OPPORTUNITY COSTS OF REDD+ TO COMMUNITIES OF MUFINDI DISTRICT, IRINGA, TANZANIA

FARAJI NURU

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FORESTRY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The main objective of this study was to assess the opportunity costs of REDD+ to the communities of Mufindi District. The specific objectives were, to identify and assess the economic value of alternative land use, the aboveground carbon stock of the sampled forest (Idewa Forest Reserve) under PFM, the profitability of each land use and compare with the REDD+ incentives, and the willingness to accept (WTA) of the communities towards REDD+. Structured and semi structured questionnaires, personal observation, focused group discussion and forest inventory were used in data collection. Sixty households out of 975 in two villages were sampled randomly. The data was analyzed using the SPSS programme version 16 and Microsoft Excel programme. Descriptive analysis was used to generate frequencies, percentages, Chi square values, sums and means which were used to discuss the results. The main land uses were agriculture and tree planting. Main crops cultivated include maize and beans, and tree species planted was *Pinus patula*. The economic value for agriculture and tree planting were $ 2 958.52 and $3 272.94 per ha per year respectively. The aboveground carbon of the sampled forest was 39.23 t/ha (143.97 tCO_2e/ha). The opportunity costs of REDD+ was varying depending on the price per ton of carbon. The general perception of the communities in the study area towards REDD+/PFM was positive (53.3%) and their willingness to accept was positive. The opportunity costs of REDD+ to the communities will be advantageous if the price per ton of carbon dioxide equivalent will be $23 and above. Therefore there is no general unit price per tCO2e. I therefore recommends opportunity costs of REDD+ to different communities be used as guidance when making decision on unit prices of carbon.

DECLARATION

I, Faraji Nuru do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has neither been submitted nor being concurrently submitted in any other institution.

16/09/2013

Faraji Nuru — Date

MSc. Candidate

The above declaration is confirmed:

16.9.2013

Dr. Abdallah, J. M. — Date

(Main Supervisor)

16.09.2013

Prof. Ngaga, Y. M. — Date

(Co- supervisor)

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DEDICATION

This work is dedicated to my mother, Anna Amashi Mcharo, who laid the basis and encouragement in my education and hence my future.

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ABBREVIATIONS

CCIAM	Climate Change Impact Adaptation and Mitigation Programme
CBFM	Community-Based Forest Management
Dbh	Diameter at breast height
FAO	Food and Agriculture Organization of the United Nations
FBD	Forest and Beekeeping Division
FGD	Focused Group Discussion
IFR	Idewa Forest Reserve
IPCC	Intergovernmental Panel for Climate Change
JFM	Joint Forest Management
MNRT	Ministry of Natural Resources and Tourism
NAFORM	National Forestry Research Master Plan
NPV	Net Present Value
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal
RED	Reducing Emissions from Deforestation
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation; and the role of conservation, sustainable management of forest and enhancement of forest carbon stocks in developing countries
ROSE	REDD Opportunities Scoping Exercise
SPSS	Statistical Package for Social Science
URT	United Republic of Tanzania

VEO	Village Executive Officer
VNRC	Village Natural Resource Committee
WBI	World Bank Institute

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Reducing Emissions from Deforestation and forest Degradation (REDD) was recognized officially at the 2007 CoP13 in Bali. In 2005, discussions focused only on 'reducing emissions from deforestation' (RED). As it became clear that forest degradation in some countries was an even bigger problem than deforestation, 'avoided degradation' (the second D) was officially endorsed at the 2007 COP13 in Bali and RED morphed into 'reducing emissions from deforestation and degradation' (REDD). Subsequently, it was further recognized that there could be climate benefits not only from avoiding negative changes (deforestation, degradation) but also from enhancing positive changes, such as conserving and restoring forests (Angelsen and Wertz-Kanounnikoff, 2008). This can be referred to as 'removals' or 'negative emissions. It was expressed as the '+', and 'reducing emissions from deforestation and forest degradation in developing countries (REDD); and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries' (REDD+) became official language at the 2008 COP14 in Poznan (Angelsen *et al.*,2009).

A core idea underlying REDD+ is to make performance-based payments, that is, to pay forest owners and users to reduce emissions and increase carbon sequestration. Regardless of whether or not individuals or communities are being compensated financially if REDD+ limits their livelihoods (legal or not) benefits/opportunities, then they bear an opportunity cost. If these costs are not compensated in some way (financially or otherwise) there are two implications: (1) pressure on forest utilization will continue, or (2) the opportunity cost would cause harm to communities, in violation of international good practice standards (and World Bank safeguards) of "doing no harm" (Angelsen *et al.,* 2009). However, the information concerning the opportunity costs of REDD+ to communities in different areas of the world including Tanzania is inadequate hence a need for this study.

1.2 Problem statement and justification of the study

Deforestation and forest degradation, through agricultural expansion, conversion to pastureland, infrastructure development, destructive logging, fires etc., accounts for nearly 20% of global greenhouse gas (GHG) emissions, more than the entire global transportation sector and second only to the energy sector (Gurung, 2010). Reducing deforestation and degradation conserves carbon and other benefits that forests provide. This includes timber and non wood forest products, biodiversity, soil conservation, water services, and cultural and spiritual values. But it foregoes the benefits of alternative land uses, such as crop and livestock production. These foregone benefits, or opportunity costs, are very significant components of the costs of REDD+.

Other costs include costs for implementation and administration, socio-cultural and transaction costs, stabilization and indirect costs (WBI, 2011). The basic idea of REDD+ is to generate a significant level of compensation or economic incentive to outweigh the income generated through deforestation (FoEI, 2008) among which is to compensate for the opportunity costs that communities incur from alternative land uses such as agriculture and livestock keeping. Since REDD+ is an emerging issue all over the world, there is limited information on its opportunity costs to different communities especially those living adjacent to the forests.

How attractive land conversion for individual land owners is based on the balance between forest value and the value of alternative land use is a key variable for deforestation (Böttcher, *et al.*, 2009). Therefore ensuring positive economic incentives for landowners and farmers is among the fundamental requirements for REDD+ (ROSE, 2009). Opportunity costs represent the alternative land-use of the area under deforestation threat, including net revenue from the conversion itself (e.g. value of extracted timber) (Böttcher, *et al.*, 2009).

Opportunity cost analysis provides monetary estimates of how different stakeholders and sectors of the national economy would be affected by REDD+ policies and payments. It is an important part of a national planning process, but should always be considered in the broader context of other costs and benefits (Kahurani, 2011).

Participatory Forest Management (PFM) is among the vehicles used for REDD+ implementation in Tanzania where local communities are involved. Majority of Non Government Organizations (NGOs) in Tanzania are using PFM to implement REDD+. Under PFM local communities and the government co manage forest reserves through Joint Forest Management (JFM) where the owner of the forest is either central government or local government and Community-Based Forest

Management (CBFM) where local communities are the owner of the forest. The involvement of local communities in forest management in the country follows substantial reforms that have taken place in the forest sector within the past few years, following the adoption of the National Forest Policy (1998) and implementation of the Forest Act (2002) URT (1998, 2002).

Mufindi is one of the five districts in Iringa Region implementing PFM under both JFM and CBFM. The implementation of PFM is the one which made this study to be done in Mufindi district so as to determine whether the coming REDD+ initiatives will be effective because there were no study done in the area to assess the opportunity costs of REDD+ to the communities.

The results of this study are expected to help to clarify how to design an appropriate financial or policy incentive to change behavior at ground level. Prospective studies are needed as future opportunity costs will depend on REDD+ incentives and land-use incentives, price etc. However understanding cost and benefits would require extensive research in our countries as current estimates of other costs remain coarse (Swallow *et al.*, 2007). Therefore, the results of this study will assist policy and decision makers in the reform of the government policy and decisions on REDD+.

1.3 Objectives

1.3.1 Main objective

The main objective of this study was to assess the opportunity costs of REDD+ to communities of Mufindi District.

1.3.2 Specific objectives

The following were the specific objectives of the study:

i. To identify and assess the economic value of alternative land use in the study area,

ii. To assess the aboveground carbon stock of the selected forest under PFM in the study area,

iii. To assess the profitability of each land use and compare with the REDD+ incentives,

iv. To assess the willingness to accept (WTA) of the communities towards REDD+.

1.3.3 Research questions

i. What is the economic value of each land use in the study area?

ii. What is the amount of carbon of the selected forest in the study area?

iii. What is the profitability of each land use in comparison with the REDD+ incentives.

iv. What is the perception of the community towards REDD+?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 REDD+ in Tanzania

During the CoP 15 held in Copenhagen, Denmark, in December 2009, the CoP noted consensus among the Parties with the Copenhagen Accord, which agreed on the need to provide positive incentives to REDD+ actions. This was through immediate establishment of a mechanism, to enable the mobilization of financial resources from developed countries (URT, 2010a).

The Copenhagen Accord and the large scale of recent international funding pledges have served as the political and financial spring board for REDD+ plans, policies and projects to proceed in selected developing countries, including Tanzania, where climate change is the biggest problem posing challenges to sustainable livelihoods and economic development. The adoption and implementation of REDD+ provides another opportunity for Tanzania to open up a growing market for forest carbon trading.

A five year (2010-2014) research and training programme on Climate Change, Impacts, Adaptation and Mitigation in Tanzania (CCIAM) has been initiated to support the REDD+ implementation capacity in the country (URT, 2010a). Climate Change Impacts, Adaptation and Mitigation is implemented by Sokoine University of Agriculture, in collaboration with three other partners in Tanzania namely, the University of Dar es Salaam, Ardhi University, Tanzania Meteorological Agency and Norwegian institutions coordinated by the Norwegian University of Life Sciences. The purpose of the Programme is to develop and sustain adequacy in national capacity to participate in climate change initiatives and address the effects and challenges of climate change with particular emphasis on REDD initiatives.

2.2 Costs of REDD+

In order to receive REDD+ funding, countries must reduce deforestation and forest degradation, and/or enhance carbon stocks. To do so, however, generates costs. These costs can be grouped into three general categories: Implementation costs, Transaction costs and Opportunity costs.

2.2.1 Implementation costs

The costs of implementing REDD+ policies are the efforts needed to reduce deforestation and forest degradation. They comprise upfront costs of 'capacity building'; ongoing 'administrative costs' of monitoring, enforcement and other activities needed to run a REDD+ programme.

Implementation costs will vary with national capacities and strategies. In addition, the costs of generating valid REDD credits will crucially depend on the baseline-setting methodology for how REDD efforts shall be compensated (Ruben, 2008; White and Minang, 2011). These are the costs directly associated with actions to reduce deforestation, and hence emissions abatement. Examples include the costs of: guarding a forest to prevent illegal logging, relocating timber harvesting activities away from natural forests to degraded forests scheduled for reforestation, intensifying agriculture or cattle ranching so that less forest land is necessary for food, fiber and fuel production, re-routing a road project so that less forest land is destroyed as a result of opening the road, relocating a hydroelectric production project away from a natural forest, delineating and/or titling land of communities so that they have an incentive to continue protecting forests against conversion, providing capacity building, infrastructure or equipment to develop alternative livelihoods to communities (White and Minang, 2011).

2.2.2 Transaction costs

Transaction costs are the costs of establishing and operating a REDD+ program and they are involved in successfully connecting buyers and sellers. Transactions costs are incurred throughout the process of identifying the REDD+ program, negotiating the transaction, and monitoring, reporting, and verifying the emission reductions. Transactions costs are also incurred by the implementers of a REDD+ program and third parties such as verifiers, certifiers, and lawyers. These costs are separate from implementation costs, since by themselves they do not reduce deforestation or forest degradation. These activities and associated costs are nevertheless necessary for transparency and credibility of the REDD program and thus add value to the whole process. Transactions costs may also include so-called 'stabilization costs' arising from the need to prevent deforestation activities from moving to other countries that are not participating in REDD+ (White and Minang, 2011).

2.2.3 Opportunity costs

The opportunity cost of forest conservation may be defined as the net income per hectare per year or the net present value (NPV) that is sacrificed as a result of not logging (or logging more sustainably) or not converting land to agriculture (Olsen and Bishop, 2009). The opportunity costs are the foregone economic benefits from alternative land uses. Most estimates focus on the 'opportunity costs' of avoiding deforestation from a landowner's perspective, without the costs of developing institutional capacities and actually implementing and transacting a REDD programme (Ruben, 2008). Opportunity cost of forest conservation may be defined as foregone economic benefits from alternative land uses (Olsen and Bishop, 2009). White, and Minang, (2011) added that estimating the opportunity cost of REDD+ is important for a number of reasons including the following;

Opportunity costs are thought to be the largest portion of REDD+ costs (Boucher, 2008; Pagiola and Bosquet, 2009; Olsen and Bishop, 2009). Boucher's (2008) review of 29 regional empirical estimates found average opportunity costs to be between 80 and 95% of the costs of avoiding deforestation in the countries with the most forest cover. This estimate will not necessarily be true in all cases. The relative magnitude of all REDD+ costs depends on national context and specific location. In some circumstances, the opportunity costs of some land uses especially in remote locations may be less than other REDD+ costs.

i. Estimating opportunity costs provides insights into the drivers and causes of deforestation. Most economic agents do not cut down forests out of malice — they do so because they expect to benefit from do so. High opportunity costs tend to be linked with high deforestation pressures. Typically, such lands have been or are being converted to uses of higher economic value such as timber and agriculture (Pagiola and Bosquet, 2009). By helping to better understand drivers of deforestation, opportunity cost estimates can thus help develop appropriate responses. Here too, there is considerable variation; in some cases, forests are converted to very low-value uses (Chomitz *et al.,* 2006).

ii. Opportunity costs can help understand the likely impacts of REDD+ programs across social groups within a country. Land uses are associated with different social groups. Knowing who would likely gain or lose from REDD+ can help identify potentially moral/ethical consequences (if losses were borne by marginalized groups) and pragmatic repercussions (if losses were incurred by politically powerful groups able to prevent adoption of REDD+ policies or resist their implementation). With the insights gained from REDD+ opportunity cost estimates, national REDD+ strategies can develop effective policies and mechanisms to reduce deforestation and avoid adverse social consequences (Pagiola and Bosquet, 2009).

iii. Opportunity costs help to identify fair compensation for those who change their land use practices as part of REDD+. Since livelihoods are affected by land use changes arising from REDD+, opportunity costs are an estimate of the amount of income that alternative livelihoods would need to provide. for instance, in cases where natural protected areas are strengthened, the opportunity costs estimate the loss of income to nearby communities. Even if these communities are not directly compensated, the information is important for policy makers to understand the tradeoffs and risks of the REDD+ conservation policy.

iv. The information gathered to estimate opportunity costs is a basis for additional analysis of REDD+ costs. Along with other socio-economic information, field-level economic data can be used to understand farm, cattle and timber production within supply chains and impacts on the respective economic sectors. Analyses can be spatially differentiated to examine sub-national impacts, especially those of forest frontier regions. In addition, information gathered for opportunity cost analysis is a basis for conducting analysis of indirect costs. The calculation of opportunity costs also serves as a departure point for estimating indirect costs, whereby opportunity costs reflect a land use and economic context without REDD+

2.3 Challenges of using opportunity cost as an indicator for REDD payments

Gregersen, *et al.* (2010) argued that a number of problems have been observed in using opportunity cost as a useful indicator of payments needed in the political, social and economic contexts of tropical countries that will be implementing REDD+. Relying on these estimates could lead into the wrong direction and could discourage many potential supporters, once the real required payments and costs are recognized. Furthermore they summarized some of the main contextual issues that need to be addressed in using opportunity cost indicators namely; (a) "Opportunity cost may be inappropriate, e.g., in the case of illegal logging and other illegal activities that result in deforestation" , (b)"It may be inadequate in terms of understanding what payments are needed to halt deforestation, (c)"If one is not dealing with a well-functioning market system, it may be difficult to estimate cost correctly, (d)"Finally, we have to remember that opportunity cost is not a static concept.

2.4 Land uses

Land-use can be defined as the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions) (IPCC, 2000); the social and economic purposes for which land is managed such as grazing, timber extraction, and conservation. Land-use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels (Anderson *et al.*, 1976). During the period 1990–2000, land-use change contributed to approximately 20% of global greenhouse gas (GHG) emissions and has represented a lower percentage (12% in 2008) during the first decade of this century due to significant growth of global fossil-fuel emissions (Houghton, 2005; Le Que´re´ *et al.*, 2009). This study is intended to come out with information on the land uses in the study area and the economic value of each of the main land uses identified.

2.5 REDD+ payments

At the very minimum, payments need to meet the opportunity costs (plus transaction costs) that resource managers incur from changing their behavior (Bond *et al.*, 2009). A core idea underlying REDD+ is to make performance-based payments, that is, to pay forest owners and users to reduce emissions and increase carbon sequestration. Regardless of whether or not individuals or communities are being compensated financially if REDD+ limits their livelihoods (legal or not) benefits/opportunities, then they bear an opportunity cost. If these costs are not compensated in some way (financially or otherwise) there are two implications: (1) pressure on forest utilization will continue, or (2) the opportunity cost would cause harm to communities, in violation of international good practice standards (and World Bank safeguards) of "doing no harm" (Angelsen *et al.,* 2009). Some researchers have identified a major tradeoff between efficiency and equity in the future for REDD (Chhatre and Agrawal, 2009; Seymour, 2008). Therefore this study was important for identification of the tradeoff incurred by implementing REDD+.

2.6 Participatory Forest Management

Participatory forestry refers to processes and mechanisms that enable those people who have a direct stake in forest resources to be part of decision-making in some or all aspects of forest management, from managing resources to formulating and implementing institutional frameworks. Inclusion of communities in the management of state owned or formerly state owned forest resources has become increasingly common in the last 25 years. Many countries have now developed, or are in the process of developing, changes to national policies and legislation that institutionalize Participatory Forest Management (PFM). Donors' interests in PFM have moved from an initial concern with ensuring forest conservation to interest in PFM as a means of reducing poverty (Moss *et al.*, 2005). Participatory forest management in Tanzania was introduced in 1990s where local communities started being involved in forest management. The involvement of local communities in forest management in Tanzania follows substantial reforms that have taken place in the forest sector within the past few years, following the adoption of the new

National Forest Policy (1998) and enhancement of the new Forest Act (2002) URT (1998, 2002). The reforms have been geared towards operationalization of different components of the policy in order to facilitate its implementation and work to replace the legacy of the colonial past, which absolutely involved state ownership of the forests (URT, 2003).

Participatory forest management is categorized into two parts namely Joint Forest Management (JFM) and Community Based Forest Management (CBFM). Under CBFM, local communities participate in forest management through the establishment of Village Land Forest Reserves (VLFRs), where communities are both managers and owners of forests, while under JFM; local communities co-manage National Forest Reserves (NFRs) or Land Area Forest Reserves (LAFRs) with central and local government authorities.

The local Government Act (1982), the Village Land Act (1999), and Forest Act (2002) URT (1982, 1999, 2002) together provide the legal basis for villages to identify, declare, own, and manage forest resources on village land in ways that are both sustainable and profitable. The Forest Act further provides tangible incentives to rural communities to progressively 'reserve' large areas of unprotected miombo and coastal woodlands currently on general land, estimated to be 16.5 million ha. The popular term for delegated management of forest resources on village land is CBFM, and as of 2008, over 2.2 million ha have placed under local management in over 1 440 villages on mainland Tanzania (MNRT, 2008). JFM is different from CBFM in that it takes place on forestland owned usually by either central or local government. Communities living around the forest can enter into Joint Management Agreements (JMAs) with either central or local government regarding the use and management of the forest. Under such agreements, each village defines an area within the forest that it will jointly manage with government. Such areas are called Village Forest Management Areas (VFMAs) (URT, 1998).

2.6.1 Impact of PFM on local communities livelihood

In Nepal and India community forestry programmes were initially conceived to reverse degradation of national forests which could not be managed and protected effectively by state forestry services (Moss *et al.,* 2005). Rural poverty alleviation has been a further motivation behind Leasehold Forestry in Nepal and JFM in India. Certainly, the impact and potential impact of PFM on poverty differ in various case studies. PFM that focused on forest protection and provision of subsistence products for household use had less potential for reducing chronic poverty, but may function to prevent the worsening of poverty amongst the non-poor and transitory poor. Provision of new income-generating activities through PFM has greater potential for reducing poverty (Moss *et al.,* 2005).

However, the lesser ability of the poor to take advantage of new opportunities can result in inequities in the impact of PFM. For instance, some of the most profitable opportunities such as small scale logging enterprises in Honduras, may have higher initial demands on capital and skills than less profitable opportunities such as resin tapping and the sale of fuel wood (Moss *et al.,* 2005). Blomley and Iddi (2009) studies show that since the introduction of PFM in Tanzania there have been some improvements in both forest conditions and livelihoods of people adjacent to the forest under both CBFM and JFM management regimes when compared to non PFM forests. Nshubemuki (2009) cited by Blomley and Iddi (2009) investigated the impact of JFM in Ruvu North Forest Reserve (RNFR) on the livelihoods of participating communities, who are allocated plots in the degraded part of the forest where they practice agroforestry, by planting trees suitable for firewood, timber, and charcoal. The aim is to reduce pressure on forests in the relatively less degraded part of the reserve. Results showed that each household in communities in four villages (Kongowe, Mwendapole, Msangani, and Mkuza) around the reserve earned a total of TZS 310 329 in 2007 from selling charcoal, firewood, poles, agricultural crops, and tree seedlings from JFM plots. According to Blomley and Iddi (2009) this income originating from JFM plots in the forest reserve, contributed significantly to the total household income. Ngaga *et al.* (2009), cited by Blomley and Iddi (2009) has concluded that all household categories depend on and derive significant values from forest resources although they mainly depend on agriculture and business for cash incomes. While forests supply firewood as the most important product to all wealth classes, they appear to be a main stay of poor households' incomes and an important element in normal and rich households' ability to keep livestock and thereby diversify their economies.

A study by Kajembe *et al.* (2009) in the Northern and Southern highlands of Tanzania showed a general trend of decreasing gradient of stem density while at the same time increasing gradient of basal area and standing volume from non-CBFM to CBFM regimes. This may be due to more disturbance in non-CBFM which is basically open access regime compared to CBFM where there are institutions mandated to monitor forest resources. Comparison between CBFM and JFM showed that there was a decreasing gradient of stem density, basal area and standing volume from CBFM to JFM. According to these researchers, this may be due to the governance structures in CBFM which seem to be more functional as compared to JFM (Blomley and Iddi, 2009).

2.6.2 Connection between REDD+ and PFM in Tanzania

Due to its well-established PFM programme, Tanzania is strongly placed to develop a national REDD+ programme. Other factors are; stable socio-political situation, confirmed REDD Readiness funding, especially from the Government of Norway and via the UN-REDD Programme; and in view of its high rates of deforestation, especially in miombo and coastal forests, and degradation (possibly 500 000 ha of forests or woodlands are degraded annually) (Katoomba group, 2009). Mufindi is one of the five districts in Iringa Region implementing PFM under both JFM and CBFM which led to the implementation of REDD+ project in the district.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

The study was carried out in Mufindi District in Iringa Region. Mufindi District is one of the seven Districts in Iringa Region located in Southern Highland of Tanzania. It is among the five districts in Iringa Region implementing PFM under both Joint Forest Management (JFM) and Community-Based Forest Management (CBFM). The implementation of PFM is the one which made this study to be done in Mufindi district so as to determine whether REDD+ initiatives will be effective.

3.1.1 Location

Mufindi District lies between latitude $8^0.00' – 9^0.15'$ South and longitude $34^0\ 35'–35^0\ 55'$ East. The District is bordered by Iringa Rural District to the North, Morogoro region to the East, Njombe District to the South and Mbeya region to the West. It is situated about 80 km from Iringa Municipality and boarders Kilolo to the North East and Kilombero to the South East.

3.1.2 Climate

Mufindi District is characterized by two idiosyncratic features, specifically the Eastern Highlands and the Mufindi Plateau.

The Eastern highlands

The highlands lie at an altitude of 1700-2200 m above sea level. The feature ranging from south west to the eastern part which is part of the Eastern Arc Mountains and the Kihansi Dam and its Catchments. The mean annual rainfall ranges between 1200-1600 mm. The average precipitation is 1400 mm per annum where by the East and South are the wetter parts while the West is much drier. Temperatures are often below 15°C, the mean monthly is 18.4°C (maxima-November and February) and the minima is 13.2°C (July).

The Mufindi plateau

It is extensive and uniform covering halfway of Iringa rural through Mafinga up to Makambako. Its altitude ranges from 1700-2000 m above sea level. The average mean annual rainfall is 950 mm. In the eastern part of the plateau the annual rainfall is slightly higher than 950 mm. The average evapotranspiration is 1300 mm per annum, where as the maximum temperature is 18.3°C (February) and the minimum is 13.1°C (July).

Mufindi District has one rainfall season starting from early November and ends up in June. Rainfall is critical for agricultural production which is the mainstay of the Mufindi District's economy and livelihood. Thus, human settlement and land use patterns are influenced by the distribution of rainfall such that there is a concentration of people on the eastern highland area.

3.1.3 Topography

The Eastern highlands

The land unit is typified by a steep topography. The land form is steeply dissected with slopes of more than 30 percent gradient, often as steep as 50%. Flatter top slopes of 2-8% and 8-16% gradient comprise an average about 10% of this land unit. The drainage pattern is very dense, with infield flat bottom lands generally less than 20 mm width. Vegetation includes low/shrub land and scattered forests. The soil is generally red clay of moderate fertility with dark top soil composed of high organic matter. Much of the land is at risk of erosion due to steep slopes of over 30% gradient.

The Mufindi plateau

It is very extensive and uniform plateau extending from half way Iringa –Mafinga up to Makambako. Most of this land unit is undulating with slopes of 2-8%. Scattered areas and slopes towards drainage lines are steeper with slopes of up to 20% gradient. The drainage system is infield with moderately wide bottom lands. Also incised drainage occurs in areas where topography is steeper than general. Cultivated land is dominant. Miombo woodlands are common on the hill slopes in the eastern parts, while thicket vegetation and shrubs/grassland are more common in the western parts. The soils are uniform yellow highly leached clays. Due to high degree of chemical leaching and absence of humid or dark top soil, fertility is low.

3.1.4 Land uses

Crop cultivation, livestock husbandry and forestry are the main land use in Mufindi District. The District has a total area of 7 122 km2 (712 200 ha). About 95% of the District is suitable for agriculture and livestock activities since it has noticeable differences in rainfall amount and pattern, land form, soil types and practices in land use.

3.1.5 Population

According to the 2002 population and housing census, Mufindi District had a total population of 282 071 people of whom 133 150 were males (47.2 %) and 148 921 females (52.8%). The District has a growth rate of 1.5% per year during 1988 to 2002. According to this growth rate, the District is estimated to have 322 517 people of whom 152 228 are males and 170 289 are females and the population density is estimated to be 45 persons per km^2.

3.2 Research design

3.2.1 Estimation of above ground carbon

A total of 44 temporary circular sample plots of radius 15 m (0.07 ha) were established randomly throughout the forest. The distance between plots varied between 100 m and 200 m. The total number of sample plots was computed by using the formula below:

N= (292*1.07) / (0.071*100) =44...(1)

Where: N=Number of sample plots

TA=Total area

Si=Sampling intensity

Ps=Plot size

3.2.2 Costs and Benefits of alternative land uses

The sampling unit of the study was the household. A cross sectional research design was adopted and data were collected at a single point in time. Both purposive and random sampling procedures were used to select households for primary data collection. Two villages namely Kibengu and Ilogombe were sampled purposively based on their closeness to Idewa Forest Reserve, whereby 30 households in each village were randomly interviewed. The sampling frame at Kibengu and Ilogombe villages were 580 and 395 households respectively. According to Bailey (1994) a sub sample size of 30 from one observation unit is considered adequate provided that characteristics of the study population were well excluded.

3.3 Data collection

3.3.1 Estimation of carbon above-ground

Forest inventory was conducted to obtain data for above ground carbon estimation. All trees with DBH $\geq$ 6 cm within each sample plot were measured for diameter at breast height (dbh) for biomass determination (Appendix VII). The heights for the largest, medium and smallest trees were measured. Local names of all trees measured were also identified using a local enumerator followed by identification of scientific names by using literatures including URT (2010b).

3.3.2 Costs and Benefits of alternative land uses

Participatory Rural Appraisal (PRA) approaches and questionnaire survey methods were the main tools used to collect data for costs and benefits of alternative land uses. The significance of each of these tools is as explained below:

Questionnaire survey

Structured questionnaires with both close and open-ended questions were used. This approach was useful in this study as it enabled gathering of data to quantify the information with facts and figures. Data that was collected was for the WTA of the community in the study area. The information gathered here include; communities' awareness and perception of the communities towards REDD+/PFM, awareness on restrictions of PFM and the impacts of the restrictions to use of the forest.

Participatory Rural Appraisal approaches

Focus Group Discussion (FGD): Focused group discussions with the village leaders were conducted where by a checklist (Appendices III-VII) was used to guide good flow of information and avoid getting lost from the main focus of the discussion. In this study, the focus group involved village government leaders (Chairperson and the Village executive Officer (VEO)), Village Natural Resources Committee (VNRC) members. FGD provided information that supplemented the data obtained through questionnaire survey specifically those related to their perception towards REDD+. Therefore similar information to the ones gathered by households questionnaires were collected but in more detail and in form of discussion.

***Key informant interview*:** Involved here were District Natural resources officer, small scale farmers (appendices II-V). These informants helped the researcher to obtain more accurate information on production and prices of different land use product.

3.4 Data Analysis

3.4.1 Estimation of above ground-carbon

Above ground carbon was obtained as a product of tree volume, average wood basic density and biomass carbon conversion factor 0.49 (Munishi and Shear, 2004; Munishi, *et al.*, 2010).

The basal area was calculated from stems diameter at breast height (1.3m) for all trees in each plot. The formula below was used to compute tree basal area;

$$g_i = \frac{\pi d^2}{4} \qquad \text{...(2)}$$

Where by

g_i = tree basal area (cm^2)

d=diameter at breast height (dbh)

The calculated basal area, trees heights, and the form factor were then used to calculate tree volume. The form factor of 0.5 for natural forest was used. Heights for all trees were obtained by regressing diameters and the heights of measured sample trees to get the height dbh relationship. The equation below was then used to calculate heights of the remaining trees;

$$h = 7.74687 + 0.233(dbh) \ldots\ldots\ldots\ldots r^2 = 62\%, E = 3.3 \qquad \text{.....................(3)}$$

Whereby;

h=tree height (m)

dbh= diameter at breast height (cm)

a and b= constants, a=7.74687 and b=0.233

The trees volume was computed by multiplying the basal area, height and the form factor as shown below;

$$v = g_{ij} h f \qquad \text{...(4)}$$

Whereby

g_{ij}=tree basal area

h=tree height

f=form factor

The amount of carbon obtained in grams was then converted to tones of carbon per hectare (tC/ha) of carbon which was finally converted to carbon dioxide equivalent (tCO_2^e). Thereafter the computed amount of CO_2^e was multiplied by the suggested prices of carbon per hectare to get the economic value of the forest for opportunity cost determination.

3.4.2 Costs and Benefits of alternative land uses

Both quantitative and qualitative data analysis methods were used to analyze of data collected using questionnaires. Statistical Package for Social Science (SPSS) was used for analysis of the social data to assess the willingness of the community in the study area to accept REDD+/PFM. Content analysis was used for analyzing the qualitative data from the FGD. The recorded conversations were summarized into brief and easily understood information. This information was then used to supplement the results from the household questionnaires. Microsoft Excel computer program was used to analyze the economic data to obtain the net annual profit and then the NPV. Potential financial profitability was calculated for each of the important land uses identified. The profitability analysis considered all establishment costs and all cost and revenue streams over the lifetime (in this study it is 20 years) of the production systems. The net profit obtained by subtracting total costs from the total revenue for each item was discounted and summed to produce an estimate of the net present value (NPV). The value of NPV was calculated by the formulae below:

$$NPV = \sum_{1=t}^{T} \frac{\Pi_t}{(1+r)^t} \qquad \text{.....(5)}$$

Where t = year, T = length of time horizon, Π = net annual profits of the LU ($/ha), r = discount rate. The major assumptions introduced at the stage of NPV calculation were the discount rate (r) and the time horizon (T). All labour was valued at the local market wage and outputs valued by farm-level prices. Return to land was calculated as the present discounted value of net profits that a farmer would expect to earn from land allocated to a particular land use for a complete production period. The analysis used a discount rate of 10%. The discount rate can be equated to the cost of borrowing money. The interest rate on loans (often between 5 and 10% annually) is a useful proxy (White and Minang, 2011). A 20 year time horizon was used with assumption that REDD+ will be implemented for 20 years. The length of the time horizon for analysis can be an arbitrary decision, yet should be guided by REDD+ policy. Common horizons range from 20-50 years, and perhaps more (White and Minang, 2011). For discount rates, NPV analyses typically use loan interest rates which are set by a national bank or the government. Such rates can range from 10-30%. Although agricultural loans are rarely available, especially in remote forest margin regions, bank interest rates do serve as a good indicator of the time value of money (White and Minang, 2011).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

Sub-section one presents the characteristics of the respondents, sub-section two presents the economic value of alternative land uses in the study area, sub-section three presents the discussion on the above ground carbon, sub-section four presents the discussion on the profitability of each land use compared to REDD+ incentives, and sub-section five presents the willingness to accept (WTA) of the communities towards REDD+.

4.1 Respondents' characteristics

These were identified according to their relationship with the research objectives particularly objective four. The main characteristics presented here are sex, ethnic group, marital status and age. These characteristics are related to the response of an individual when asked questions on how he/she perceives the presence of REDD+/PFM.

4.1.1 Sex of the respondents

The total number of the respondents was 60 where by 66.7% were male and 33.3% were females but the proportion for males and females was different between the two study villages (Kibengu and Ilogombe) (Table 1). At Kibengu 76.7% of the respondents were males and 23.3% were females while at Ilogombe males were 56.7% and 43.3% were females. This implies that most households were headed by men. This also shows that gender was considered in this study so that the output of the study is not based in only one gender.

Table 1: Sex of the respondents in the study area

		Male (%)	Female (%)	Total (%)
Respondent's village	Kibengu	76.7	23.3	100.0
	Ilogombe	56.7	43.3	100.0
	Total	66.7	33.3	100.0

4.1.2 Respondents ethnic group

The main tribe in the study area was the Hehe occupying 93.3% of all respondents followed by Bena and Kinga with 5% and 1.7% each respectively. This information was important in this study because it tells whether there was acculturation (cultural change) of the original community. Group mobilization enhances the capacity of people to work continuously and vigorously for their welfare. However, depending on the perceived needs, and results of social development, ethnic group mobilization can act either as a positive or negative force (Behera and Sahu, 2007)). Table 2 below describes the distribution of each ethnic group in the two villages.

Table 2: Ethnic groups of the respondents

		Respondent ethnik group (percentage)			Total
		Hehe	Bena	Kinga	
Respondent's village	Kibengu	90.0	10.0	0.0	100.0
	Ilogombe	96.7	0.0	3.3	100.0
	Total	93.3	5.0	1.7	100.0

4.1.3 Marital status of the respondents

The distribution of each group of marital status of the respondents in the study area as to whether married, divorced, or widowed are summarized in Table 3. The results show that the proportion for married, divorced and widowed respondents were 88.3%, 1.7%, and 10% respectively. The observed results indicate that the respondents were old enough to be able to provide clear information.

Table 3: Marital status of the respondents

		Respondent marital status (%)			
		Married	Divorced	Widowed	Total
Respondent's village	Kibengu	86.7	0.0	13.3	100.0
	Ilogombe	90.0	3.3	6.7	100.0
	Total	88.3	1.7	10.0	100.0

4.2 The economic value of alternative land uses

The crops grown include maize, beans, peas, irish potatoes, and pyrethrum where by maize and beans are the main crops. Apart from crop cultivation respondents in the study area were also involving in tree planting activities. Most of the sample households had an area of about 0.2 ha of trees. The main species preferred was *Pinus patula.* The economic value of each of the main crops cultivated and trees were as discussed in the following sections.

4.2.1 The economic value of maize and beans

Maize and beans are the main crops cultivated in the two study villages, Kibengu and Ilogombe. They all involve similar stages of management which are land preparation, planting, weeding and harvesting.

4.2.1.1 Land preparation and weeding costs

Most of the sample households used family labour for all farm activities so the costs for the farming activities were taken basing on those few farmers who use casual labours. Land preparation for crop cultivation includes slashing and tilling. These are normally considered as a single activity. The costs for land preparation differed in the two villages, at Kibengu it was varying between TZS 74 100 and TZS 123 500 per ha while at Ilogombe it was TZS 98 800 per ha. Weeding costs varied between TZS 49 400 and TZS 74 100 per ha at Ilogombe and at Kibengu village it was TZS 74 100 per ha. These costs equal TZS 3 000 per man day where it takes seventeen to twenty days for a person to weed one ha and 24 days to dig one ha. This is underpayment if compared to the current value of the Tanzanian shilling. The minimum government payment per man day for the financial year 2011/2012 was TZS 5 192.

4.2.1.2 Seeds and fertilizers

Most of the households recycle seeds used last season. This was a practice for both maize and beans. Fertilizer application in the study area was not common for all villages, some use fertilizers and others don't depending on their economy and access. Prices for fertilizers depend on the type of fertilizer and whether the fertilizers are subsidized or not. Fertilizers like NPK (nitrogen-phosphate-potassium compound fertilizer) which is used for planting was TZS 47 000/50kg with subsidy and TZS 70 000 to 90 000/50kg without subsidy and for growth enhancing fertilizers like DAP (Diammonium phosphate) it was TZS 25 000 up to TZS 50 000 depending on whether it is subsidized or not.

4.2.1.3 Production and selling prices

Results show that the average production of maize per ha per season for Kibengu and Ilogombe was about 140 bags (20kg per bag) and 94 bags respectively. The minimum production was 69 bags and 17 bags while the maximum production was 346 bags and 131 bags per ha respectively. Beans production per ha per season was about 44 bags and 57 bags respectively. For beans the minimum and maximum production per ha at Kibengu was 17 and 52 bags, and at Ilogombe was 17 and 138 bags per ha respectively. Some of the farmers produced crops without fertilizer application; some were using fertilizer during planting only while others were using fertilizer for planting and growing. The amount of fertilizer per pit was also varying from one farmer to another. These might be the reasons for the big difference in productivity per ha between farmers. Other reasons may be due to exhaustion of soils in farms and lack of records by farmers which might lead into information which is different from the reality.

4.2.1.4 Farm size

The farm size per household in the study area was varying depending on the type of crop produced. For maize production the sample households cultivate between 0.3 ha and 1.2 ha while for beans production they cultivated between 0.1 ha and 1.2 ha per household. This implies that farm size per household was small and it might be due to the use of hand hoe for cultivation which consumes a lot of energy.

4.2.1.5 Profitability of agriculture

The profitability of agriculture in the study area was estimated by calculating the NPV of the main crops cultivated by the villagers. The average undiscounted annual profit for maize and beans at Kibengu village were TZS 416 915.42/ha/year and TZS 641 925.56/ha/year respectively. At Ilogombe, the average undiscounted net profit was TZS 184 049.83/ha/year and TZS 732 450.00/ha/year for maize and beans respectively. These results were then discounted to obtain NPV for the twenty years time horizon for maize and beans (Table 4).

Table 4: Profitability of Maize and Beans farming Kibengu and Ilogombe Villages

Village	Product	Undiscounted net profit/ha	NPV/ha (20 years)
Kibengu	Maize	416 915.42	3 966 351.39
Ilogombe	Maize	184 049.83	1 000 969.81
Kibengu	Beans	641 925.56	6 106 999.67
Ilogombe	Beans	732 450.00	6 968 209.75
Weighted average profit		493 835.20	4 698 132.66

4.2.2 Woodlots

All respondents (100%) in the study area own woodlots. At Ilogombe the size of the woodlot per household ranged from 0.2 ha to 1.2 ha, and between 0.4 ha and 3.24 ha at Kibengu village. Malimbwi (2001) reported that woodlots in the Southern high lands of Tanzania range from 0.25 to 3 hectares per household. Most of the households in the study area used family labour to manage the woodlots. These include land preparation, Planting, and pruning.

4.2.2.1 Land preparation, planting and pruning costs

In the study area, many of the silvicultural activities were carried out using family labour therefore it was difficult to predict the actual costs for land preparation, planting and pruning activities. There were few respondents who used labour for doing these activities where by land preparation costs TZS 111 150 per ha at Kibengu and TZS 74 100 per ha at Ilogombe. According to the respondents land preparation here meant slashing grasses and shrubs, but this was rarely done. Most of the time they plant trees in previous crop cultivated land where there is no need for clearance.

Tree transplanting costs were predicted by using the information from the few respondents who use labour force for planting activities like wise in the case of pruning. Transplanting cost was TZS 49 400 per ha and pruning costs was TZS 74 100 per ha in the two study villages. The costs for land preparation, planting, pruning, and thinning at Sao Hill Forest Plantation (SHFP) were 46 728, 62 304, 72 688, and 72 688 TZS/ha respectively for 9, 12, 14, and 14 man days respectively. This is equal to the payment of TZS 5 192 per man day. Pruning and thinning activities at SHFP were normally carried out two times per rotation. This means that, small scale farmers use more costs for land preparation than the SHFP, but lower costs in pruning and no thinning costs.

4.2.2.2 Preferred species, spacing, rotation age and selling price

The most preferred species in the study area was *Pinus patula* for business purposes. Some Eucalyptus spp and *Acacia meansii* were observed in some areas in the study area but were not mentioned by the respondents. Planting spacing was 2m×2m, 2.5m×2.5m, and 3m×3m but many used 2.5m×2.5m. The rotation age of *Pinus patula* in the study area was between 5 and 15 years, with the average of 9 years depending on the purpose for instance poles can be obtained from trees of 5 years. The selling price for trees was between TZS 2 500 and TZS 10 000 per tree where 69% of the respondents sell their trees for TZS 5 000 per tree. The trees were sold for timber purposes and the farmers used to sell standing trees where buyers cut and saw to get timber at their own costs.

4.2.2.3 Source of seedlings

The main source of tree seedlings in the study area was local, they collect seeds from old *Pinus patula* plantation stands for nursery establishment. Most farmers usually establish their own tree nurseries to get enough seedlings for own use and any excess is sold to other villagers who didn't manage to have own nurseries. The cost per seedling was between 60 and 100 Tanzania shillings. Therefore for easy calculation of the seedling costs in the study area, the researcher made an assumption that all the respondents were buying seedlings rather than preparing for themselves. The researcher also observed that the prevailing price was TZS 100 per seedling. Due to lack of adequate financial resource for buying polythene tubes, some of the households prepared their own traditional nurseries known as Swaziland.

4.2.2.3 Profitability of woodlots

The profitability of tree planting was determined by calculating the NPV at a discount rate of 10% and time horizon of 20 years assuming that REDD+ will be implemented for 20 years from 2012 (Section 3.4.2). The results of analysis show that the average NPV of woodlots in the two study villages was TZS 5 199 647.21/ha (Table 5).

Table 5: Profitability of woodlots establishment at Kibengu and Iligombe villages

Village	Product	Undiscounted net profit (TZS)/ha	NPV/ha
Kibengu	*Pinus patula*	586 095.70	5 575 858.92
Ilogombe	*Pinus patula*	506 539.99	4 819 000.58
Total		1 092 635.70	10 394 859.50
WeightedAverage profit		546 317.86	5 197 429.75

Source: Field data (2012)

4.3 The aboveground carbon stock of Idewa Forest Reserve

The total amount of carbon at Idewa forest Reserve (IFR) was estimated to be 39.23t C/ha which is equivalent to 143.97 tCO_2e/ha. Munishi and Shear (2004) reported the above ground carbon of 427±14 and 318±8 tC /ha for the Usambaras and Ulugurus respectively. The authors concluded that their estimates were just approximations and a preliminary contribution to the assessment of such potential in the Eastern Arc Mountain forests and recommended further studies to improve these estimates. Brown *et al*., (1991) concluded that only about 6% of mature forests in Tropical Asia had biomass less than 500t/ha (245tha^{-1} C) while more than 61% of the forests had biomass less than 250 t ha^{-1} (122.5 t ha^{-1} C). Carbon results in this study seem to be very low as compared to other montane forests as presented above. This difference may be due to difference in geographical location, soil characteristics, forest structure and the research designs between these studies. The results show that most of people adjacent to IFR have their own woodlots which serve them for timber, firewood and cash flow. They are also aware of the importance of the forest as a source of rainfall for their rain dependent agricultural crops. The value of the forest in terms of carbon when multiplied by various prices as proposed by different authors is presented in Table 6.

Table 6: Quantity of aboveground carbon stock and profitability based on prices reported by various authors

Unit Price ($/	AUTHOR (S)	Carbon (t C/ha) at IFR	t CO_2e/ ha at IFR	PV ($/ha)
25	Anderson (1991)	39.23	143.97	3 599.35
5	Nordhaus (1993)	39.23	143.97	719.871
	Faunkhauser (1995)	39.23	143.97	2 879.48
6	Sedjo and Ley (1997)	39.23	143.97	863.84
36.5-44.13	Healey *et al.*, (2000)	39.23	143.97	5 255.06-6 353.58
12-59	Tol (2005)	39.23	143.97	1 727.69-8 494.47
178	Jakob *et al.*, (2005)	39.23	143.97	2 5627.39
18-90	Stern (2006)	39.23	143.97	2 591.53-12957.67
29	Bloomberg News (2007)	39.23	143.97	4 175.25
150	Maibach *et al.*, (2008)	39.23	143.97	21 596.12
20-50	Litman (2009)	39.23	143.97	2 879.48-7 198.705

4.4 Profitability of agriculture and woodlots in comparison with the REDD+ incentives

The profitability of agriculture and woodlots in comparison with REDD+ incentives was determined by calculating the NPV for agriculture and woodlots and the total amount of cash flow of CO_2e per ha. Results show that the NPV for agriculture and woodlots were USD 2 958.52 and USD 3 272.94 per ha per year respectively. The cash flow per ha of tCO_2e was depending on which unit price per tCO_2e was adopted. Based on Nordhaus (1993) unit price, the NPV was USD 719.87/ha and when based on Jakob *et al.* (2008) unit price, the NPV was USD 25 627.39/ha (Table 9). These two authors show the minimum and maximum unit prices of carbon respectively. Results show that for the communities in the study area to get benefits from land use change for REDD+ implementation, the unit price of carbon should start at USD 23/tCO_2e) and above. This is because it will provide benefits which equal the maximum profit when land is used for woodlots in the study area. The unit prices of USD 5 and USD 6/tCO_2e) result in low NPV compared to the alternative land uses. According to Bond *et al.,* (2009), two programmes in Latin America – Pimampiro (Ecuador) and the PSA-H (Mexico) – pay between USD 6–12 and USD 27–£6 per hectare per annum respectively. In Vietnam, the government pays between USD 3 and USD 6.5 per hectare per annum, although this is considered to be low compared with alternative land uses (Liss, 2008). The opportunity costs of agriculture and woodlots in the study area are as shown in table 7.

Table 7: Opportunity costs of REDD+ on Agriculture and Woodlot establishments for different carbon unit prices

AUTHOR (S)	Unit Price ($/tCO$_2$e)	Agriculture	Woodlot
Anderson (1991)	25	-640.83	-326.41
Nordhaus (1993)	5	2 238.65	2 553.07
Faunkhauser (1995)	20	79.04	393.46
Sedjo and Ley (1997)	6	2 094.68	2 409.10
Healey *et al.*,(2000)	36.5-44.13	-2 296.54- -3 395.06	-1 982.12- (-3 080.64)
Tol (2005)	12-59	1 230.83- -5 535.95	1 545.25- (-5 221.53)
Jakob *et al.*, (2005)	178	-22 668.87	(-22 354.45)
Stern (2006)	18-90	366.99- (-9 999.15)	681.41- (-9 684.73)
Bloomberg News (2007)	29	(-1 216.73)	(-902.31)
Maibach *et al.*, (2008)	150	(-18 637.60)	(-18 323.18)
Litman (2009)	20-50	79.04- (-4 240.19)	393.46- (-3 925.77)

Source: Field data (2012)

4.5 Willingness to accept (WTA) by the Communities towards REDD+

In order to predict whether implementation of REDD+ will be possible and sustainable in the study area, the researcher observed that it is important to assess the perception of the community towards REDD+. This is because even if REDD+ was more profitable than the alternative land uses, if they are not willing, it is quite difficult to be assured of the sustainability of REDD+ in that area.

4.5.1 Community awareness towards PFM/REDD+

Before investigating on their perception towards PFM/REDD+, the researcher wanted to know if the respondents were aware of the existence PFM/REDD+ in their area. Results show that almost all respondents were aware of PFM but they did not know anything about REDD+. The knowledge about REDD+ was not yet introduced in this study villages. Some of them said that they have heard the word but they don't know what it is. This implies that the knowledge was not yet introduced in these villages. When cross tabulation and chi-square were conducted to see whether the difference in awareness between the respondents in the two villages was significant, it was found that there was no significant different at the probability level of 0.05. It was also found that the respondents who were aware of PFM at Kibengu and Ilogombe villages were 86.7% and 76.7% respectively with 81.7% overall (Table 8).

Table 8: Community awareness towards PFM

		Respondent's village (%)		
		Kibengu	Ilogombe	Total
Have you heard about PFM ?	yes	86.7	76.7	81.7
	no	13.3	23.3	18.3
	Total	100.0	100.0	100.0

χ =1.002; df=1; p=0.317

4.5.2 Community awareness to the restrictions of PFM

The results show that 80% of respondents at Kibengu village and 70% at Ilogombe village were aware of the restrictions of PFM (Table 9). About 75% of all respondents were aware on the restrictions of PFM in their villages. Some of the PFM restrictions mentioned by the respondents include; avoiding uncontrolled fire, asking for permission when in need of either firewood collection in the forest, timber, building poles, or any other forest product.

Table 9: Community awareness on the restrictions of PFM

		Respondent's village (%)		
		Kibengu	Ilogombe	Total
Are you aware of the restrictions that have been associated with PFM?	yes	80.0	70.0	75.0
	no	20.0	30.0	25.0
	Total	100.0	100.0	100.0

$\chi = 0.8$; df=1; p=0.371

4.5.3 Perception of the Communities towards PFM/REDD+

Perception of the community was another very important factor to find out in order to judge the sustainability of REDD+ in the study area. Although the community was not aware of REDD+, the researcher used PFM instead because it is one of the strategies for REDD+. The overall account of the respondents' perception were 1.7%, 53.3%, 26.7% and 18.3% for negative, positive, indifferent and don't know respectively. These results indicate that the overall community perception towards PFM was positive and this was supported by the direct observation of the condition of the forest. To compare the perception of the respondents from the two villages, Chi-Square Test showed no significant different (Table 10).

Table 10: Perception of the Communities towards PFM/REDD+

		Respondent's village (%)		
		Kibengu	Ilogombe	Total
How you perceive REDD+ (PFM) and its impact in your area?	Negatively	3.3	0.0	1.7
	Positively	53.3	53.3	53.3
	Indifferent	26.7	26.7	26.7
	don't know	16.7	20.0	18.3
	Total	100.0	100.0	100.0

$\chi = 1.09$; df=3; p=0.779

4.5.4 Impact of PFM restrictions on the current use of the forest by the households

The results show that the respondents in the study area were generally not affected by the presence of PFM restrictions for management of IFR. About 76.7% of all respondents said that the presence of the PFM restrictions does not limit the use of the forest for their household needs. Moss *et al.,* (2005) reported that, in Nepal, satisfaction with product supply varied amongst Forest Users, with poorer households feeling the restrictions on forest use more than wealthier households. Kumar (2002) found that the poor living near JFM forests in Jharkand, India, have been net losers over a 40-year time horizon. Most of the households are living far away from IFR and have their own trees in their farm that is why they don't invade the forest and they don't feel the impact of the restrictions. This implies that the distance from the forest to the households and availability of forest resources within communities' farms have an influence to the status of forests surrounding them. For example, most of the respondents from Kibengu village did not even know which forest, the researchers were talking about because IFR was further away from the village than Ihang'ana Forest Reserve therefore they thought that the discussion was about Ihang'ana. Again the results show that the respondents' responses to the question were exactly the same in the two villages (Table 11).

Table 11: Impact of PFM restrictions to the current use of the forest by households

		Respondent's village (%)		
		Kibengu	Ilogombe	Total
Do you think that any of these restrictions limit the current use of the forest?	Yes	23.3	23.3	23.3
	No	76.7	76.7	76.7
	Total	100.0	100.0	100.0

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study concludes that, the economic value of alternative land uses depends on the type of the land use and the requirements for production. The aboveground carbon stock of the montane forests along the Eastern Arc Mountains varies from one location to another. Also, the profitability of any land use is determined by inputs used for production, and the selling price of the products which indicate the opportunity costs incurred when implementing REDD+. However, based on this study it can be concluded that there is no general price per tCO2e, it depends on REDD+ opportunity cost when compared with alternative land uses of a particular place. The willingness to accept of the communities towards REDD+ depends on their awareness on the benefits obtained from REDD+ initiatives and contribution of those benefits in their day to day life. Therefore careful examination of the costs involved to adopt REDD+ is very important for the initiative to be effective and sustainable.

5.2 Recommendations

Based on findings and conclusion of this study, the following are recommendations for success of REDD+ to the communities of Mufindi District;

i. Opportunity costs of REDD+ to different communities should be used as guidance when making decision on unit prices of carbon. This is because, the opportunity costs of REDD+ varies from place to place depending on the alternative land uses available and production techniques.

ii. More studies are needed in the study area to identify the more accurate opportunity costs of REDD+ to the communities by involving all alternative land uses rather than taking the main land uses only, and measuring the size of their farms rather than depending on the information provided by farmers because most of them were just making estimates.

iii. There is also need of carrying out training and workshops for awareness rising to the community towards REDD+. This is very important because the communities in the study area do not know what is REDD+, and therefore they may not make informed decisions.

iv. Studies should be conducted to determine the carbon below ground including roots, soil, and litter so as to obtain the total amount of carbon. The researcher also recommends development of carbon model for IFR for more accurate results of carbon per hectare.

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APPENDICES

Appendix 1: Questionnaire for household interview

A: BASIC INFORMATION

Village Name. ______________________________Ward.

____

Division.____________________________________District.____________________

1. Date ______________________

2. Household ID/No__________________

3. Name of head of household/respondent_____________________

4. Sex

i) Male

ii) Female

5. Age ______________ years

6. Ethnicity/Tribe

____

7. Marital status

i) Single

ii) Married

iii) Divorced

iv) Widowed

B: COMMUNITY'S PERCEPTION ON REDD+ EXISTANCE

8. Have you ever heard about REDD+ (PFM)?

9. How do you perceive the establishment of REDD+ (PFM: JFM or CBFM) and its impact in your area?

i. Negatively

ii. Positively

iii. Indifferent

Give reasons for your answer;

....

....

10. How much would you like one to pay you to stop deforestation?

11. What is your role in the conservation of the forest?

Appendix 2: Checklist for Farmers

1. Farming systems used e.g. shifting cultivation and/ or permanent farming system.
2. Ownership of land indicating the size in hectares (ha)
3. List of different types of crops cultivated
4. Contribution of each crop to the respondents livelihood
5. Costs of production of each crop such as costs for seeds, fertilizers, labour, equipment and harvesting.
6. Type and amount of product for each crop
7. Prices per given unit of product e.g. kg, bag, bucket etc
8. Total revenue per ha.

Type of crop	Size of land per crop (ha)	Costs of production	Amount produced per ha	Revenue collected per crop

Appendix 3: A checklist for livestock keepers

1. List of categories and number of livestock per individual or family

Kind of Livestock	Total number	Where do you graze them (Source of fodder)

2. Source of animal fodder for each category of livestock (such as zero grazing, tethering, rotational grazing of free grazing.
3. Costs of production
4. Types and amount of product per season, year etc
5. Total revenue by providing information on prices for different animal products

Appendix 4: Checklist for charcoal makers

1. Sources of wood for charcoal making
2. Tree species preferred for charcoal making
3. Costs of production per kiln of charcoal
4. Total production per kiln (kilograms, bags etc.)
5. Selling price per unit amount of charcoal e.g. x kg or bags.
6. Total revenue per kiln
7. Production per given period of time (e.g. month, season, year etc)
8. Limitations of the work.
9. Sources of raw materials for charcoal making.

Appendix 5: Checklist for tree planting organizations

1. Name of the organization
2. Year of establishment
3. Purpose of its establishment
4. Size of land owned and already portion
5. Tree species planted and age
6. Management plan of the organization
7. Production costs per ha of trees per rotation and the total revenues.
8. Limitations

Appendix 6: Checklist for Firewood collectors

1. Sources of firewood
2. Species preferred
3. Price per bundle of firewood
4. Number of bundles per day, week, or month
5. Number of bundles used by a single household per week
6. Size of a bundle

Appendix 7: Inventory data collection form

Transect No.	Plot No.	Tree No.	DBH (cm)