. What are their costs in each?
   f. If the options were made available do you think it would help reduce fire incidences in forest?
   g. How do you ensure that fire does not spread to the forest while burning the farm?
   h. How do you manage fire if it gets out of hand?
   i. Have you or any other farmer caused forest fire? Yes/No
   j. If yes how many hectares were burnt?
4. What strategies do you think could help to reduce the occurrence of fire in the forest?
5. What other socio-economic activities do you undertake?

2.0 Checklist for focused group discussion

1. What activities are likely to use fire in their management? (circle the answer)
   a) Crop farming
   b) Livestock keeping
   c) Charcoal works
   d) Hunting
   e) Honey gathering
   f) Others (specify).....

2. Why do you use fire in these activities?
3. Are there any other means of managing those land use practises rather than using fire? 1.Yes 2.No
4. If yes, what are the alternatives of using fire in those land use practises?
5. What is the reason that you don't use these alternatives?
6. Are there incidences of fire outbreak to forest due to any of these land practises?
7. What are the major practises (ranking) that cause fire in forest?
8. What are the effects of fire to the forest and the environment in general?
9. What is the fire regime in the study area(s)? (season, frequency, intensity and extent) .
10. What are the strategies to manage forest fires?
11. What do you think should be done to sustainably manage forest as well as improving livelihood strategies?