ECONOMIC VALUATION OF NON-TIMBER FOREST PRODUCTS UNDER THE CHANGING CLIMATE AROUND IYONDO FOREST RESERVE IN KILOMBERO DISTRICT, TANZANIA

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

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ABSTRACT

The study on economic valuation of Non Timber Forest Products (NTFPs) and its implication for adaptation to climate change was conducted in four villages surrounding Iyondo Forest Reserve (IFR). The study specifically aimed at identifying and quantifying NTFPs for subsistence use and trade, examining factors influencing supply and demand of NTFPs, examining the total economic value of NTFPs and determining profit margin between different actors along the NTFPs market value chain. Data were collected through PRA techniques, household and market surveys. Analysis of data through descriptive and inferential statistics was done using the Statistical Package for Social Sciences (SPSS) and Ms Excel software tools. 14 NTFPs were identified including firewood, mushrooms, wild fruits, herbal medicines and honey which were used for trade by local communities surrounding IFR for their livelihoods and during adverse climatic conditions. The results at $p<0.05$ showed that household income, household size and distance influenced supply of NTFPs, probably because of their increasing vulnerability to economic shocks due to climate variability. Other factors that constrained supply were existing tenure system, occasional floods, drought, scarcity, fire and seasonality. Demand for NTFPs was influenced by household size and marital status. The total economic value of NTFPs at a discount rate of 10% was TZS 20 523 473 790 indicating the contribution of NTFPs for rural livelihood in the changing climate which also influences adaptive capacity. High profit margin along the NTFPs actors was found to benefit collectors of charcoal and honey followed by retailers selling firewood. Beverage traders accrued high profit than other actors because of value addition. The recommendations were to improve future

availability of NTFPs, by sensitizing communities to practice agroforestry and establish community woodlots, to encourage local communities, to engage in alternative income generating activities such as beekeeping in order to improve their income and to meet the needs of their big household size, to promote preservation and value addition of products in order to ensure benefits to various actors along the market value chain and sustainability of products. Also, economic valuation for other forest services from IFR including carbon sequestration under the changing climate condition should be conducted so as to capture the full value of the IFR.

DECLARATION

I, DANFORD LUPYUTO MWAITELEKE, 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 concurrently been submitted in any other institution.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
CIFOR	Centre for International Forestry Research Development
EAMs	Eastern Arc Mountains
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
ha	hectare
IFR	Iyondo Forest Reserve
Km	Kilometre
KNR	Kilombero Nature Reserve
MDGs	Millennium Development Goals
MNRT	Ministry of Natural Resources and Tourism
NBS	National Bureau of Statistics
NDUFR	New Dabaga Ulongambi Forest Reserve
NTFPs	Non-Timber Forest Products
NWFPs	Non – Wood Forest Products
PRA	Participatory Rural Appraisal
REDD	Reduced Emissions from Deforestation and forest Degradation
REDD+	REDD plus role of conservation, sustainable management of forests and enhancement of forest stocks in developing countries.
SFC	Standing Forestry Committee
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture

TaTeDo	Tanzania Traditional Energy Development and Environmental Organization
TEV	Total Economic Value
TMA	Tanzania Meteorological Agency
TZS	Tanzanian Shillings
URT	United Republic of Tanzania
USAID	United States of America Agency for International Development
USD	United States Dollar
WTP	Willingness to Pay

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Non-Timber Forest Products (NTFPs) are important source of livelihoods for the rural and urban populations all over the world. According to FAO (1995), NTFPs include all goods of biological origin (both plants and animals) other than timber, as well as services for human and industrial consumption derived from forest resources and or any land under similar uses. People adjacent to the forests depend on these resources for fulfilling subsistence needs like food, fodder, construction materials and fuel wood and for generating income. For instance, the World Bank (2001) reports that 1.6 billion people depend on forest for their livelihoods with 350 million living in or near dense forests.

In Tanzania, during food shortage wild vegetables in some areas are used as complete meals and in some parts of the country farmers derived up to 58% of their cash income from the sales of NTFPs (CIFOR, 1999; FBD, 1999). Climate change is threatening the world including Tanzania. The consequences of climate variability and change are more significant for the poor in developing countries than for those living in more prosperous nations, due to dependence on economic activities that are sensitive to climate change, essentially agriculture and forestry sector (USAID, 2007). Therefore, increasing adaptive capacity to minimise the impacts to livelihoods from climate change is a necessary strategy to compliment mitigation efforts (ADB, 2003).

Iyondo Forest Reserve (IFR) in Kilombero Nature Reserve (KNR) is important to adjacent communities for NTFPs, water protection, carbon sequestration, conservation of biodiversity, spiritual and cultural values (Rovero, 2007). Maintaning carbon sequestration ability and other services of the IFR to mitigate impacts of climate change needs strict management regime. However, according to Harrison (2006) the livelihoods of the population around the KNR depend, partly on forest resources.

1.2 Problem Statement and Justification

Currently climate change impacts have been observed in Tanzania and are associated with increased flooding, frequent drought, increased temperature and change in rainfall pattern than in the previous 30 years (MNRT, 2010). In Kilombero District, a study by Augustino *et al*. (2012) have revealed evidence of climate change particularly in areas around IFR as indicated by change of rainfall patterns and increased temperature. For example, the average amount of rainfall to be received in November and December which are important for crop planting has been decreasing from 1991 - 2011. Also, there have been increase in rainfall from February to March, a period in which floods normally occur. The impact of climate change has been also noticed in terms of increased occurrence of pests and diseases affecting human beings, crops, livestock and the livelihood of communities as a whole.

Forests play a big role in poverty reduction in Tanzania because of their high biodiversity values, thus important to communities adjacent to forest areas.

REDD+, a strategy towards reducing emission from forest deforestation and degradation and enhanced conservation is associated with restriction in terms of access to forest areas (World Bank, 2011, Schaafsma *et al.* (2011). However, the appeal of REDD+ by many of its advocates has been poverty reduction through its co- benefits to communities around forest resources (Brown *et al.* 2008). According to Schaafsma *et al.* (2011) local people would bear economic loss if NTFPs collection is effectively banned. Collection of NTFPs is expected to increase the adaptive capacity to local communities as one of the coping strategy to climate change by majority of people in Tanzania including those surrounding Iyondo Forest Reserve. A study by Msalilwa (2013) showed that demand for NTFPs has been perceived to increase by forest dependent communities with use pattern ranging from food, primary health care and income than it used to be 30 years ago, due to climate change impacts on the main community livelihood. A similar situation could apply to communities around IFR in Kilombero.

However, knowledge on the economic value for NTFPs for subsistence use, trade and its importance to livelihoods of communities under the changing climate is inadequate in Tanzania including IFR and its surroundings. Trade of NTFPs is considered as one option to improve the livelihood of people by contributing towards MDGs in terms of poverty reduction (Marshall *et al*., 2006), but the role of NTFPs trade for adaptation to climate change is not well established. It is not clear if the increasing trade of NTFPs can enhance adaptive capacities of local communities to climate change impacts. Lack of financial benefits of NTFPs to the Gross Domestic Product of many African countries has led to insufficient recognition, in national planning of their contributions to local livelihoods

adaptation measures (Nkem *et al*., 2008). It's within this background, where the study to valuate NTFPs in IFR and its surrounding communities becomes vital.

Results from this study generate scientific information regarding the total economic benefits of NTFPs to the communities adjacent to IFR. It also provides an understanding on the contribution of NTFPs for rural livelihoods and the role played by markets for adaptation to climate change. The study is also very useful to policy makers and overall implementation of the National REDD+ Strategy in Tanzania including promoting development of NTFPs as carbon co- benefits for effective benefit sharing mechanism, and sustainable management of natural resources.

1.3 Objectives

1.3.1 Main objective

The main objective of this study was to assess the total economic value of selected NTFPs and its implication for adaptation to climate change by communities around Iyondo Forest Reserves in Kilombero District, Tanzania.

1.3.2 Specific objectives

The specific objectives of the study were to:

(i) identify and quantify important NTFPs for subsistence use and trade under the changing climate and variability from the study area;

(ii) examine factors influencing supply and demand of NTFPs under the changing climate;

(iii) examine the total economic value of selected NTFPs from the study area;

(iv) determine profit margin between different actors along the NTFPs market chain in the study area.

1. 4 Research Hypotheses

Ho_1: Valued NTFPs have no effect on communities' adaptive capacity to climate change

Ho_2: Socio-economic factors do not influence supply and demand of NTFPs, around IFR under the changing climate.

1.5 Limitation of the Study

Valuation of NTFPs was based on household questionnaires on amount collected per annum. There is a possibility that the total economic value of NTFPs could be higher than the stated value, because some of the products were illegally obtained from the forest reserve and in many cases responses relied on memories, therefore it is possible to get biased answers from respondents. However, the challenge were overcome by the researcher crosschecking the data, collecting extra information apart from the questionnaire and explaining the aim of the research.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The Concept of Non -Timber Forest Products

The definition of Non-Timber Forest Products (NTFPs) has posed debates to many scholars since the term was coined (Belcher, 2003). The use of the term depends on the interests and the objectives of the user. For instance, Ros-Tonen and Wiersum (2003) defined NTFPs as all plant and animal products that come from forested landscapes; including human modified ones. According to FAO (1995), NTFPs include all goods of biological origin (both plants and animals) other than timber, as well as services for human and industrial consumption derived from forest resources and or any land under similar uses. The FAO definition include firewood, charcoal and other products that are not timber, like bamboo products, carvings, building poles, essential oils, bees wax, honey, gum, tannins, latex, dyes, medicines, fibres, food (leaves, roots, fungi fruits) and fodder as well as services from the forest and allied land use. Some NTFPs definitions however exclude firewood and charcoal resulting into the term Non Wood Forest Products (NWFPs). For the context of this study, the definition of FAO (1995) was adopted, and used.

2.2 Importance of NTFPs to Livelihoods

More than 800 million people worldwide live in or near tropical forests and savannas and rely on these ecosystems for fuel, food and income (Chomitz *et al.,* 2007). In developing countries, NTFPs meet basic subsistence needs for rural population's income, contributing from 6% to 95% of a household's annual income; providing a safety net when other activities fail to provide income and opportunity to generate cash for rural communities thereby leading to improved for food

security (Belcher, 2005; Sunderlin *et al.,* 2005; Shackleton *et al.,* 2007). Globally the NTFPs dependence by people close to the forests is estimated at more than one billion (World Bank, 2004) and for Tanzania over 20 million people are estimated to depend on forest resources (URT, 2008).

In Tanzania for example, wood fuel consumption rate ranges from 5.6 to 6m^3 per household per year which is equivalent to 1.12 to 1.2m^3 per capita per year (Lusambo, 2009). The contribution of NTFPs to food security and income is also significant and it was estimated that 75% of households residing in proximity to catchment forests in Morogoro depended on wild vegetables (FBD, 2003).

2.3 NTFPs and Climate Change Adaptation

Climate change and variability seems to impede rural livelihoods in developing countries. According to Eriksen and Naess (2003) livelihoods are linked with natural resource management and poverty reduction. The effects of climate change are more pronounced for the poor because they mainly depend on economic activities that are sensitive to climate (USAID, 2007). A report by MNRT (2010) showed that more than 80% of the population in Tanzania relies directly on agriculture for their livelihoods, thus climate change unfavourably affects food production, energy and water supply. The effects of climate change and variability push the vulnerable households in search of alternative and additional livelihood means especially NTFPs from the forest (Kalame, 2011). These forest resources are safety nets during drought or flood-induced crop failures, poor health, energy shortage, political and social crisis (Shackleton and Shackleton, 2004). However, benefits from biodiversity conservation are unevenly distributed (Pagiola *et al*.,

2004). Local communities bear the brunt of the costs, as a result of restricting them from using protected areas for either agriculture or collection of NTFPs. According to the author, an economic valuation therefore, it's important to understand who receives the benefits and who bears the costs. This is important on developing strategies for sustainable NTFPs exploitation.

2.4 NTFPs Valuation

The term economic value is defined as a measure of the contribution that a certain economic activity makes toward human wellbeing (Brown *et al.,* 2007). Valuation is therefore anthropocentric. According to Bateman *et al.* (2003), Total Economic Value (TEV), as shown in Figure 1 is the sum of use and passive values. Use value includes direct use value, indirect use values and quasi-option values while; passive values include existence values, quasi- option, self and bequest value. Direct use values capture the benefits received by using the resource through direct consumptive uses like firewood and direct non-consumptive uses like bird watching or boating. Indirect-use values relate to the ecological functions performed by forests, such as carbon storage and regulation of watersheds. Therefore TEV is understood as more than cash or monetary inputs which take into account the value of free goods (Ambrose –Oji, 2003).

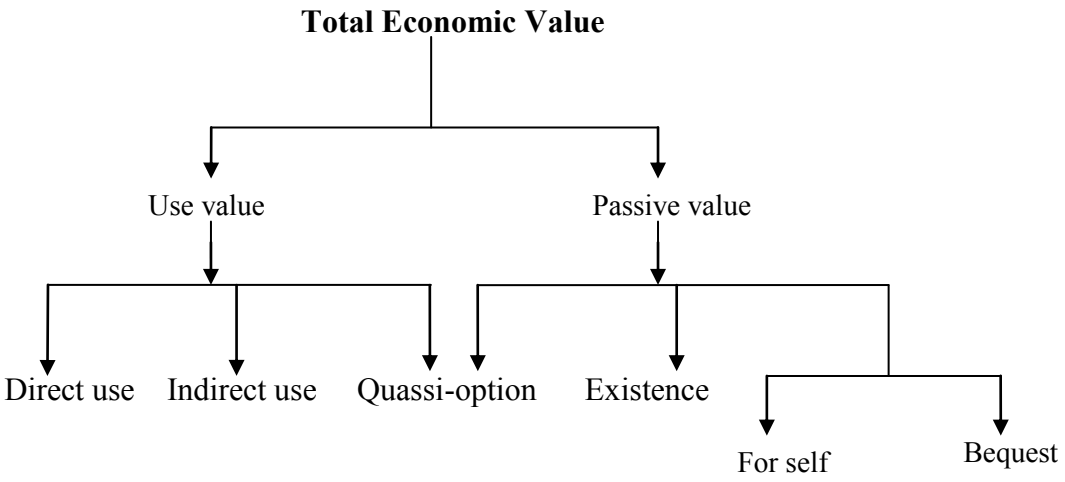

Figure 1: Diagramatic presentation of TEV components

Source: Adopted from Bateman *et al.* (2003) and Lusambo (2009)

According to Cesar and Chong (2004), economic valuation shows the importance of goods and services and also the costs of inaction in the face of threats. Valuation of forest products also identifies the main beneficiaries of conservation and the magnitude of the benefits received (Pagiola *et al.,* 2004). By knowing magnitude of benefits, economic valuation can assist in setting scale, for compensation (SCF, 2008).

Through assigning monetary values to the NTFPs as a major source of food, medicines and income for the poor, the value of maintaining the forest becomes apparent (Dorp *et al.,* 2001). This also presents local communities and policymakers with a strong argument for forest conservation or wise use. Many authors acknowledge the role of NTFPs to the local populations but consider non-marketed NTFPs as food of the poor, a safety net, or reserve food in case of famine (Senaratne *et al.,* 2003; Shackleton *et al.,* 2002). However, NTFPs that are not

marketed are also important when setting the policies for the extraction of all forest resources to ensure sustainable forest management (Delang, 2006).

The value of NTFPs in Tanzania has been generalized and in some cases underestimated. For instance valuation of NTFPs by Msemwa (2007) and Kilonzo (2009) did not separate between NTFPs for subsistence use and income generation. Some NTFPs are valuable to local communities but often used for subsistence and not sold. Further, even those sold NTFPs sometimes have higher values to communities than as reflected by the market price. Therefore NTFPs for rural communities have safety net function and insurance role or option value and its value exceeds market value (Paumgarten, 2007).

2.4.1 Methods for valuation of NTFPs

Market price method estimates economic values for ecosystem products or services that are bought and sold in commercial markets (Lusambo, 2009). Non-marketed goods can be valued indirectly by using revealed preference techniques such as travel cost, hedonic price and avertive approach or directly by using stated preference techniques. NTFPs which do not have market price are indirectly valued by using cost of collection method which estimate the value of time expended in gathering NTFPs. Another method is substitute which infers value based on close direct substitute that have market prices (Delang, 2006). According to Lipton *et al.* (1995) the value for goods and services can also be obtained by using a method known as the contingent valuation through Willingness to Pay (WTP).

2.5 Commercialization and Market Valuation of NTFPs

With respect to rural safety net, commercialization of NTFPs is a potential recourse for households experiencing misfortune and can be considered as a manifestation of the safety net function (McSweeney, 2003; Shackleton and Shackleton, 2004). Whilst some households in rural areas are involved in permanent trade of NTFPs, most sell on adhoc basis to generate cash during adverse times (Angelsen and Wunder, 2003; Shackleton and Shackleton, 2004). Households that commercialize NTFPs as a safety net utilize a range of products in response to changing resource availability, market demands and alternative income opportunities (Angelsen and Wunder, 2003).

Market value chain is a range of activities through which a product passes from the stage when it is harvested or processed until it gets to the final consumer (Ingram and Bongers, 2009). Product passes through different actors. For the case of NTFPs market value chain it may include collectors, sellers, middlemen and consumers. According to Ndoye *et al.* (1998) in Cameroun, actors in the NTFPs market value chain are traders, retailers and wholesalers while Nkwatoh (1998) also from Cameroun identified collectors, buyers and transporters. On the other hand Nkem *et al.* (2010) and Piya *et al.* (2011) pointed out that collectors have the least margin in the NTFPs value chain. Profit margins of actors are important in any trade, because they serve as strong incentive for participants to stay in the business (Omualabi, 1994). The price received by the collector depends on the length of the chain, location, quality and means of transportation (Ahenkan and Boon, 2011).

In Tanzania for example the major beneficiaries in the charcoal market value chain are not producers (World Bank, 2009). In this chain, profit is usually concentrated in the hand of the few intermediaries, mainly middlemen, transporters and wholesalers while retailers in urban centres and producers receive small benefits. This situation can be reversed, for example FAO (2007) observed that marketing by village or community groups seem to be beneficial in Rufiji District than marketing individually or through middlemen.

2.6 Factors Affecting Commercialization of NTFPs

Consumption of NTFPs as reported by Paumagarten (2007) and Shackleton (2004) is influenced by land tenure, resource availability and accessibility, institutional dynamics, available alternatives and population dynamics (age, wealth). To achieve development of any effective management approach on promoting sustainable use of biodiversity, understanding the relationship between households, socio-economic and consumption of NTFPs becomes absolutely necessary (Kiplagat *et al.* 2010). Age affects the type and amount of resources consumed. NTFPs like wild fruits have been reported to be mainly collected and consumed by children (Paurmagatten, 2007). Also Cavendish (2000) pointed out the relationship between the household development cycle and NTFPs utilization. A young household in the process of establishing home and a family has a greater need for construction materials than more established household. A more developed household which accumulated assets such as livestock, has a greater need for fencing materials whilst, a household with elderly household members is constrained by the shortage of labour.

Location of a village relative to the forests also affects resource use. Households or villages closer to the natural forests have easier access to the resources. The distance from the household to the NTFPs harvesting location is positively related with the opportunity costs of labour and time spent to collect NTFPs (Pattanayak and Sills, 2001). The spatial distribution of harvesting efforts is also affected by forest accessibility, forest protection status and enforcement (Robinson 2009; Lokina, 2011).

According to Marshall *et al*. (2005), the most constraining processes of NTFPs commercialization are marketing and sales. Marketing is basically done individually; unorganized, dispersed and the producers lack necessary marketing skills and information required for optimal performance (Ahenkan and Boon, 2011). Problems hindering the development and or marketing of NTFPs in Tanzania include, the unreliability of markets, transportation problems and lack of credit for running business (FAO, 2007).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Mpofu, Igima, Njage and Mngeta villages which surround the IFR in Kilombero District. The District has a total land area of 14,918 km^2 while IFR has a total area of 27,975 ha and it lies between latitude 8°00' and 8°16' South and Longitude 36°06' and 36°22' East, 55 km west of Ifakara town. The area receives about 1200-1600 mm of rainfall and temperature ranges from 26 ^{0}C to 32^{0}C. This reserve is part of the Eastern Arc Mountains which was upgraded into a nature reserve and became part of KNR in 2007, the highest category of protected areas under Tanzania forestry legislation, comparable to National Parks. The IFR is surrounded by six villages namely Mbingu, Igima, Mpofu, Njage, Mchombe and Mngeta (Figure 2). According to URT (2013), the population of Kilombero District is 407,880 and population of Mbingu and Mchombe wards in which these six villages belong is 22,717 and 38,651 respectively. Eighty percent of the population in Kilombero District depend on agriculture for food and cash. Food crops grown include rice, bananas, cassava, maize, potatoes and legumes. Cash crops include sugar cane, cocoa, sesame, sunflower and rice. The main economic activities of the adjacent communities include livestock keeping, agriculture, hunting, petty trading and collection of NTFPs (MNRT, 2005).

Access to the study area is through the earth road from Ifakara to Mlimba. The choice of the study site is based on the importance of the forest reserve to adjacent communities for their livelihoods (Harrison, 2006).

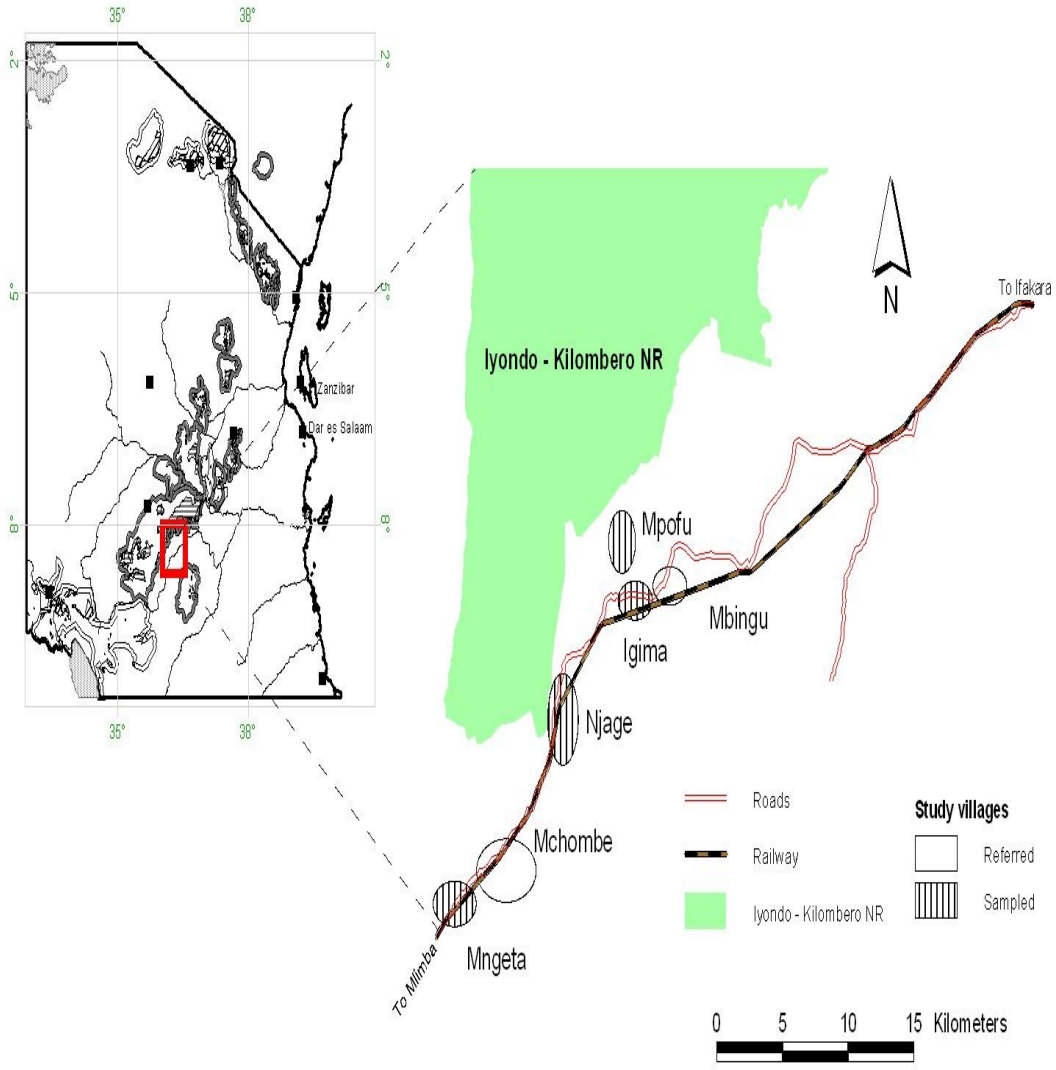

Figure 2: Location of study villages around Iyondo Forest Reserve.

3.2 Research Design

A cross sectional design was used for data collection. In this design data are collected at single point in time, hence using minimum time and resources (Bailey, 1994). According to Babbie (1990) such research design can be used for description purposes and for determination of relationship between variables.

3.2.1 Sampling procedure

Four villages surrounding IFR were purposely selected based on relative distance to the forest reserve. Two villages which are relatively close and two villages which are relatively far from the forest were sampled. The sampling unit was the household. Random selection was used to obtain households from four villages of the study area. In each selected village, 5% of the total households were randomly sampled. According to Boyd *et al.* (1981), in order for a random sample to be representative of that population should at least constitute 5% of the total population. A household was chosen because is a social and economic unit (Alelign, 2011). In rural areas a household is a primary unit of production, distribution, consumption and is a point of decision making.

The study involved a total of 208 households which were randomly selected from four villages of Mpofu, Igima, Njage and Mngeta (Table 1). Mpofu and Njage villages are relatively close to the reserve while Igima and Mngeta villages are relatively far from the Reserve.

Table 1: Sample size distribution in the study area

Village	Relative distance	No. of households	Sampling intensity	Sample size Estimate
Mpofu	Very close	714	0.05	35.7
Igima	Close	1,282	0.05	64.1
Njage	Very close	868	0.05	43.4
Mngeta	Far	1,293	0.05	64.65
Total		**4,157**		**207.85**

3.3 Data Collection Methods

Both primary and secondary data were collected. Primary data were gathered using household questionnaire, market surveys and Participatory Rural Appraisal (PRA). Secondary data were obtained from Kilombero Nature Reserve Office, Tanzania Forest Services offices and data from published materials including journals and books which were obtained from SUA library and online web resources.

3.3.1 Household survey

Household survey was achieved by using semi- structured questionnaires with both closed and open ended questions (Appendix I). The questionnaire contained information on collectors, buyers, and end users of NTFPs. Respondents also were asked their WTP for NTFPs which are normally not traded such as recreation and worship. The information collected included socio-economic aspects of the household, the distance travelled for collecting NTFPs, type and amount of NTFPs collected. Questionnaires were pilot-tested to 30 households in all villages before the actual survey to check applicability and appropriateness of the questions.

3.3.2 Market survey

The spot market survey was carried out using a questionnaires administered to collectors, sellers and buyers in the local markets and around households where NTFPs were being displayed for sale (Appendix IV**).** This was done in informal market places located within Igima, Njage, Mngeta and Mbingu Villages as well as at Ifakara town. The information collected included prices, types, costs and average amount of NTFPs sold and utilized as well as supply and their potential in enhancing adaptive capacity to climate change at household level.

3.3.3 Participatory Rural Appraisal (PRA)

The PRA exercises were carried out in order to get priority NTFPs for trade through a focus group discussion, with 30 village members irrespective of age, gender and position. The method involved free listing, pair wise ranking and group discussions. Uses of NTFPs were discussed based on their contribution to livelihoods and in enhancing adaptation to climate variability, and then a pair wise ranking exercise (stratified by the sex of respondents) was conducted with groups ranking the different NTFPs in terms of their importance to trade.

3.4 Data Analysis

3.4.1 Qualitative data

Data collected through PRA tools were analysed with the help of communities and results communicated back to the communities for verification and retention.

3.4.2 Quantitative data analysis

Both descriptive and inferential statistical analyses were carried out by using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel computer software tools. The data were first coded in a form suitable to address research questions and the employed method of analysis. Through descriptive statistics, percentage of responses, frequencies and means were obtained.

Inferential statistical analysis were carried out to compare variables and determine the strength of relationship between variables. Multiple regression was carried out to find out socio-economic factors affecting supply and demand of identified NTFPs.

$$Y = a + \sum_{i=1}^{n} B_i X_i + e \quad \text{.....(1)}$$

Y = Annual income from NTFPs

e = error term

a = Constant or intercept bi = Regression coefficient,

Xi = Independent variables

X_1 = Occupation of the respondent (Dummy: 1 if farmer, 0 otherwise)

X_2 = Marital status (Dummy: 1 if married, 0 if otherwise)

X_3 = Distance from the household to the forest (Km)

X_4 = Education in years

X_5 = Family size (Number.)

X_6 = Household income other than NTFPs

X_7 = Age of the respondent (Years)

Annual income from NTFPs was obtained by multiplying quantity of NTFPs extracted and its market price. Annual income of NTFPs involved income from poles, firewood, withies, wild vegetable, wild mushroom, medicinal plants, thatch grass, ropes, wild fruits, bush meat, handles and honey.

Factors influencing demand of selected NTFPs by the households, multiple regression analysis was performed with annual total expenditure on NTFPs as the dependent variable and household size, education level, income from other sources and distance as the independent variable (Equation 2).

$$Y = B_0 + \sum_{i=1}^{n} B_1 X_1 + e \quad \text{.....(2)}$$

Y = Annual total expenditure on NTFPs

e = error term

B_0 is the constant term

Xi = Independent variables

X_1 = Occupation of the respondent (Dummy: 1 if farmer, 0 otherwise)

X_2 = marital status (Dummy: 1 if married, 0 if otherwise)

X_3 = Distance from the household to the forest (Km)

X_4 = Education in years

X_5 = Family size (No.)

X_6 = Household income other than NTFPs

X_7 = Age of the respondent (Years)

Annual total expenditure was calculated from poles, firewood, withies, wild vegetables, wild mushrooms, medicinal plants, thatch grass, charcoal, bush meat, honey, handles and wild fruits.

The total Economic Value (TEV) for a period of one year was calculated from identified NTFPs and different ecosystem services. Values of NTFPs were obtained through questionnaires information on household usage per year. The quantity of each product was multiplied with market price. Also secondary data were used to estimate values of the forest ecosystem services such as water. Key assumptions and considerations in the calculations of the economic values of NTFPs were:- (i) A discount rate of 10 percent which is recommended by the World Bank was chosen (Monela *et al.,* 2005).

(ii) In the conversion to present values, an infinite time horizon was adopted.

Present Value (PV) of time horizon when approaches infinity such that:-

$$PV = \left[\frac{a}{r}\right] \quad \text{.....(3)}$$

where, PV= Present Value; a = is the annual value; r = discount rate (Monela *et al.,* 2005).

(iii) Total economic value of NTFPs was in terms of gross values since estimation of cost based on time spent in collection of NTFPs for household consumption was difficult to get due to the fact that collection of most of these products was done along with farming activities and some NTFPs were collected jointly, so estimating them could lead to double counting.

(iv) Estimation of cost was taken care during determination of profit margin of NTFPs because it was assumed that during collection of NTFPs for trade, collectors were concentrating in collection of a single item.

Profit margin was calculated with the average prices of priority NTFPs prevailing at each level of the market chain and the various charges incurred by each actor.

$$M = S - C \quad \text{..... (4)}$$

where M = market margin; S = Total sales; C = Cost of production

Production cost involved in this study considered only the labour cost. It was assumed that cost of tools involved were negligible. Production cost was obtained as follows:-

$$PC = \frac{M\ X\ W}{Q} \text{ ----------(5)}$$

PC = Production cost

M = Mandays

Q = Quantity

W = Wage rate

Local wage rate per day at the study area for weeding or cultivating a field plot was estimated by respondents at 5,000/= per manday.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characteristics of the Respondents

The characteristics of the respondents included socio-economic aspects which are age, sex, marital status, education in years/education level, occupation and household size (Table 2). These characteristics influence behaviour of respondents in collection and trading of NTFPs.

Table 2: Characteristics of the respondents in the study area (n = 208)

Socio- economic attribute		Total %
Sex	Male	38.5
	Female	61.5
Marital status	Single	1.4
	Married	91.3
	Widow/widowed	3.9
	Separated/divorced	3.4
Education level	No formal education	13
	Primary level	82.7
	Secondary level	3.4
	Post-secondary education	1
Age	18-30	27.9
	31-60	65.4
	Above 60	6.7
Occupation	Salaried employment	2.4
	Farmers	94.7
	Businessmen	2.9

4.1.1 Sex and marital status

The results showed that 61.5% of respondents were women and 38.5% were men (Table 2). However, it should be noted that all women interviewed were not necessary heads of households because in some instance head of households (men)

were not available at home during interview for various reasons, so they were represented by their wives. Regarding marital status, about 91% of the respondents were married (Table 2). This implies that in rural areas, the majority get marriage sooner after completing primary education due to lack of opportunities in secondary education. This trend might however change in the future due to increased number of affordable secondary schools in recent years, within Tanzania.

4.1.2 Household size

The minimum and maximum household sizes were 1 and 11 respectively, while the average household size was 5.2. This average is high compared to the Kilombero District and national household size which is estimated at an average of 4.3 and 4.8 individuals per household respectively (URT, 2013). In the study area, about 60% of the household sizes were above the national average. This implied high population in villages surrounding IFR; this probably due to conducive environment for agriculture. Also, another reason could be due to high birth rate and immigration. The presence of large household sizes implies increase in utilization of natural resources to meet their basic needs.

4.1.3 Education level of the respondents

As indicated in Table 2, the majority of the respondents had primary education (82.7%) whereas secondary and post-secondary education was only 3.4% and 1% respectively. The remaining, percentage, that is 12.9 % had no formal education. Therefore majority of the respondents are literate. The literacy level in the surveyed villages was higher than the literacy level in Kilosa District. According to Msemwa (2007) about 63% of the interviewed respondents were literate. This could show

that it is easy to impart knowledge to them on various issues including climate change mitigation and adaptation issues.

4.1.4 Occupation of the respondents

The results in Table 2 showed that main occupations of the respondents were farming, salaried employment and business. Majority of the respondents (94.7%) in the study area were farmers while 2.4 and 2.9% employed in formal sectors and in business respectively. The results conform to the study by Msemwa (2007) who found that 88% of the respondents in Kilosa, their main occupation were farming while only 0.8% were civil servants.

4.1.5 Age of the respondents

The age distribution revealed that 93.3% of the respondents were aged between 18 to 60 years (Table 2). This showed that majority of the respondents were economically active to engage in various production activities including collection and trading of NTFPs. The results are similar to Lusambo (2002) who observed that active working group in Kilosa District were 94.5%.

4.2 NTFPs Available in the Area

In the study area, various NTFPs ranging from food products (both plants and animals), firewood and construction materials were collected by households living adjacent to IFR mainly from farmlands, village forest reserve and mostly illegally from the Nature Reserve despite the restriction imposed. About 72.7% of the households collect NTFPs for subsistence use only while about 23% collected and sold at least one NTFP (Figure 3).

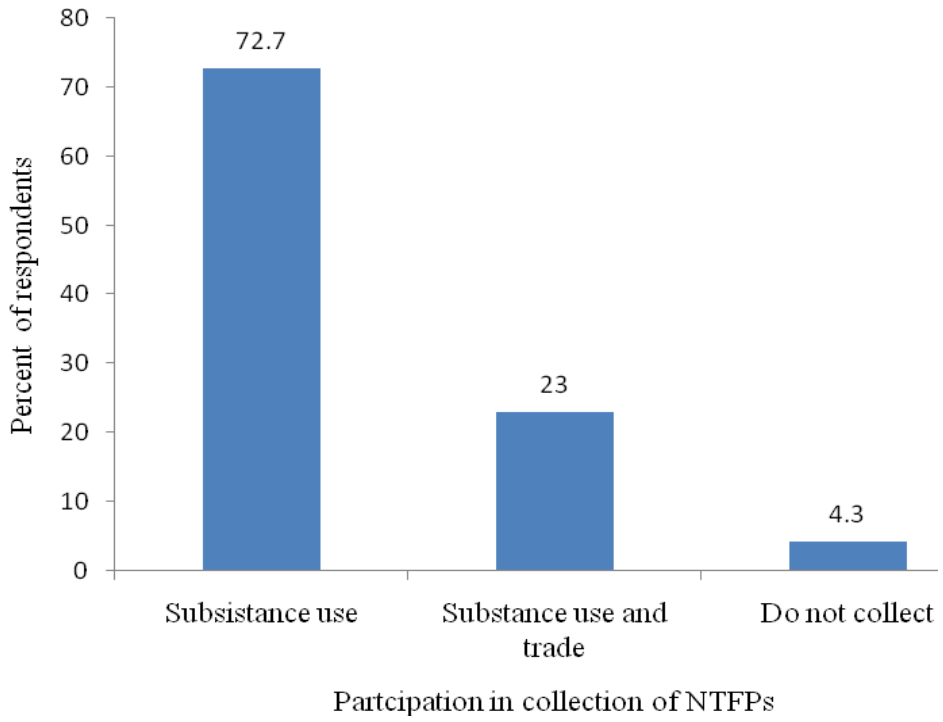

Figure 3: Response on collection of NTFPs by communities living adjacent to IFR

The identified NTFPs were firewood, wild vegetables, wild fruits, thatch grass, medicinal plants, mushrooms, poles, handles, ropes, withies, honey, bush meat, charcoal and pastures (Appendix 4). Similarly, Kilonzo (2009) found the same NTFPs being used by communities surrounding Nyanganje Forest Reserve in Kilombero District. The importance of NTFPs seems to increase at this period as a livelihood response to climate change and variability. According to Msalilwa (2013), about 43% of communities living adjacent to New Dabaga – Ulongambi Forest Reserve admitted to consume and sell NTFPs from the forest reserve as the climate change and variability copying strategy. Women were the most collectors of firewood, wild vegetables, wild fruits, thatch grass, medicinal plants and wild mushrooms. Men were mostly engaged in collection of poles, tool handles, ropes,

withies, honey and bush meat. This observation, suggest that women are active in activities undertaken near households, while men are more engaged in activities taken relatively far from their homesteads. According to Paavola (2008), due to decline in farming both men and women in Morogoro collect NTFPs for subsistence needs and for generating income.

Different findings are reported elsewhere with regard to NTFPs collections. For instance, Guinand and Lemessa, (2000) in Ethiopia reported that wild-food and famine-food plants are collected by children and women frequently when they are on their way to fetch water, collect firewood, go to market, and when walking home from their fields. The same could apply to communities around IFR. Participation of children is reflected mainly in collection of wild fruits and to some extent in collection of firewood and mushroom while collection of medicinal plants and mushroom in some households is performed by both men and women (Table 3). Involvement of both men and women indicate the importance of the resources to communities' livelihoods. During interview in Mngeta village some men collectors admitted to collect mushroom illegally in difficulty terrain within the KNR, where women could not access. Medicinal plants, are collected by both men and women since traditional healers, whether men or women frequently carry out the collection themselves in the forests partly to maintain secrecy of knowledge on species (Kajembe *et al*., 2000, Otieno 2000).

Table 3: Identified NTFPs for subsistence use from IFR and actors involved in collection

Actors by	**Collection of NTFPs for subsistence use by percentages**											
Gender	**Fire Wood**	**Wild vegetable**	**Wild fruits**	**Thatch grass**	**Medicinal plants**	**Mush room**	**Poles**	**Handles**	**Ropes**	**Withies**	**Honey**	**Bushmeat**
Women	75.4	62.5	20	46.6	17.8	31.7	0.5	Nr	0.5	1.4	1	nr
Men	1.4	Nr	7.7	0.5	15.4	0.5	28.4	23.6	22.6	21.2	2.4	1
Children	0.5	Nr	13.5	nr	nr	0.5	nr	Nr	nr	nr	nr	nr
All	1	Nr	6.7	nr	nr	1	nr	Nr	nr	nr	nr	nr
Men/women	Nr	Nr	0.5	nr	2.4	1	0.5	Nr	nr	nr	nr	nr
Total households	**78.3**	**62.5**	**48.4**	**47.1**	**35.6**	**34.7**	**29.4**	**23.6**	**23.1**	**22.6**	**3.4**	**1**

Note: nr = no response

A total of seven NTFPs were identified to be commonly collected for trade from public land, farmland and illegally from IFR (Table 4). Priority NTFPs highly traded included firewood and mushrooms. Low trading for other NTFPs in the study area could be caused by market being mainly confined in the study area where majority of the households can collect NTFPs themselves; also restriction from collecting NTFPs from IFR where various NTFPs can be obtained may have reduced the participants and quantities to be traded. No response on children collection and trading may due to the fact that most of their time they were in schools.

Table 4: Identified NTFPs for trade and actors in collection and trading

Response (%) of collectors of NTFPs for trade n = 208							
Traders	**Firewood**	**Thatch grass**	**Mush room**	**Honey**	**Tool handles**	**Medicinal Plants**	**Wild fruits**
Women	9.6	2.9	9.1	1	nr	0.5	4
Men	Nr	nr	nr	2.4	4	1.4	nr
Men/Women	Nr	nr	0.5	Nr	nr	0.5	nr
Children	Nr	nr	nr	Nr	nr	Nr	nr
Total no. of households	**9.6**	**2.9**	**10.1**	**3.4**	**2**	**2.4**	**2**

Note: nr = no response

Commercialization of NTFPs had also a gender dimension. Women were mainly involved in collection and selling of firewood, wild fruits, thatch grass and mushroom. This conform to FAO (undated) who reported that women tend to be more actively involved than men in the household economy, providing their families with food, water, fuel, medicines, fibres, fodder and other products. At IFR honey and medicinal plants were found to be collected and sold by both men and women contrary to Mhapa (2011) in Njombe district who claimed that beekeeping

activities were carried out by men only. Since women were cultured to be at their homes before sunset while beekeeping activities using traditional technologies were carried out after sunset. In the study area there is diversity of tribes unlike Njombe district, dominated mainly by Bena people. Tool handles were collected and sold by men. Women were engaged in trading most of NTFPs because they are responsible for nutritional needs of the family, meaning that income from NTFPs was mainly directed for food needs. This implies that collection of NTFPs for trade could form an important copying strategy for household food shortage during adverse situation resulting from climate variability.

Around IFR growing regimes and yield of climate sensitive crops essentially maize and paddy has been decreasing due to changing rainfall intensity and pattern. Previously maize were planted three times per year but now only twice or once while paddy is now grown once per year. In order to cope with such situation collection of NTFPs is perceived to increase. Also, in low plain when floods occur, there is loss of some crops such as maize, communities which suffer from such loss are likely to collect NTFPs.

As a result of changing rainfall intensity and pattern, there is increased usage of wild vegetables, wild fruits and construction materials during drought conditions for communities around IFR. At this period, there is low production of domestic vegetables such as Chinese cabbage and Pumpkins (Kalubwagila*)* but in some water spots wild vegetables such as *Conchorus sp* (Mlenda) do exist, to assist local communities cope with the situation. Wild fruits such as *Tamarind* fruits are collected and consumed by communities of all ages as well as for generating

income. When floods occur, there is loss of various crops including green vegetables, but at this period mushrooms are available in the forests. Other NTFPs important when flood prevail include bush meat which is easily available during heavy rainfall around the villages.

Information collected from informal discussion with communities around IFR showed that prolonged drought increases chance for termites to attack construction materials such as poles, withies, ropes and thatch grass, as a result collection of construction materials increases. Similarly, Sileshi *et al*. (2009) observed that, termite damage to crops and trees was more severe during dry spell or drought periods in Zambia. The authors further contend that increases in termite damage could be associated with climate change-induced drought. Construction materials such as thatch grass are also important when floods occur; since they are used to repair damaged buildings. This fact is supported by Augustino *et al*. (2012), who observed that one of the current climatic hazards experienced by communities around IFR is floods resulting into damaged dwellings.

Increased usage of medicinal plants by many households was evidenced by increased domestication of medicinal tree such as Neem tree around households in the study area and extraction of plants parts from forest areas for treatment of malaria and stomach diseases. This situation conform to the report by World Bank (2010) that the key human health impacts of climate change include increases in the incidence of vector borne diseases (malaria) and water-borne disease (diarrhoea).

4.2.1 Quantity of NTFPs for Subsistence and Trade

From Table 5, it was revealed that higher proportions of households are collecting NTFPs for subsistence use and few households collect the resources for trade. Large quantities of firewood, bush meat and mushrooms are collected for trade by relatively many respondents than other NTFPs. This implies that most of the collected NTFPs are not traded in large proportion by respondents but consumed at household level to supplement dietary, primary health care and construction needs.

Table 5: Average of NTFPs quantities collected for household uses and trade

Products	Units	Subsistence		Trade	
		Average per collector/year	% of the households	Average per collector/year	% of the households
Poles	Pcs	27.3	29.3	52	0.5
Firewood	Headlot	110.3	78.4	328.3	9.1
Withies	Pc	1.9	22.6	0	0.0
Medicinal plants	Kgs	2.6	35.6	26.3	2.4
Wild vegetables	Kgs	27.3	62.5	0	0.0
Mushroom	Kgs	68.1	35.6	324.3	21.0
Thatch grass	Headlot	26.3	47.1	25.8	2.9
Ropes	Bundles	2	23.1	0	0.0
Bushmeat	Kgs	77	1	340	0.5
Honey	Litres	4.6	3.4	21.1	3.4
Wildfruits	Kgs	19.7	50.54	10	1
Tool handles	Pcs	3.7	23.6	10	1

Though the involvement in trade was observed to be low, the restriction of NTFPs access through change of tenure system may result into negative consequences, especially for the poor because option value of having NTFPs as an emergency net must be considered greater than their direct value. Emergency net is the increased

use, or trade in NTFPs in response to unexpected economic, social or climatic hardship or misfortunate (Shackleton and Shackleton, 2004). At the study area respondents sometimes sell NTFPs on ad hoc basis to meet medical expenses and food needs. At this period where climate is perceived to change, low trading of NTFPs could imply that poor households who depend on NTFPs are not deprived of essential resources which help them to cope effectively during adverse climate condition such as drought. According to Angelsen and Wunder (2003), more trade can lead to over harvesting of forest resources, depriving poor people of their access to subsistence and small scale commercialization. Currently trade on NTFPs does not diminish safety net role of NTFPs around IFR, however, trend of low trading in the study area is likely to change in the future because demand of NTFPs seem to increase due to changing climate thus; there is a need to promote sustainable harvesting, domestication of priority NTFPs products and value addition of some products so as to achieve sustainable utilization in the future.

Firewood

Majority of the households (78.3%) collect firewood, but only 9.1% of the households collect firewood for trade (Table 5). Average quantity of firewood collected for subsistence use per households per year was 110.3 head loads while average amount of firewood collected for trade by 9.1% of the households were 328 head loads (Table 5).

Similar results on low participation of households in firewood trading were obtained by Paulo (2007) in Kilwa District, where only 8% of respondents were involved in collection and selling of firewood and the quantity of firewood sold per

household was 20 head loads. Also Schaafsma *et al.* (2011), reported that 95% of the households who collected firewood in 57 villages surrounding EAMs; only 4% sold some of the quantity collected.

Low percentage of people involved in trade of NTFPs could be due to the fact that sales of firewood to many households is not a full time activity but done to supplement income from other sources. Another reason for low involvement in firewood trade could be the fact that the trade is normally confined in production areas, due to low profit as a result of high transport costs over longer distances to major market areas. Since firewood has high market value, traders can be sensitized to promote their production and customers collect the products on bulky using their own transports.

Poles

The amount of poles used by a collector per year was 27 poles but average amount sold by a collector was 52 poles at a price of TZS 1000 per pole. Though average quantity of poles for trade seems to be higher than poles for own use, the amount for trade is represented by only 0.5% of the respondents, while that of household use represent 29% (Table 5). Therefore value of poles in trade is less than that for household use. The findings differ from Hamza *et al*. (2007) who reported that in communities surrounding Mgori Village Land Forest Reserve, 26% of the respondents specialized in selling poles.

Also, higher percentage of involvement in collection of poles has been reported in communities surrounding NDUFR in Kilolo District by Masam (2009) where the

majority of the respondents collected poles for construction. Variations in household pole collection can be due to low level of law enforcement in other areas and availability of substitute construction materials in the study area such as domesticated bamboos. Also, the market of poles being confined in the study area could imply that most households can access the product from forested areas themselves. However, this is unsustainable in future if domestication strategies are not emphasized in the area.

Wild mushroom

The results from Table 5 showed that wild mushrooms were collected from forested areas including village forests and illegally inside IFR as responded by 35.6% of the households surrounding the reserve. Few of the collectors (21%) were selling the products directly to other households. An average of 68 kg per household per annum was consumed by a collector alone. The quantity of mushroom collected for trade per household per year by the respondents was 324.3kg.This indicates that collectors can earn significant amount of money to meet various needs during adverse climatic condition. However, there is variation on average quantities of mushroom collected per household per year in different areas, for instance Paulo (2007) reported that in Kilwa District average of 29 kg yearly was collected for subsistence use while Msemwa (2007) reported that 29% of households in Kilosa District were consuming wild mushrooms from general land at the average quantity of 7.5 kg per household per year. Kilonzo (2009) reported 71kg of wild mushrooms per household per year being consumed by 66% of the households.

Differences in amount of wild mushroom collected can be due to difference in rainfall intensity or pattern, condition of the forests as well as indigenous knowledge. Also, could be due to differences in reporting, where some report only mention amount collected for subsistence use while others report subsistence use and trade together. Availability of mushroom is higher in protected forest than in unprotected one. Many forests in general land are not well protected, hence highly disturbed for growth of wild mushroom. It has also been reported by Marshall *et al.* (2006) that harvesting of wild mushrooms is likely to be sustainable as long as the habitat of the fungi is not unduly disturbed. The authors further reported that there is huge annual variation in the volume of wild mushroom available for harvesting caused by climate variability, especially rainfall. Also, difference in indigenous knowledge of suitable mushroom and ways of harvesting can contribute into variations in collection and usage pattern.

Thatch grass

Thatch grass is traditional building material, used for roofing. At the study area, thatch grass is also important during hazards like floods, whereby it can be used to restore damaged roofs. Types of thatch grass identified and collected included *Veteraria nigritana* (Mbasa) and *Hyparrhenia rufa* (*S*wago). About 47.1% of the respondents as indicated by Table 5 were involved in collection of thatch grass, at an average of 26.3 head loads per year and only 3% of the surveyed population were selling the product to other households at an average of 25.8 head loads per year. Low percentage of respondents in collection of thatch grass for trade is similar to the findings by Schaafsma *et al*. (2011) who found that 4% of the respondents

surrounding EAMs were selling the resource. The reason behind low involvement in trading the resource could be because many users of thatch grass are poor who collect thatch grass for roofing themselves, but few of the users are forced to buy due to unavailability of the material in nearby areas.

Honey

Very few respondents, (3.4%) (Table 5) were found to engage in honey collection and selling, whereby 4.6 and 21 litres per household per year were collected for household use and trade respectively. The prices of this resource in the study area was very high as could be sold up to TZS 10, 000 per litre and some of the honey was being brought by traders from Iringa Region. In other parts of Tanzania, for instance Tabora District, a study done by Mapolu (2002) reported that 30% of the respondents were beekeepers, collecting and selling about 271.5 litres per year per beekeeper. Availability of these resources also influenced the utilization because in the study area only 32.7% were using the resource while in Tabora District 82% were using the product. The difference in production could be due to lack of technical knowhow in harvesting, processing, poor extension services and weak organization among beekeepers.

Results from this study concur with Kasongo (2007) who observed that in Morogoro Region except Kilosa District, production of honey is low and demand is greater than supply. This situation at the study area implies that beekeeping products are not well exploited, but could play a big role in addressing environmental and socio-economic challenges. Honey products are highly valued and therefore potential for reducing dependence on climate sensitive crops, hence

good for enhancing communities' adaptive capacity to climate change and variability. Informal discussion with some collectors in Njage Village noted lack of suitable areas for keeping their beehives, as many of the suitable woodlands in forest reserves and private lands are restricted, therefore policies for KNR should think of accommodating beekeeping as REDD+ co- benefits in future since extraction of honey-bee products have low impact to forest reserves and also under good supervision beekeepers can protect the nature reserves when they are executing their jobs. Currently in Tanzania some forest reserves have adopted beekeeping which involves local communities, for instance at Kitulanghalo and Rau Forest Reserves in Morogoro and Kilimanjaro region respectively.

Wild fruits

Many types of wild fruits were found to be collected for subsistence use and few types for trade from IFR and in farm lands. For instance fruits from *Sorindeia madagascarensis* (Mpilipili*), Ximenia caffra* (Mpingipingi*), Vangueria infausta (*Msada*), Vitex doniana*, *(*Mfuru), *Acylobothrys petersiana (*Mbana milomo*), Synsepalum brevipes* (Mkumbulu*),* were mentioned to be often collected for subsistence use. Commonly sold fruits were Tamarind fruits which were collected from forest reserve and farmlands and used in porridges and for producing juices. About half of the households (51%) in the study area mentioned to collect wild fruits for domestic use and trade at an average of 19.7 kg per household per year (Table 5). The above average quantity conforms to the finding by Kilonzo (2009) who reported an average of 17kgs used by communities surrounding Nyanganje Forest Reserve.

Other studies have reported different results. For instance, Paulo (2007) and Masam (2009) found that households in Kilwa and Kilolo Districts were using 58 and 102kgs of wild fruits per households per year, respectively.

The reported lower consumption values for communities surrounding Iyondo Forest Reserve could be due to limitation of access to the forest reserve. Since some wild fruits are available during dry season, there are potential for addressing problem of food insecurity and income of the households during adverse climate condition.

Medicinal plants

An average of 2.4 and 26.3kg per household per year was collected per household for subsistence use and trade, respectively; as reported by 35.6 and 2.4 % of respondents respectively (Table 5). This low in usage could be due to religious beliefs, since some respondents' associated the use of medicinal plants with witchcraft. This observation is shared by Mhapa (2011) who reported that in Njombe District only 6% of the respondents were engaged in medicinal plant trade for religious reasons. In some areas in Tanzania, medicinal plants are widely used probably due to absence of conventional treatment or where religious beliefs have no influence on usage for primary health care.

For instance, Paulo (2007) in Kilwa District reported, an estimate of 13 kgs per year while Masam (2009) in Kilolo District reported an average of 38 kgs being consumed per year per household. During the study, women showed high knowledge in knowing types of medicinal plants available and types of diseases

which were cured by those plants. Diseases which were mainly treated by herbal medicines were stomach ache, malaria, hernia and sometimes snake bites. Active participation of women in using medicinal plants, conform to what Paulo (2007) found in Kilwa District where women were knowledgeable on medicinal plants affecting infants and women. Despite low response on use of medicinal plants at the study area, there are signs of increasing usage of the resources in Cocoa farming and to human beings due to emergence of new diseases on crops and increased incidences of malaria and water borne disease like diarrhoea.

Withies and ropes

Withies and ropes were mentioned to be used for construction of houses or huts. The average of 1.9 and 2 bundles of withies and ropes respectively were collected as mentioned by 23% of the respondents (Table 5). In Kilwa District, Paulo (2007) found an average of 18 bundles of ropes being consumed per household per year. On utilization of withies, Msemwa (2007) found lower value of 154 withies equivalent to 1.5 bundles (In this study one bundle was equivalent to 100 withies). The differences in consumption could be caused by availability and level of utilization.

In the study area the use of withies is low because of the substitutes. Palm tree fibres in most cases were used in favour of withies. However, availability of ropes is decreasing due to increasing demand. Through informal discussions, it was learnt that substitutes of traditional ropes, that is sisal was not preferred due to its susceptibility to termites, especially during drought period. In order to use sustainably withies and ropes from some indigenous trees under the changing

climate it's important to domesticate tree species for these products. Some of tree species used for rope at the study area include *Brachystegia speciformis* Benth. (*Mkwee*), *Brachystegia microphylla* Harms. (*Mtelela*) and *Annona senegalensis* Pers. (*Mdomongo*).

Wild vegetables

Wild vegetables were claimed to be collected from farmlands and illegally in KNR, mainly for subsistence use. Some of the common mentioned wild vegetables included *Conchorus trilocularis* (*Mlenda*)*, Amaranthus spinosa (Mchicha pori)* and *Justicia heterocarpa* (*Mwidu*). About 62.5% of the respondents in the study area were collecting wild vegetables for subsistence use, at an average of 27.3 kg per household per year (Table 5). However most of the wild vegetable species were available seasonally and some grew only in moist places or shady forest sites therefore if there is no access into those areas, local communities can be adversely affected. Since majority of the respondents collected a significant amount per year, then wild vegetables as close substitute of domesticated vegetables were potential for food security and trade. Processing, drying and preserving can make them available throughout the year and can address shortage of vegetable when there is low supply of this resource. Furthermore, maintaining access of local communities into the forest for collecting vegetables which are only found in the forest could improve food security.

4.3 Factors Influencing Supply and Demand of NTFPs under changing climate

Socio-economic factors are important for understanding the local dynamics that influence the supply and selling of NTFPs at the household level. Socio-economic factors such as education, occupation, distance, household size, marital status, income and age of the respondents were regarded as independent factors and were regressed with total income of NTFPs and total expenditure on purchasing NTFPs.

4.3.1 Socio economic factors influencing supply of NTFPs

The results of regression analysis (Table 6) show the factors that influence the supply from NTFPs. The overall model was statistically significant at F = 20.7.553, at $p<0.05$. This implies that it is unlikely to find out that the factors included in the model do not explain the variation obtained in dependent variable by the respondents. R^2 is 0.513, was explained by using six independent variables. The R^2 of 51.3% implies that 48.7% of the variations in the dependent variable were explained by other factors not included in the model. Household size was significant and positively related with NTFPs supply while distance and household income from respondent's main occupations were significant but negatively related with NTFPs supply at probability level of 5%.

Table 6: Factors influencing supply NTFPs– Multiple regression analysis (n =208)

Particulars	Coefficient(Beta)	t	Sign
Occupation (Farming)	0.053	3.53	0.353Ns
Marital status (Married)	0.023	3.82	0.703Ns
Distance	-0.147	- 2.623	0.010*
Education in years	-0.040	-0.685	0.494Ns
Household size	0.661	10.986	0.000***
Household income	-0.145	-2.362	0.019*
R^2 = 0.513 Adjusted R = 0.494			

Key: *, *** = Significant at 5% and 0.1% respectively
Ns = Not significant at 5%
R^2 = Coefficient of determination

4.3.1.1 Distance

According to the results from Table 6 distance had significant contribution to the NTFPs collection. The amount of NTFPs collected decrease as distances increases. This means that opportunity cost of labour time spent for collections increase with distance, also indicates that people living closer to the forest are more dependent on NTFPs despite the restrictions imposed. Similarly for communities surrounding Nyanganje Forest Reserve, collection of firewood (part of NTFPs) was significantly decreasing with increasing distance (Kilonzo, 2009). This implied that communities residing near IFR still depended more on NTFPs such as firewood and mushroom than others. Collection is likely to increase during adverse climatic condition, especially drought and floods. Therefore current total restriction from accessing NTFPs from the reserve to communities closer to the IFR will aggravate poverty levels. It is recognized that poverty is linked to vulnerability. According to Bohle *et al.* (1994) the poor are among the most vulnerable to famine, malnutrition and hunger, which can occur due to prolonged drought and presence of flood. Therefore

if communities adjacent to forest reserve are denied access spatial vulnerability will increase in absence of alternative income generating activities such as beekeeping and others.

4.3.1.2 Household size

The regression analysis performed for the supply of NTFPs (Table 6) showed that household size had significant contribution to the collection of the resources or income. This implied that increase in household size significantly influence extraction of NTFPs due to the fact that more products are needed to meet the increased needs of the household for food, construction material as well as medicinal needs. According to Mhinte (2000), increase in number of members in the household implies not only more mouths to feed, but also more availability of labour. Also, the study by Kilonzo (2009) showed that increase in size significantly affected collection of firewood by households surrounding Nyanganje Forest Reserve in Kilombero District.

It is likely that families with big household size will be more vulnerable to climate change impacts because of having many needs in terms of food, primary health care and construction materials, thus when adverse climatic condition occur they might collect more quantities of NTFPs than others. This imply that for households with big household size, diversification of income sources apart from NTFPs trade is important for enhancing adaptive capacity and to lessen pressure on forests. But also promotion of agroforestry as a way to domesticate potential NTFPs becomes crucial in future.

4.3.1.3 Household income

Household income from other sources apart from collection of NTFPs is significantly related with its collection (Table 6). Collection of NTFPs products was increasing with the decrease in household income. Similarly, Kilonzo (2009) found that collection of some NTFPs like wild fruits, wild vegetables, wild mushroom and honey for households adjacent to Nyanganje Forest Reserve was increasing for households with low income. This implied that households with low income are also food insecure and therefore turn to cushion their economic shocks and crop yield failure by collecting NTFPs.

It is argued that the poorest in society often depend directly on the natural resources, therefore most vulnerable to increased restrictions on NTFPs extraction (Cavendish, 2000). According to Pelling (1998) highest levels of household vulnerability in coastal Guyana was characterized by low household income, whereby households with higher levels of income were better able to manage vulnerability. People with low income, are likely to engage in collection of NTFPs as one of the coping strategy because, the main investment in collection is their labour, therefore if denied access there would be temporal vulnerability. Temporal vulnerability may lead to inequity especially where REDD+ will prevent access to subsistence forest products from the natural forests that are used to cope with temporal shocks (Peskett *et al.,* 2008).

4.3.2 Social- economic factors affecting demand of NTFPs

Results from regression analysis (Table 7) showed factors that influence demand on NTFPs. The overall model was significant at F = 8.8, at $p<0.05$. This implied that it is unlikely to find out that the factors included in the model do not explain the variation obtained in dependent variable by the respondents. R^2 was 0.663% implying that, the variation in expenditure on NTFPs was explained by 66.3% of the seven independent factors. The R^2 of 66.3% implied that 33.7% of the variations in the dependent variable were explained by other factors not included in the model. The variables, namely marital status and household size were significant and positively related with expenditure on NTFPs.

Table 7: Factors influencing demand of NTFPs –Multiple regression analysis (n = 208)

Explanatory variables	Coefficient	t	Sign.
Occupation (Farmer)	-0.110	-0.936	0.358Ns
Marital status	0.331	2.794	0.010*
Distance	0.074	0.501	0.621 Ns
Household income	0.100	0.754	0.458Ns
Education in years	0.067	0.574	0.571Ns
Household size	0.823	6.275	0.000***
Age of the respondent	0.235	1.869	0.073Ns
$R^2 = 0.663$			
Adjusted R = 0.588			

Key: *, *** = Significant at 5% and 0.1% respectively
Ns = Not significant at 5%
R^2 = Coefficient of determination

4.3.2.1 Marital status

The results from Table 6 showed that marital status influences significantly demand of NTFPs. According to this result, a household whose head of household is

married buy more NTFPs than household whose head of the household is not married. This implies that households with married couples are likely to have bigger household size to care for hence more vulnerable during low yield of climate sensitive crops when rainfall received is not adequate.

4.3.2.2 Household size

Household size had significant contribution to the demand of the NTFPs (Table 7). This implied that increase in household size significantly influenced amount of NTFPs bought due to the fact that more products are needed to meet the increased needs of the household for food, construction material as well as medicinal needs.

4.3.3 Other factors affecting supply and demand of NTFPs under the changing climate

4.3.3.1 Change in forest tenure

Since 2007, the then Iyondo Forest Reserve changed its tenure into Nature Reserve. A Nature Reserve is the highest category of protected areas which do not allow human consumptive activities (Harrison, 2006). About 43% of the respondents (Table 8) claimed that prevention of people by the government from going into the forests to collect NTFPs such as firewood, mushrooms, poles, withies has decreased the supply of NTFPs, hence increasing their vulnerability to effects of climate change and variability.

Table 8: Response on factors affecting supply of NTFPs

Sex	Factors (%) n = 208			
	Tenure change	Distance/scarcity	Changing weather	Seasonality
Female	24.2	39.5	3.8	25.5
Male	18.5	26.1	2.5	15.9
Total	**42.7**	**65.6**	**6.4**	**41.4**

However some of the respondents confirmed that they are still taking risk of entering into the forest unlawfully to collect firewood and mushrooms and few with enough land have started domesticating trees for fuel wood. Therefore, restriction on forest access to promote conservation requires additional policies to prevent a consequent increase in poverty, and an enforced trade – off between conservation and extraction of NTFPs (Schaafsma *et al.,* 2011). It could be appropriate if surrounding communities could be allowed to use the Nature reserve for activities which do not pose a threat but enhances conservation. Such activities include beekeeping, cultural and spiritual activities. Other activities which can be conducted in a reserved forest if carefully planned according to Chidumayo *et al.* (2011) include collection of firewood, edible fruits and other foods, honey and medicines.

4.3.3.2 Seasonality

In this study 41% of the respondents (Table 8) showed that seasonality is one of the constraints which limit them from procuring NTFPs throughout the year. This result is different from Paumagarten (2007) who reported that 22% of the households in two villages of Limpopo and Eastern Cape Province in South Africa, perceived resource scarcity, seasonality and over use as the weakness of NTFPs as a rural safety net. In villages surrounding IFR, mushrooms are available from February to

April. Wild fruits such as *Tamarind* are collected from July to November. Other NTFPs which are available only in some months of the year include wild vegetables and thatch grasses. Similarly seasonality of wild fruits (*Marula*) in South Africa, which is only available in summer have been reported to affect production of *Marula* beer (Makhado *et al.,* 2009).

When mushrooms and wild vegetables are available some household use them almost daily. Peak season of *Tamarind* fruits occur during the dry season when other fruits for making beverages are not available. Proportion of women who perceived seasonality as one of the constraints in utilizing NTFPs was higher than that of men (Table 8) probably because they are the main collectors, hence knowledgeable on constraints facing its availability. Some wild fruits such as *Tamarind* fruits and can be stored for six months. Also mushrooms and wild fruits are dried and stored for sometime but processing and storage conditions are poor. Therefore, mushrooms, wild vegetables and wild fruits availability can be improved if adoption of simple but improved technologies of processing and storage will be promoted for countries for anticipatory adaptation.

4.3.3.3 Changing weather condition

The changing weather condition is among the factors that were claimed to lower supply of some NTFPs like mushroom and wild vegetables. Normally in December varieties of mushrooms collected are *Amanita zambiana (*Ulelema*)* and *Termitomyces letestui (Wikulwe)*, but due to changing of onset and cessation of rainfall in recent years, sometimes they are not seen. Also, from the indigenous

knowledge perspective of some respondents, it was reported that prolonged drought have increased the chance of occurrence of fire which burn all litters that form substrate for mushrooms to grow, hence decreasing the supply of mushrooms. Similarly, Chidumayo *et al*. (2011) reported effect of climate change on availability of forest product and services through forest fires which are associated by drought, resulting into biodiversity loss.

4.3.3.4 Availability/scarcity of NTFPs

Availability of NTFPs during the time of study was compared to the past years and many respondents (87%) believed the NTFPs were less available than in the past (Table 9). Causes of decreased supply were increased, low rainfall and occasional floods linked to climate change, population farming inside forests and fire occurrences. Similarly, it was reported by Augustino *et al.* (2012) that due to climate change and variability people claimed the NTFPs to decrease in Kilombero District.

Table 9: Availability of NTFPs (n =208)

	Response on NTFPs availability (%)			
Sex of the respondent	**Increasing**	**Decreasing**	**Constant**	**Total**
Female	1.5	53.3	7.7	62.6
Male	nr	33.8	3.6	37.4
Total	**1.5**	**87.2**	**11.3**	**100**

Note: nr = no response

Perceptions of local communities on low rainfall and occasional floods as causes of decreased supply of various NTFPs were supported by existing rainfall and temperature data from the Tanzania Meteorological Agency (TMA). The rainfall

data have showed a trend of rainfall decrease for the past 30 years while temperature data indicate an increase in both maximum and minimum annual temperatures. (Figure 4 and 5).

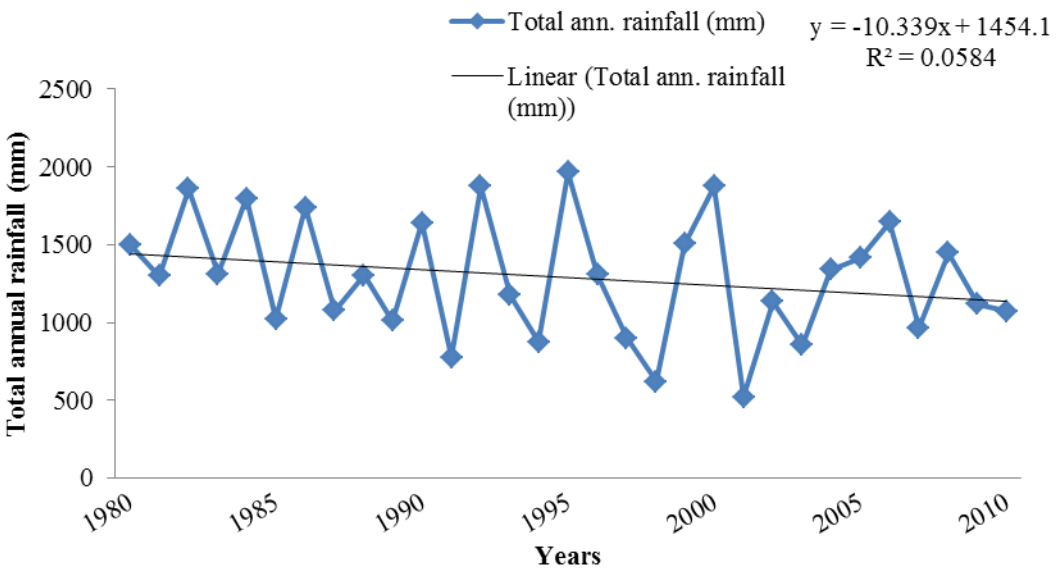

Figure 4: Total annual rainfall (mm) recorded between 1980 and 2010 around the study area

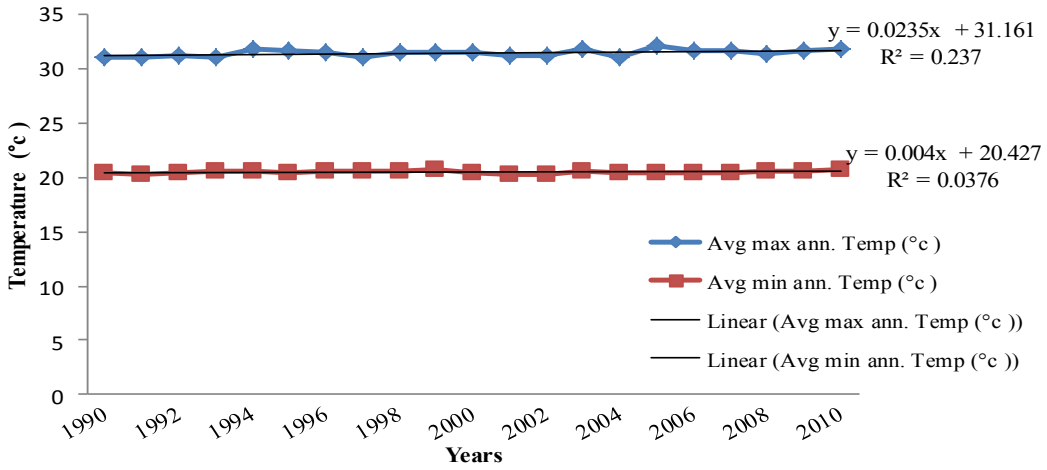

Figure 5: Average maximum and minimum temperature (°C) recorded between 1990 and 2010 around the study area

Fertile land for agriculture has attracted many people from other parts of Tanzania to shift to Kilombero District. Many people migrate to Kilombero looking for pastures for their livestock and for arable land. The underlying reason of immigration could be due to increased drought in areas of original attributable to climate variability and change.

Similar results have been reported by Masam (2009) in Kilolo District who found that, 82% of the respondents claimed a decreased trend in availability of NTFPs caused by increasing population.

Price differences between dry and wet season affects the supply of several NTFPs. For instance, during rainy season supply of firewood decline causing price to go up, since few individuals are intensively engaged in supply of these commodities as they are engaged in farming activities.

4.4 Total Economic Value of NTFPs and other Forest Ecosystem Services

Total economic value TEV of forest ecosystem services at a discounting rate of 10% was TZS 20 523 473 790 from IFR and surrounding areas, NTFPs contributing large percent (Table 10). This is the value of NTFPs and other ecosystem services which indicates the socio-economic contribution to sustainable livelihoods for communities surrounding IFR areas. It will enable the local communities and other stakeholders to appreciate the importance of forests in provision of various products and in enhancing adaptation to climate change and variability and hence participate in conservation of IFR and other forests in general.

Table 10: Total Economic value of NTFPs and other ecosystem services

Item	Actual annual values ((TZS)	Present annual values (TZS)
NTFPs	1, 698, 582,879	16,985,828,792
Water for domestic use	318, 404, 100	3, 184, 041, 000
Cultural values	11, 050, 125	110, 501, 250
Biodiversity values	24,310,275	243, 102,750
Total	**2, 052,347,379**	**20, 523,473,790**

Therefore restricting access to NTFPs could probably exacerbates the poverty levels of Iyondo surrounding communities and hence increase vulnerability to climate variability. Communities at the study area indulge in collection of NTFPs for domestic use and trade as means to fight poverty and to address food security but sources of their supply are not well established, sometimes they extract illegally from IFR. According to Van Rijsoort (2000), marketing NTFPs can only provide sustainable source of income and make the forest more valuable resource if it is based on an ecologically sustainable extraction system. There is a need to have sound policies which integrate extraction of various NTFPs and other ecosystem services with conservation initiatives around KNR in order to ensure sustainable supply of NTFPs and in turn improve livelihoods of forest dependent communities.

Forest services such as water, biodiversity, spiritual and cultural values are also important for communities' livelihoods. When regarded as REDD+ co- benefits constitute a present value of TZS 3 537 645 000. The value of these services has the potential of lowering the opportunity costs of reducing emissions and for livelihood of communities. TEV of NTFPs were calculated from 12 priority NTFPs from 14 identified NTFPs. NTFPs involved were firewood, thatch grass, tool handles, poles, bush meat, medicinal, vegetable, mushroom, withies, ropes wild fruits and honey.

The TEV of TZS 16 985 828 379 (USD 10 616 143) from a population of 8 308 households in the study area was obtained. Average value per household is 1 277.8 USD. These results differ from the study by FBD (2003) who found that average value per household from a population of 316 561 households surrounding catchments forests in four regions of Tanzania was USD 543.41. Average value per household at the study area, are higher due to exclusion of cost of collection. In this study gross value was taken while the other study took cost of collection as half of the gross profit.

4.4.1 Total Economic Value of NTFPs

The TEV of NTFPs were obtained from 12 priority NTFPs, which were poles, firewood, bush meat, wild vegetables, wild mushrooms, thatch grass, medicinal values, honey, hoe handle, wild fruits, withies and ropes. Valuation of these 12 priority NTFPs revealed that firewood is highly valued (Table 11). Other priority NTFPs with high value were mushrooms, thatch grass, medicinal plants, wild vegetables and poles. Any program meant to promote and improve availability of NTFPs for communities surrounding IFR should focus on these NTFPs with higher TEV.

Firewood

In the study area, 78.3% of the respondents mentioned to collect the firewood at an average of 110.3 per household per year for subsistence use while only 9.1% of the respondents apart from collecting for subsistence use were also collecting for trade. An average unit value of a head load weighing 16.5 kg was estimated at TZS 1 170. An average value per household per year was TZS 129 051 (USD 80.7) and 384

111 (USD 240) for subsistence and trade respectively, contrary to the value of TZS 99 000 (USD 76.15) reported by Kilonzo (2009) for communities surrounding Nyanganje Forest reserve. The reason could be differences in size of head load and different types of reporting. At the study area, the value involved amount collected for both subsistence use and trade while for Nyanganje it involved value for subsistence use only. The total economic value of firewood for the study population for household use and trade, at discount rate of 10% from total population of 8 308 was therefore TZS 11 298 965 905 (Table 11).

Thatch grass

Thatch grass was mentioned to be collected for subsistence use and in small proportion for trade by about 47% of the respondents (Table 11). An average of 26.3 head loads per household, equivalent to TZS 26 300 (USD 16.4) was collected for subsistence use only. Amount collected for trade by 2.9% of the respondents was 25.8 head lots per household, equivalent to 25 800 (USD 16.1), contrary to the value of thatch grass for Kilosa as reported by Msemwa (2007), where value per household per year was TZS 9 870 (USD 9). In this study the average price per head load was TZS 1000, therefore the total economic value for 8 308 households surrounding IFR at a discounting rate of 10% is TZS 1 091 297 340. The higher value per household per year at the study area could be due to higher availability as well as higher demand than in Kilosa District.

Tool handles

Most of the tool handles for equipment like hoes, axes, and machetes were made from wood. Many handles were used as hoe handles, which are used in crop cultivation. About 24% of the respondents were capable of extracting tool handles from the public land for their own use and sometimes for sale. The price of piece of tool handle was 900/=. In a population surrounding IFR with 8 308 households, the total economic value at a discount rate of 10% was TZS 72 768 110 (Table 11).

Poles

Poles were mentioned to be collected for construction of houses and sometimes for trade. About, 27.3 poles were collected per household per year for their own use as mentioned by 29.3% of the respondents. The average value per household for own use was TZS 27 300 (USD 17), at a price of 1000. Average poles collected for trade was 52 poles but from only 0.5% of the respondents, valued at 52 000 per household per year. Similarly for communities surrounding Nyanganje Forest Reserve the poles value for own use was TZS 28 000 (USD 21.54) per household per year (Kilonzo, 2009). At a study area, the present value of poles for both subsistence use and trade for 8 308 households was TZS 800 924 432 (Table 11), implying that poles is one of priority NTFPs with higher economic value, hence important for community surrounding IFR.

Bush meat

Bush meat was mentioned to be consumed in all surveyed villages. An average of 77 kgs and 340 kgs per household per year was hunted for consumption and trade respectively. Wild animals hunted included *Arbot duickers* (*Sheshe*), Bush pigs

(*Nguruwe pori*) and Giant pouched rat (*Ndezi*). The value of bush meat per household per year, collected for own use by 1% of the respondents was TZS 231 000 (USD 144.4) and 1 020 000 (USD 637.5) for subsistence use and trade respectively, higher than the value of TZS 12,150 (USD 11) reported by Msemwa (2007). It seems that at the study area availability of bush meat is higher than other areas, such as Kilosa. The total economic value per annum at the study area for 8 308 households at a discount rate of 10% for subsistence and trade was therefore TZS 224 066 760 (Table 11). Generally, the price of bush meat per kg was TZS 3 000 relatively low compared to domesticated animals' meat. However most of the bush meat was claimed to be obtained illegally hence a threat to biodiversity and sustainability of this resource. Therefore in order to enhance adaptive capacity of the local communities, improvement of poultry essentially local chicken and other domesticated animals is essential.

Medicinal plants

Results in Table 11 indicated that few households (36%) respondents claimed to collect medicinal plants for households use and trade. An average of 2.6 kg per household per year was collected for domestic use while about 26.3 kg was collected for trade. The value per household per year for own use was 20 800 (USD 13) where as the value for trade was 214 400 (USD 134), higher than those reported in other studies. For instance, Kilonzo (2009) reported that at Nyanganje in Kilombero District, average value per household was TZS 7000 (USD 5.4). The difference might be caused by variations in plant parts used in estimating quantities used. Total economic value for both subsistence use and trade for 8 308 households at the study area was estimated at TZS 702 590 944.

Wild vegetable

Wild vegetables were claimed to be collected from farmlands and forests, mainly for subsistence use. The common mentioned wild vegetables consumed include C*onchorus trilocularis* (*Mlenda*) *Amaranthus spinosa* (*Mchicha pori*) and *Justicia heterocarpa* (*Mwidu)*. A kg of wild vegetable was sold at an average of TZS 500. Therefore the value of per household per year was TZS 13 650 (USD 8.5), while in Kilosa, the value was TZS 13 141 (USD11.9) higher than that of the study area. The difference might be caused by availability and indigenous knowledge. The annual total economic value for 8 308 households at 10% discount rate was therefore TZS 708 776 250.

Wild mushroom

The average quantity of wild mushrooms collected for subsistence use and trade from the forest reserves for a household per year was 68.1 kg and 324.3 kgs respectively by 36% of the respondents (Table 11). The value for subsistence use per household per year was TZS 34 050 (USD 21.3) while value of wild mushroom traded was TZS 162 150 (USD 101.3) contrary to the value of TZS 1425 (USD 1.3), reported by Msemwa (2007) in Kilosa District. Total economic value per annum for subsistence use and trade at the discount rate of 10% for 8 308 households is TZS 1 191 142 884 higher than wild vegetable. This show that wild mushroom were used by local communities especially when times are tough. To ensure sustainability there is a need to impart knowledge to communities on growing it.

Withies and ropes

Withies and ropes were mentioned to be used for construction of houses or huts. The average of 1.9 and 2 bundles of withies and ropes, respectively; were used by about 23% of the respondents (Table 11). The price of withies was TZS 5000. In a population surrounding IFR with 8 308 households, the Total Economic Value at a discount rate of 10% was TZS 178 372 760. The price of rope was TZS 800 per bundle, its total economic value at the same discount rate in a population of 8,308 households is 30 706 368.

Wild fruits

An average of 19.7 kgs of various types of wild fruits was collected per household per year (Table 11) by about 51% of the respondents for own use. The price per kg TZS 300, therefore the total economic value for 8 308 households, for subsistence use at a discount rate of 10% is TZS is 248 152 815. The total economic value for wildfruits traded was TZS 2 492 400.

Honey

Results from Table 11 showed that only 3.4% of the respondents extract honey for both subsistence and trade at an average of 4.6 litres per household per year for subsistence use and 21.1 litres for trade. The annual value per household per year for own use was TZS 27 600 (USD 17.25) and for trade was TZS 126 600 (USD 79.13. The average value for communities surrounding Nyanganje Forest Reserve was TZS 116 000 (USD 89.23) per household per year, lower than the result of the study area. The total economic value at a discount rate of 10% as shown by Table

11 was TZS 435 571 824, lower than medicinal plants, thatch grass, wild vegetables, wild fruits, withies and ropes. The difference in values could be caused by extent of availability, at the study area low availability resulted into higher price than the other area and other NTFPs.

Table 11: Total Economic Value of NTFPs for subsistence use and trade

NTFPs	Unit	Average. quantity/year	Price	Proportions	Population	Annual value	Discount rate	Annual present value
				NTFPs for trade				
Firewood	Headlot	328.3	1170	0.091	8,308	290,398,671	0.1	2,903,986,711
Thatch grass	Headlot	25.8	1000	0.029	8,308	6,216,046	0.1	62,160,456
Tool handles	Pcs	10	900	0.01	8,308	747,720	0.1	7,477,200
Poles	Pcs	52	1000	0.005	8,308	13,637,582	0.1	136,375,820
Bushmeat	Kgs	340	3000	0.005	8,308	3,215,196	0.1	32,151,960
Medicinal plant	Kgs	26.3	8000	0.024	8,308	8,740,016	0.1	87,400,160
Mushroom	Kgs	324.3	500	0.21	8,308	18,406,374	0.1	184,063,740
Wild fruits	Kgs	10	300	0.01	8,308	249,240	0.1	2,492,400
Honey	Litres	21.1	6000	0.034	8,308	35,760,955	0.1	357,609,552
Subtotal						**377,371,800**		**3,773,717,999**
				NTFPs for Subsistence Use				
Firewood	Headlot	110.3	1170	0.783	8,308	839,497,919	0.1	8,394,979,193.6
Thatch grass	Headlot	26.3	1000	0.471	8,308	102,913,688	0.1	1,029,136,884.0
Tool handles	Pcs	3.7	900	0.236	8,308	6,529,091	0.1	65,290,910.4
Poles	Pcs	27.3	1000	0.293	8,308	66,454,861	0.1	664,548,612.0
Bushmeat	Kgs	77	3000	0.01	8,308	19,191,480	0.1	191,914,800.0
Medicinal plant	Kgs	2.6	8000	0.356	8,308	61,519,078	0.1	615,190,784.0
Wild veg.	Kgs	27.3	500	0.625	8,308	70,877,625	0.1	708,776,250.0
Mushroom	Kgs	68.1	500	0.356	8,308	100,707,914	0.1	1,007,079,144.0
Withies	Bundles	1.9	5000	0.226	8,308	17,837,276	0.1	178,372,760.0
Ropes	Bundles	2	800	0.231	8,308	3,070,637	0.1	30,706,368.0
Wild fruits	Kgs	19.7	300	0.5054	8,308	24,815,282	0.1	248,152,815.1
Honey	Litres	4.6	6000	0.034	8,308	7,796,227	0.1	77,962,272.0
Subtotal						**1,321,211,079**		**13,212,110,793.2**
Grand total						**1,698,582,879**		**16,985,828,792.24**

4.4.2 Economic value of other forest ecosystem services

The majority of respondents (87.5%) appreciated the importance of other forest ecosystem services for their livelihoods. The other forest ecosystem services perceived to be important were recreation, watershed protection, precipitation formation, biodiversity and worshiping. However, only 27% of these respondents were willing to pay for these ecosystem services. The low response on WTP could be due to low education and income levels of respondents, as well as religious beliefs. In low income communities, recreation is not ranked high among forest resources and services. The value of TEV at 10% from water services for domestic use, biodiversity and non- use values was TZS 3 537 645 000. This amount represents the value of the other forest ecosystem services to the surrounding communities and other areas.

4.4.2.1 Water

The value of water for the households living adjacent to IFR was calculated based on the average consumption of water per person per day in rural areas. Consumption of water for households surrounding IFR per day per person was 26.6 litres. The average household size for the four surveyed villages was 5.2. Therefore a household used 138.3 litres per day, equivalent to 7 buckets of 20 litres. At a value of TZS 50/= per bucket, for 7 buckets of water makes the total of TZS 350 per day. Annually, cost of water was TZS 127 750. Forest reserves provide important watershed for rural and urban rural supply (FBD, 2006). According to the author 30% of water will disappear or become unavailable for domestic purposes as a result of forest clearing. Therefore the value of water protection per household is

TZS 38 325. There are 8 308 households surrounding IFR, making the value of TZS 318 404,100. At the discounting rate of 10%, present value of water protection was TZS 3 184 041 000 (USD 1 990 025). This represents value of domestic water which will be lost if watershed areas will be destroyed. According to FBD (2003), values based on the loss of water can be seen as mere indications of the problems that would ensure if catchment forest reserves disappeared. The average value of water per household per year was USD 239.53, contrary to the value of USD 170.53 for communities surrounding catchment forests in Morogoro, Tanga, Kilimanjaro and Arusha regions. The variations were caused by differences in estimating price per litre. Communities around IFR fetch water from streams, shallow wells and few individuals from tapes, but currently there are water shortages at the study area especially in Mngeta village, perceived to be caused by climate change. According to World Bank (2010) water for domestic use is becoming scarce due to combined effect of declining rainfall, lowering of ground water, drying streams and poor water retention capacity due to climate change. In response to water shortage communities walk longer distances to fetch water or construct deep wells. Planned adaptation is required to create awareness on the value of water lost as a result of poor conservation of watershed areas and the cost incurred by communities by walking longer distances searching for water.

4.4.2.2 Non-use values

Non use values included cultural, aesthetic, heritage and bequest values. According to Pearce and Moran (1994), non-use value for tropical forests is estimated at 5 USD/ha /year, thus non-use value for IFR was calculated as 27 975 ha x 5 = 139

875/= x 0.05 (Tanzania share). = 6 993.75 USD per year equivalent to TZS 110 50125. The present value of this annual stream at a discounting rate of 10% was TZS 110 501 250 less than that of water. Similarly FBD (2003) reported non-use value of USD 1 834 210 for 733 684 ha of catchment forests in Morogoro, Tanga, Kilimajaro and Arusha in Tanzania.

This figure represents cultural or spiritual value that is essential to the social framework of local community. Under this period of changing climate, cultural and spiritual values of the IFR and other sacred forest reserves in the study area, are important for adaptation to changing climate whereby local communities through some members make sacrificial activities inside the nature reserves, dedicated to bring rainfall during drought or to reduce rainfall during flooding. Also, there is visit to sacred sites in the reserves practiced by some members of the society including traditional herbalists and sometimes initiation rites for some tribes like *Matumbi* is practiced. If the communities are allowed to exercise such values, will be an incentive for them to protect the forest and sacred trees which in turn may improve watershed areas and biodiversity.

However, due to migration and increasing formal education, beliefs in spiritual and cultural values of the forest seem to be decreasing; as only 5% of the respondents appreciated the role of spiritual value for their well being. There is a need to increase environmental awareness on importance of conserving the forest especially at this period when the world is experiencing impact of climate change. Also, in order to preserve indigenous knowledge related to spiritual and cultural

practices, areas used for this practice should be defined and right of access to some members of the local communities should be granted.

4.4.2.3 Biodiversity and option value

Biodiversity and option value for tropical forests for potential pharmaceutical range from 11 to 20 USD per hectare/ year (Pearce and Moran 1994, FBD 2003). According to FBD (2003) low estimate which is based on global study is chosen. IFR total area is 27 975 ha. Therefore biodiversity and option value per year was equal to 27 975 ha x 11USD = 307 725 USD/year x 0.05 (Tanzania share) = 15 386.25 USD equivalent to TZS 24 310 275. Five percent was chosen as a Tanzania share because the country is in the developing country category where the willingness to pay of its people is low (FBD (2003). The present value of this annual stream at a discounting rate of 10% was therefore TZS 243 102 750/= lower than that of water.

Biodiversity is a global value, therefore benefits not only local communities. Most benefits from biodiversity which include human drugs and carbon sequestration are enjoyed outside the country (World Bank 2011). Biodiversity values apart from financial values associated with products that are sold, there are also value to human drugs whose benefit spread all over the world (Fearnside, 1997). Therefore in order to achieve equity and poverty alleviation objectives, Hein *et al.* (2006) and Turner *et al*. (2010) claimed that effective conservation policies should not only be informed by the potential for carbon and biodiversity protection, but also by the distribution of costs and benefits of forest conservation among stakeholders at different spatial scales.

Biodiversity loss increases both the severity of climate change and our ability to adapt it (Perrings, 2010). Therefore, conservation and sustainable use of biodiversity may contribute to adaptation by increasing resistance to natural disasters such as flood and maintaining ecosystem goods and services, such as the provision of NTFPs, clean water and by amelioration of climate to communities living around IFR. This biodiversity and option values highlight the importance of forests to the local communities because biodiversity is important for supply of various needs for rural dwellers livelihoods.

4.5 Profit Margin along the NTFPs Value Chain

4.5.1 NTFPs trade

Marketing of NTFPs along the chain was divided in gender lines. Extraction of charcoal was effected by male who were selling the products in bags to either final consumers or village retailers who were mainly women. Collection and trading of firewood was mainly done by women. Both women and men played role in collection and trading of honey along the NTFPs market chain. In *Tamarind* market chains, women had a special role of processing and selling beverages. NTFPs were found to be sold in informal village markets including displays in front of households and in streets (Plate 1).

Plate 1: Firewood for sale being displayed in front of a house at Mngeta village, Kilombero District

In these markets one vendor, could be selling several NTFPs such as firewood, charcoal and tool handles. The market of these products at the study area was not stable and not well established. For instance, supply of firewood and charcoal was high during dry period, but demand was low because farm preparation in many households was associated with charcoal making and firewood collection. Also during this period firewood is easily obtained. However (9%) of respondents, sold firewood collected contrary to other areas. Schaafsma *et al.* (2011) reported that only 2% of the households sold the firewood collected.

4.5.2 Actors in the NTFPs market chain

During the study four main chains through which NTFPs passes, starting from collection until a product reaches a final consumer were identified in communities around IFR. The chains were differentiated by the relationship of buying and selling

between the different actors in the NTFPs value chain. Actors in the chain were local collectors, Village retailers, processors and consumers. Four common chains were identified as follows:-

(1) Collectors → Village retailers → Consumers

(2) Collectors → Consumers

(3) Collectors → Village retailers → Processors (Fruits) → Consumers

(4) Collectors → Processors (For fruits) → Consumer

The first and second channels were the most prominent**.** The third and fourth channel involved wild fruits, especially *Tamarindus indica*. The common NTFPs which pass through the first channel were firewood, honey and Tamarind fruits. The second channel involved mainly firewood and mushrooms. The third channel involved only Tamarind fruits which are bought by village retailers who in turn sell to final consumers or beverage dealers who also sell to final buyers. These beverage makers for trade sometimes go directly to collectors; therefore the fourth channel involved collectors of Tamarind fruits who sell their products directly to processors. No middlemen were noted in all these chains possibly because almost all products were sold within the study area. The findings are different from other areas. For instance, Semu (2004) identified five main chains through which charcoal passes from production to the end from Rufiji District. The difference in number of chains involved could be caused by availability of the produce, demand and transport cost involved.

4.5.2.1 Collectors

These were the first actors in the NTFPs value chain. They represented the households who were the collectors/producers of NTFPs for both subsistence use and trade. The majority of the collectors had low income from their main occupations that is farming (Figure 6). Collectors were selling firewood directly to consumers at 1,000 per head load or sell to village retailers at 800 per head load. Other NTFPs which could be sold directly to consumers were honey, mushrooms and charcoal.

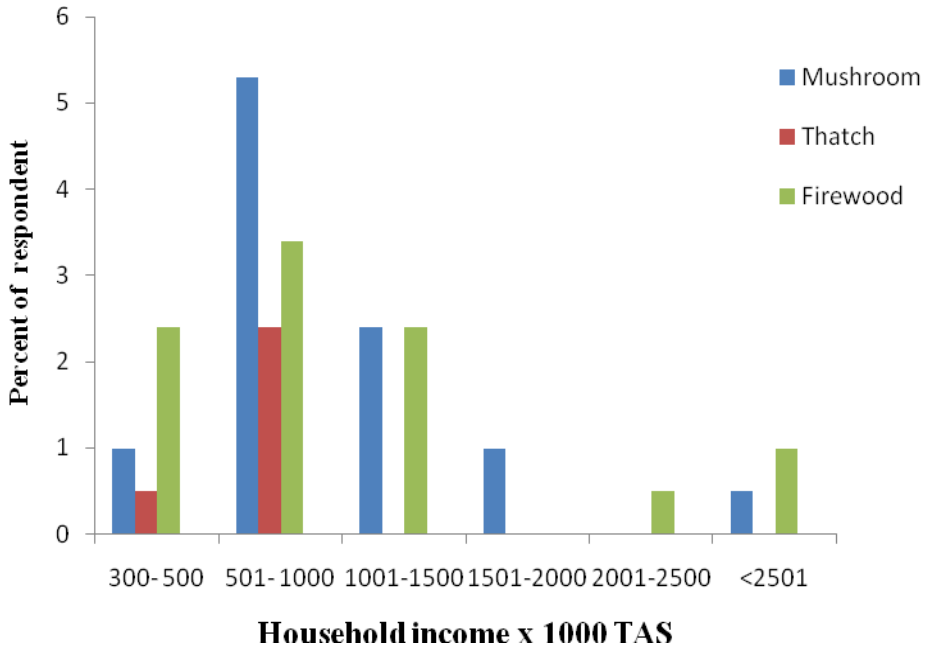

Figure 6: Collectors income from traded NTFPs

4.5.2.2 Village Retailers

These represented the households that were involved in buying NTFPs from collectors. They were normally selling the NTFPs to final consumers except Tamarind fruits which were either sold to final consumers or shop owners who were

processing to make beverages for sale. Charcoal was bought in terms of a bag or tin. A bag was divided into approximately 44 sachets or heaps which were sold to final consumers.

4.5.2.3 Processors

These were mainly shop owners in the market areas of the villages who were selling different goods ranging from household utensils to beverages. These dealers were either buying the *Tamarind* fruits directly from the collectors or from retailers. They manage to sell the drinks because they have refrigerators for cooling the drinks. This implied that in the chain that involve collectors, retailers and processors, major profit is appropriated by processors due to their ability to process and store the beverage unlike other actors who cannot do so.

4.5.3 Profit distribution among different actors

Profit margin is the difference between the price and cost of the products (Magar, 2008). Price and costs varied according to NTFPs traded (Table 12) and Appendix 6-8. In this study charcoal makers and honey collectors were getting high profit margin than village retailers. Village retailers of firewood were getting slightly higher profit margin than collectors (Table, 12). Mushrooms were sold directly to final consumers implying that the products were perishable and sales are confined to households near the collectors.

Table 12: Profit margin along NTFPs market value chain

NTFPs traded	Unit	Quantity /annum	Actors	Average sales/unit (TZS)	Average cost/unit (TZS)	Average profit margin/unit (TZS)	Profit margin %
Charcoal	Bags	90	Collector	10,000	2,694	7,296.3	44.8
	Bags	240	Wholesaler	15,000	13,000	2,000	12.2
	Bags	30	Retailers	22,000	15,000	7,000	43
Honey	Litres	21	Collector	6,040	500	5,540	58
	Litres	24	Village trader	10,000	6,040	3,960	42
Tamarind	Tin	96	Collector	1500	625	875	7.6
	Tin	50	Villager	2500	1,875	625	5.4
	Tin	21	Processors	50,000	40,000	10,000	87
Firewood	Head load	328	Collector	800.60	330.25	470.35	48.5
		370	Village trader	1,300	800	500	51.5
Mushroom	kg	324	Collector	500	170	330	100

On other hand, beverage traders of *Tamarind* fruits were getting higher profit margin than collectors and village retailers. Mushroom collectors were selling the product, directly to consumers that is, they were getting 100% of the profit. Charcoal collectors, were benefiting from the chain by securing about 44.8% of the profit margin while whole seller and village retailers were getting 12 and 43% respectively. Average of TZS 656 667 of the profit was appropriated by a collector per year while TZS 480 000 and 210 000 were earned by whole seller and village retailer of charcoal per year. Honey production was low such that average of 21 litres per annum was extracted per collector per year. The collector profit margin was 52% of the total profit along the chain which involve collectors and retailers. Collectors of charcoal and honey were fewer than village retailers giving them the power to control the market. However, the majority of village retailers were trading

this product on small scale. For instance, one bag of charcoal could be bought by one village retailer and sold for two weeks, giving a profit of about TZS 7 000.

Firewood trade was more favourable to village retailers than collectors. Appropriation of profit margin was more favourable to firewood retailers because were accessible to customers at anytime. Village retailers stay with the firewood at their households and were able to accumulate the product and sell even during low supply. Similarly, Mhapa (2011) reported that large traders were noted to be important as they supplied the products throughout the year. From Table 12, the results showed that collectors of firewood earned an average of TZS 154 274.5/= by selling an average of 328 head loads annually while firewood retailers were fetching about TZS 185 000.

In the market chain of *Tamarind* fruits, collectors were selling the products directly to consumers or to village retailers including beverage dealers. However, the profit margin received was very small, compared to beverage dealers who were getting high profit margin. Value addition to tamarind fruits, made the beverage traders to earn high profit. Engaging in value addition of products is suitable for products under threat of low supply. According to Marshall *et al. (*2006), in the face of decreasing supply of NTFPs, one of the options for ensuring sufficient supply could be the introduction of processing technologies in order to obtain higher values from a more limited resource. Therefore, through value addition local communities can enhance their adaptive capacity to climate change by generating supplementary income through NTFPs harvested despite decreasing supply. This results whereby

collectors of charcoal and honey seem to benefit, are contrary to many previous studies. For instance, World Bank (2009) found that producers of charcoal transported to Dar es salaam capture around one-third of the final price of charcoal, with transporters and wholesalers capturing around half while retailers capture 17%. The difference is due to the length of the chain; in this study charcoal and other NTFPs chain is short, since it involves mainly producers, village retailers and consumers and confined within the study area.

Also cost of transport from production area to market centres and to the household was minimal, about TZS 2000 per bag of charcoal using bicycles. In short chains like this observed at the study sites, according to Marshall *et al.* (2006) are supply driven with collectors making all the key decisions, unlike longer chains, which are almost always demand driven, with actors closer to the consumers determining what is produced, where, when and how. This implied that there is potential for producers of honey and charcoal to benefit along the chain if supply of these products will be improved by eliminating supply constraints facing them. Therefore, for sustainable utilization of these products, there is a need to facilitate improved production of honey bee products by supporting individuals who are practicing traditional methods of extraction which are not useful for sustainable production. Also, efficient charcoal production kiln should be introduced for sustainable utilization, according to Semu (2004), TaTeDo improved kilns may improve efficiency by 34.3%.

4.5.4 Contribution of NTFPs trade to household income

The average amount earned by collectors by selling at least one NTFP product annually was TZS 258 990, contributing about 17% of the total household income (Figure 7). Other sources of income were obtained mainly from annual crops, petty trade, livestock keeping and casual labour, these sources amounted to TZS 1 230 790 per household per year.

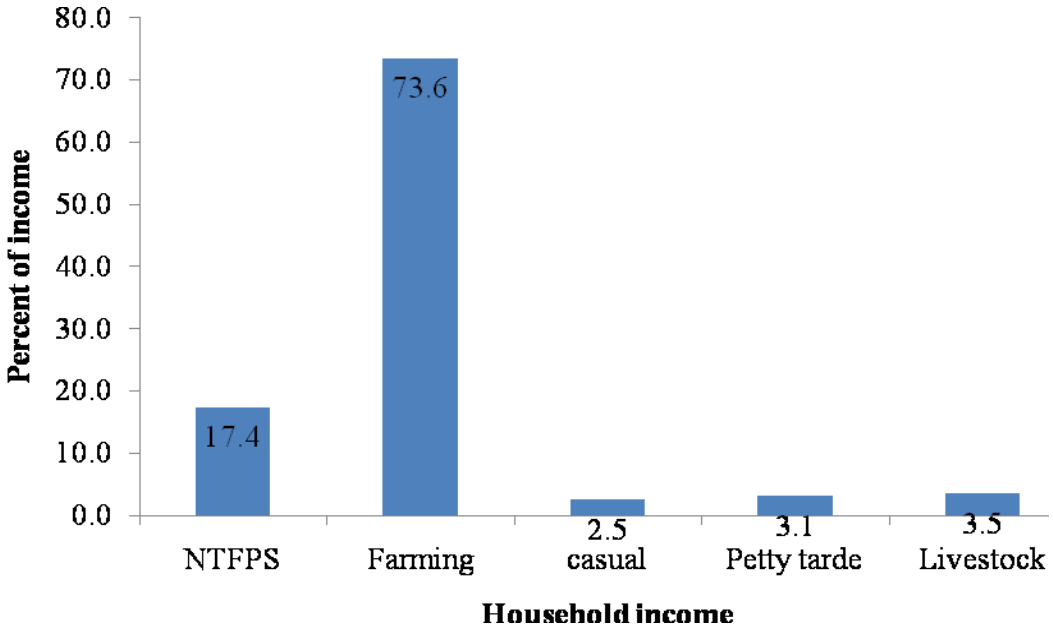

Figure 7: Distribution of household income in the study area

These results are different from other results. Masam (2009) reported that NTFPs contributed about 40% to the household income in Kilolo District where as Nyingili (2003) reported a lower value of 7.5% contribution of annual household income from forest products in Mbozi District. Economic returns from NTFPs can vary widely because of differences in resource access, richness of the forest resource stocks and demand. However, some households generate their income from selling forest products when farm production is not enough. On average, NTFPs

contributed 17% to the total household income. The income generated from sales of NTFPs enabled them to meet various expenses related to food, primary health care and for school fees on daily basis and during adversity such as floods and drought.

4.5.5 Constraints towards commercialization of NTFPs in the study area

Commercialization of NTFPs in the study area faces a number of challenges. These challenges range from supply to demand. Supply of NTFPs was constrained by decreasing forested areas due to expanded farming, seasonality of products and changes of weather patterns. There were also variations in demand of several NTFPs. About 55% of the village retailers surveyed reported that low and unreliable supply of NTFPs was the main constraint in their business while about 30% claimed that low demand of firewood during non- rainy months was one of the problems which prevent for them from engaging in the business throughout the year. There was also low supply of mushroom due to loss of habitat and seasonality. Low supply in some months underscores the importance of adoption of simple technologies of processing and storage as well as domestication of various NTFPs such as wild mushrooms.

Other constraints were the harassment from game warden and some members of village environmental committee. In two incidences, firewood vendors from Mngeta village were arrested and their produce confiscated, being alleged to posses forest produce illegally, though firewood in question were collected from their homestead. Forest produce dealers should be given directives by foresters on proper procedures for conducting their businesses legally.

In the *Tamarind* market chain, collectors were not able to process and sell the beverage due to their low income which makes them unable to buy inputs for processing and packaging. Equipments, such as refrigerators, blender and electricity are important for running beverage trade, including beverage from *Tamarind* fruits. Commercialization of *Tamarind* fruits in the study area seems to increase the value of the commodity but their contribution to collectors was low. Value addition was beneficial to beverage traders who were businessmen in the village markets with capital enough for adding value to products. Failure of collectors to benefit from NTFPs trade conform to Arnold and Ruiz Peres (2001), who reported that commercialization, help the wealthier rather than the poorer that do not have the skills and technologies to benefit from market opportunities. Collectors around IFR can be empowered by organizing groups which can be easily supported financially and technically.

4.5.6 Marketing opportunities of NTFPs in the study area

Through market surveys conducted at the study area and Ifakara town, there are some NTFPs which can be sold at Ifakara. *Tamarind* fruits, mushroom and charcoal seem to attract the collectors to send their products there (Table 14).

Table 13: Prices of some traded NTFPs from the study area

		Price in various markets TZS			
NTFPs traded	**Unit**	**Tandale/Igima**	**Njage**	**Mngeta**	**Ifakara**
Firewood	Headload	1 000	1 000	1 500	-
Charcoal	Bag	17 000	17 000	20 000	20 000-30 000
Bush meat	Kg	3 000	3 000	3 000	4 000
Tamarind fruits	Tin	3 000	3 000	3 000	-
	Kgs	300	300	300	1 000
Honey	Litre	10 000	8 000	10 000	12 000
Mushroom	Kgs	600	1000	1000	4 000

However there are some constraints which are not favourable. Currently transport cost is high and products like mushrooms are perishable unless processed. If the road from Mngeta to Ifakara will be improved to a tarmac status cost of transport will decrease, and therefore improve profit margin of the collectors, especially if they transport themselves to major market areas. Processing and preservation of wild mushrooms, also can lead to opening outside market and in turn improve income of collectors.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study dealt with the assessment of total economic value of selected NTFPs and its implication for adaptation to climate change by communities around Iyondo Forest Reserve in Kilombero District, Tanzania. The study estimated the value of NTFPs and ecosystem services in order to understand the importance of these forest products and services to the livelihoods of communities living adjacent to Iyondo Forest Reserve.

According to the results and discussion, 14 priority NTFPs for subsistence use and trade were identified, these were firewood, thatch grass, tool handles, poles, bush meat, medicinal plants, wild vegetables, wild mushrooms, withies, ropes, wild fruits, charcoal, honey and pastures. Among these products, NTFPs used for both subsistence and trade were firewood, thatch grass, wild mushroom, poles, bush meat, medicinal plants, wild fruits, charcoal and honey. NTFP traded in large quantities were firewood, mushroom and bush meat. These products were important for local communities surrounding IFR for their livelihoods and during adverse climatic conditions.

Several factors influenced supply and demand of these products. Social economic factors that influenced supply were household income, household size and distance. Farmers with low income and big household size, who are adjacent to IFR, seem to get more income from NTFPs possibly because of their high vulnerability to

economic shocks and food insecurity due to climate variability. Distance influenced the households negatively, whereby household income increased with decrease in distance from natural forest. Other factors that affected supply of NTFPs were existing tenure systems, seasonality and scarcity caused by increasing population, expansion of farms, occasional floods, drought and increased restriction from accessing resources of IFR and fire occurrences. Demand was influenced by household size and marital status, household with big family size and married were spending more income on various NTFPs than otherwise.

Total Economic value of selected NTFPs and forest ecosystem services, were obtained from 12 NTFPs, that is Firewood, thatch grass, tool handles, poles, bush meat, medicinal plants, wild vegetables, wild mushrooms, withies, ropes, wild fruits and honey. Forest ecosystem services were estimated from water, biodiversity and non use values. TEV for both NTFPs and forest services amounted to TZS 20 523 473 790. This is the value of NTFPs and ecosystem services which indicates the socio-economic contribution to sustainable livelihoods for communities surrounding IFR areas. It will enable the local communities and other stakeholders to appreciate the importance of forests in provision of various products and in enhancing adaptation to climate change and variability and participate in conservation of IFR and other forests in general.

Four market value chains were identified. Main actors in these chains were Collectors, Village retailers, Processors and Consumers. Distributions of profit margin between NTFPs were not uniform. Collectors of charcoal and honey were

getting higher profit margins than retailers. However retailers of firewood were getting higher profit margin than collectors. Beverage traders were getting higher profit margins than collectors and retailers of tamarind fruits, as a result of value addition. Wild mushroom were the only product sold directly to consumers due to its perishable nature.

5.2 Recommendations

Based on the fact that the economic value of the forests shows communities' benefits from the forest reserve, the following are pertinent recommendations:-

(i) To improve future availability of various NTFPs, communities should be sensitized to practice agroforestry and to establish community woodlots so as to cater for various needs for food, energy, construction, primary health care and trade.

(ii) The study has indicated that NTFPs are collected by communities of low income and big family size. To improve livelihoods of forest adjacent communities at this period where supply of NTFPs is decreasing due to changing rainfall pattern and expansion of agriculture, they should be encouraged to engage in alternative income generating activities such as beekeeping.

(iii) Since the TEV of the forest highlight the importance of the forest for communities' livelihood through provision of products and services, including importance of forests in enhancing adaptive capacity to climate

change and variability, then planned adaptation is required to create awareness on the value of biodiversity and water loss as a result of poor conservation of forest resource.

(iv) To ensure benefits to various actors along the market value chain as well as sustainability of the products traded, preservation and value addition of products is important.

(v) Economic valuation studies of other forest ecosystem services from IFR e.g. erosion control and carbon sequestration under the changing climatic condition should be done so as to capture full value of the Nature reserve and its potential to dependent communities.

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APPENDICES

Appendix 1: Questionnaire for households' survey to collect information on total economic value of NTFPs from villages surrounding Iyondo Forest Reserve

Section A. Background information

1. Questionnaire number----------2. Division----------

3. Ward----------4. Village----------. 5. Date----------

6. Name of the household head----------

7. Name of the respondent----------

8. Marital status [01]. Single [02]. Married [03].Widowed [04]. Divorced----------

9. Sex of household head [01[. Male [02]. Female

10. Age of respondent.....

11. Education [01]. None [02].Primary level [03]. Secondary level [04] Tertiary

12. Occupation [01]. Employed [02]. Farmer [03]. Business [04]. Others (specify]

13. Number of people in the household----------

Section B: Information on NTFPs

14. Do you collect/were you collecting NTFPs? 01. Yes 02.No. If No go to question

15. What type of NTFPs do you collect /were you collecting?

NTFPs collected	Collector 01 02 03 04 05	Unit (bundles, Bunch etc)	Time in hrs	Season	Source 01. FR 02. VFR 03.Farm lands			Frequency of collection			Actual amount collected per		Total cost
								Days/week	Days/ month	Days/year	Own use	Trade	
Poles													
Firewood													
Withies													
Charcoal													
Medicinal plants.													
Wild veg.													
Mushroom													
Wildfruits													
Thatches													
Ropes													
Bushmeat													
Honey													
Wild tubers													

Key: Who collects NTFP: 01= women, 02 = men, 03 = children, 04 = men and women 05 All

16. Do you buy NTFPs [01]. Yes [02]. No if yes what type of NTFPs

Product	Unit	Amount bought per annum		Price/unit	Total amount bought	Total cost
		Own	Trade			
Poles						
Firewood						
Withies						
Charcoal						
Medicine						
Wild vegetables						
Mushroom						
Thatches						
Ropes						
Bushmeat						
Wild tubers						

17. To whom do you buy NTFPs? [01] Collectors [02] retailers

18. Do you have any other source of income apart from selling NTFPs [1] Yes [2] No.

If yes how much do you earn from those sources ?

Item	Total amount (TZS)
Formal employment	
Casual labour	
Business	
Liverstock keeping	
Farmer	
Others (Specify)	

19. Availability and amount of NTFPs collected per household.

Months/season	Available NTFPs	Distance (km)	Amount collected

20. What problem(s) do you face during collection/extraction of NTFPs?------- ------

21. Have you ever experienced drought periods? 01. yes 02. No

22. If yes when?.....

23. If yes what types of food/NTFPs or strategy did you use during drought due to climate variability?----------

24. Which factors forced you to collect NTFPs?

[01]. Financial constraints [02]. Lean season [03]. Lack of alternative source of income [04]. Others (Specify)

25. What types of NTFPs do you sell during drought period----------

26. How much do you earn during such period?----------

27. Where do you sell collected NTFPs? [01]. Village markets [02]. Surrounding villages [03]. Infront of your house [04]. In town market 05. Others

28. What is the trend of NTFPs availability in your area for the past 5 years [01] increasing [02] decreasing [03] constant. Why do you think so?.....

29. Do collection and sales of NTFPs improve your living condition? 01 Yes 02 No

30. If yes, in which area NTFPs help you? 01 food needs 02 School fees 03 Others specify

Section C : Value of services

31. Which forest services from Iyondo Forest Reserve are important to you? Circle them 01. Recreation 02. Watershed protection 03. Biodiversity conservation 04. Sacred graves 05. Worshipping.

32. How much are you willing to pay in order to maintain them?

No	Service	Payment mode	Maximum WTP
1	Recreation (Camping/picnic)	Per visit	
2	Watershed protection	Through water bills	
3	Biodiversity conservation	Monthly	
4	Visiting camping sites	Per visit	
5	Visiting worshiping sites	Per visit	

33. How many buckets of water do you draw per day?

THANK YOU FOR YOUR COOPERATION!

Appendix 2: Market Survey questionnaire

Section A. Background information

1. Questionnaire number----------2. Division----------

3. Ward----------4. Village---------- 5. Date----------

6. Name of the market----------

7. Name of the vendor/actor----------

8. Marital status [01] Single [02] Married [03] Widowed [04]. Divorced----------

9. Sex [01]. Male [02]. Female

10. Age of the respondent.....

11. Education level [01]. None [02]. Primary [03]. Secondary [04] Tertiary level

12. Occupation [01]. Employed [02]. Farmer [03]. Business [04]. Others

13. Number of people in the household.....

14. Specify your involvement in NTFPs market chain 01. Collector and Seller 02. Seller

and buyer 03. Transporter and Seller 04. Buyer 05. Others specify

Section B: Information on NTFPs traded

15. What types of NTFPs do you normally sell at the

market.....

16. What is the price of each NTFPs that do you sell .....

17. Where do you get NTFPs for sale [01]. Collect yourself from the forest

[02].Buy from collectors.....

18. What are types of NTFPs bought and the corresponding costs?

NTFP	Buying price per unit	Quantity bought	Mode of transport	Transport Cost per

19. Do you incur any other costs apart from Transport cost?

Activity	Type of NTFPs	Quantity	Unit (TZS)	Total cost
Packing				
Loading/offloading				
Others (Specify				

20. If you collect the NTFP from from the forest and sell directly to consumers fill the table below----------

NTFP product	Time spent collecting (days)	Transport cost to the market	Cost of collecting

21. What types of transport do you use and how much do you pay?

Mode of Transportation	Cost	Distance (km)
Bicycle		
Motorbike		
Vehicle		

22. Indicate number of your customer per week from the following categories

Customer/week	No.	%
Local buyers for consumption		
Local buyers for resale		
Traders outside this village/town		
Others specify		
TOTAL		

23. Apart from trading on NTFPs mention other activities you are engaged with-----

---

24. What is your average income from this activities per month?

25. Are you are a permanent dealer of NTFPs [01]. Yes [02]. No

26. If no, when do you engage in NTFPs trading? 01. When there is drought 02. When you run short of staple food 03. When no farming activities. 04 others specify

27. Please rank the importance of income from NTFPs as compared with other sources of income [01]. Most important [02] Important [03] Less important [4] Not applicable

Section C: Availability

28 . How frequent do you sell the NTFPs? [01]. Daily [02]. Weekly [03]. Monthly

29. Is the level of supply uniform the whole year? [01] Yes [02] No

30. What are types of NTFPs sold during drought or floods. Please fill the table below

NTFPs	Unit price in TZS		Supply	
	Flood	Drought	High/Low	High/Low

31. What factors affect supply apart from weather condition?

[01]. Law enforcement [02]. Accessibility [03]. Availability from the forests [04] Drought

32. How is trend of quantity supplied within the five years [01]. Increasing [02]. Decreasing [03]. Moderate [04]. Not known.

33. What is the trend of price within the 5 years? [01]. Increasing [02]. Decreasing 03. Moderate [04]. Not known.

34. What did you observe when the market of the NTFPs increase?

[01]. Producer/supplier also increase price [02]. Producer retain old price [03]. Producer increase supply [04]. Producer increase supply.

35. What is the demand of NTFPs during drought condition?

[01]High [02] Low [03] constant [04] unknown

36. If demand of NTFPs is high during drought condition, do you meet the demand?

[01] Yes [02] No.

37. If No why demand is not met?

[01] low supply from the forest [02] law enforcement [03] other reason specify.....

38. What are constraints facing the trade of NTFPs (Specify type of NTFPs and problems faced)----------

Section D: Collectors cost

39. If, you don't have NTFPs to sell what alternative activities do you engage with.....

40. What can you earn per day from those activities.....

41. What amount of NTFPs for selling can be collected per day

NTFPs	Units	Amount collected per day	

Appendix 3: Participartory Rural Appraisal checklist

Participatory Rural Appraisal ranking of the contribution of NTFPs to households

1. List all the types of NTFPs normally used in your own households or that you know other households use-------

2. Rank the NTFPs below according to their importance to the livelihood and when there is poor yield due to adverse climate condition.

S/N	**NTFPs**	**Rank**														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Firewood															
2	Charcoal															
3	Mushroom															
4	W/vegetable															
5	Wild Fuits															
6	Thatches															
7	Poles															
8	Ropes															
9	Withies															
10	Bushmeat															
11	Honey															
12	Wild Tubers															
13	Recreation															
14	Worshiping															
15	Water															

Appendix 4: Pair wise ranking by respondents surrounding IFR on NTFPs

	F/wood	Charcoa	Thatch	M/room	B/meat	Wld	Medicinal	Poles	Veg	Ropes	Withies	Honey	Pastures	Handles
F/wood		Fwhr	Fw	fw	Fw	Fw	fw	fw	Fw	fw	Fw	fw	fw	Fw
Charcoal			Thatc	m/room	B/meat	w/fruits	Med	Poles	Chrc	rope	Char	honey	chr	Handle
Thatch g				Thatc	Thatc	Thatc	thatch	Poles	thatch	thatch	thatch	thatch	Thatch	Thatch
M/room					B/meat	Mush	medc	Poles	mush	m/room	Withies	mushr	M/room	Handles
Bushmeat						B/me	B/meat	Poles	B/me	B/me	B/me	b/meat	B/meat	Handles
Wildfruits							Medicin	Poles	Veg	Ropes	Withies	w/frts	W/fruits	Handles
Medicinal								Poles	Medcn	Medcn	Withies	Medicin	Medicinal	Handles
Poles									Veg	Poles	Pole	Pole	Poles	Handles
Vegetables										veg	Veg	veg	Veg	Handles
Ropes											Withies	Ropes	Ropes	Handles
Withies												honey	Withies	Handles
Handles												Handle	Handles	
Honey														Handles
Pasture													Honey	
Total scores	**13**	**3**	**10**	**5**	**8**	**3**	**7**	**9**	**4**	**4**	**5**	**3**	**0**	**10**
Ranking	**1**	**12**	**2**	**8**	**5**	**11**	**6**	**4**	**7**	**10**	**9**	**13**	**14**	**3**

Appendix 5: Pair wise ranking for forest services

Service	Water/Precipitation	Recreation	Biodiversity	Worship	Ranking
Water					1
Recreation					3
Biodiversity					2
Worship					4

Appendix 6: Cost incurred by a collector

S/n	**NTFPs**	**Unit**	**Daily average production**	**Cost description**	**Unit cost TZS/unit**
2	Mushroom	Bucket/Tin	3	Collection cost = 1*5,000/3	1,700.00
3	Firewood	Headload	15	Collection cost = 1*5,000/15	330.00
4	Wildfruits	Bucket	8	Collection cost = 1*5,000/8	625.00
6	Honey	Litres	10	Collection cost = 1*5,000/10	500.00

Collection cost = Mandays x Wage rate/Quantity sold

Appendix7: Cost incurred during charcoal making

S/N	Activities	Cost per kiln	Production per kiln (Bags)	Average cost per bag
1	Tree felling activities	8,000	4	2000
2	Other charges	2800	4	700
3	Total	10800	8	2700

S/n	NTFPs	Unit	Average production	Cost description	Cost (TZS)
1	Tamarind juice	Litres	50	Proccessing time (Labour time) = 8hrs	5,000
				Sugar for 50 litres	25,000
				Cost of 1 tin of fruits	3,000
				Electricity	7,000
				Total	40,000

Appendix 8: Monthly rainfall (mm) report at Idete Prison, Kilombero District

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1980	145.6	103.4	311.3	403.2	152.4	0	6.6	1.1	14.6	44	98.8	221.6
1981	260.1	119.5	210.5	314.5	175.6	0	0	12.7	4.7	22.6	30	149.8
1982	52.9	87.2	348.8	363.6	178.6	30.8	36.5	8	30.5	142.2	206.5	372.7
1983	120.5	110.6	467.8	258.2	163.4	3	0	0	0	0	0	189.9
1984	179	211.8	286.5	336.8	108.7	34.3	32	0	0	56.9	143.4	406.6
1985	113.8	132.7	253.7	215.5	63	10	5.3	12	0	5	177	36.8
1986	342	126	281	423	140.5	3.5	3.5	3.5	0	7.4	87.4	321.3
1987	303.8	181.7	98.5	158.7	124.6	0	47.1	0	0	7.3	96.9	58
1988	183.3	162.1	286.3	170.6	72.4	137.7	0	0	0	30.8	85.2	175.4
1989	235.4	39.5	76.3	31.5	250.6	59	10.8	26	0	20.2	65	198.2
1990	102.5	254	308.2	529.4	112.6	18.7	24.1	21.8	8.5	2.4	105	152.4
1991	134.3	106.5	143.1	167.6	121.2	0	0	0.4	0	0	0	104.7
1992	166.8	150.6	114.75	226.05	251.6	1.6	1.45	3.7	0	0.1	7.75	52.35
1993	199.3	194.7	86.4	284.5	381.9	3.2	2.9	7	0	0.2	15.5	0
1994	167.7	165.3	173.65	182	77	0.5	0	0	33.3	1.8	57.8	15.5
1995	215.3	516.8	488.7	384.5	295.9	0	11	0	0	0	1.8	52.8
1996	270.9	209.9	296.2	384.9	130.6	2.3	0	11	0	0	0	1.8
1997	124.5	57.1	176.6	89.7	3.3	16.4	0	0	0	36	82.1	314.1
1998	196.8	132	109	136.5	35.7	0	0	0	9.2	0	0	0
1999	123.5	99.5	400.5	562	51.5	13.5	0	98	0	0	0	154.9
2000	175	132.5	290	163.5	14	0	12.6	1.5	0	0	219.5	867
2001	96.8	132	109	136.5	35.7	0	0	0	9.2	0	0	0
2002	169.9	150	294.7	388.7	30.3	0	0	0	10.4	23.7	7.4	57.8
2003	147.8	196.4	230.9	110.9	66	0	8.4	0	0	15	0	78.5
2004	399.1	217.2	143.7	272.8	0	17.5	4.6	0	6.4	61.4	88.3	130.5
2005	316.1	195.8	428.4	268.05	107.7	5.5	0	0	4.3	45.5	41.2	0
2006	93.9	191.4	176.9	521.9	127.7	52.4	5.7	20.9	21.4	8.9	36.2	387.4
2007	159	82	362	201	101	14	0	28	0	0	0	20
2008	207	256	273	454	26	5	10.6	2	1.5	8.5	4.2	200.7
2009	33	268.5	148.7	193	70.6	51.4	0	85	0	0	124.8	141.1
2010	157.4	200.1	242.8	160.45	78.1	23.2	4.1	0	0.7	0	133.1	70.7