A COMPARATIVE ANALYSIS OF RANDOM UTILITY MODEL AND CONTINGENT VALUATION ESTIMATES OF NON-TIMBER FOREST PRODUCTS' INCOME IN SOUTH NANDI, KENYA

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL ECONOMICS, UNIVERSITY OF ELDORET

SEPTEMBER, 2013

DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for a degree in any other University. No part of this thesis may be reproduced without the prior written permission of the author and/or University of Eldoret.

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DEDICATION

I dedicate this thesis to my sons, Pistos Lapkey and Nikao Kalya, for inspiring this accomplishment.

ACKNOWLEDGEMENTS

In pursuance of an academic study of this magnitude it is impossible to accomplish much without the support of others. These people gave their time, talent, moral and material support to this research. Without reservations, my gratitude goes to Dr. Anderson Kipkoech and Dr. Wario Adano, my supervisors, who put their energy and knowledge to this thesis. Your constant encouragement, patience and invaluable guidance are highly appreciated. May God richly bless you. The School of Environmental Studies provided an academic environment that stimulates intellectual reasoning.

Special thanks go to my wife, Salome, for her unfailing love and tolerance. This is much appreciated especially given that I suspended my attention to my family for this onerous task. Above all, I would like to thank the Almighty God for His grace and great favour in this academic journey. Thank you Jesus!

ABSTRACT

Non-timber forest products (NTFPs) provide a variety of economic benefits to forest-adjacent communities in rural economies. However, forest products exhibit non-competing consumption and lack market-driven excludability, subjecting them to open access degradation. To identify market inefficiencies and propose better policies, this study compares revealed and stated estimates of non-timber forest products' incomes in South Nandi, Nandi County of western Kenya. Using survey data of 224 households located within a four km radius of South Nandi forest, income diversification strategies are examined by applying the inverse Simpson index of diversity. Regression analysis is used to evaluate the factors that influence forest income dependency. Convergence and criterion validity tests are employed to compare the economic values obtained from random utility model and contingent valuation estimates. The benefits of NTFPs in the rural household welfare, and the local economy of South Nandi are assessed using compensating variation and Gini coefficient analyses. The results show that forest-fringe households use off-farm and forest portfolio of activities in constructing income diversification programs. The income index of diversity measure shows the farm income stream as financially secure and stable. The NTFP income had a strongly equalizing effect (Gini reduction of 9%) contributing 24% of the household income while farm and off-farm incomes contribute 54% and 22%, respectively. The compensating variation analysis demonstrates that when disposable income reduces marginally, households with low education fall back on the local environmental resources than those with high education and the households are not willing to use off-farm incomes to compensate for a reduction in NTFP incomes. The findings of Random utility model (RUM) and Contingent valuation method (CVM) preferences reveal significant correlation (0.611, $p<0.01$) and confirm similarity of the theoretical construct of the two approaches. These methods, however, yield significantly different willingness to pay mean values (CVM had KSh. 4,033 and RUM KSh. 68,261, $p<0.05$). CVM construct validity tests reveal a systematic relationship between key socio-economic variables (farmland size, forest proximity, off-farm income, number of household cattle) and the households' willingness to pay (WTP), which demonstrate that contingent bids are consistent with theoretical expectations. Hence, the difference in the households' stated and revealed preferences amounts cannot be adequately explained on the basis of economic theory. The main reasons of the difference could be that the CVM bids were capped by the low forest permit fees as demonstrated by the strong correlation between Maximum WTP values and NTFPs user fees charges (0.602, $p<0.01$). Lack of pricing of most forest products and the weak enforcement of institutional arrangements governing use of forest resources affect availability of environmental markets leading to undervaluation in the contingent market. The study concludes that the RUM and CVM preferences converge in the predictors for the WTP bids but diverge in the valuation estimates. The RUM is more effective in valuing NTFPs, but the CVM bid function give qualitative information that can be used to support design and planning of forestry programs that incorporate improved rural incomes for sustainable management of forest resources. The revealed and stated preferences' convergence analyses can be used to reconcile and determine economic values of environmental commodities as well as understand underlying drivers of the rational economic decisions in both the expressed and contingent markets. Restricting access of the rural poor to NTFPs might have effect of increasing income inequalities with substantial impacts on households' welfare. Reliable compensating welfare analysis can guide policy makers in determining compensation measures in situations where forest resources become unavailable to the forest dependent households. The study recommends the establishment of an independently managed Forest Trust Fund at the county level to finance regulation and management of South Nandi forest.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA – Analysis of Variance

CFA - Community Forest Association

CVM – Contingent Valuation Method

DI – Diversification Index

FAO – Food and Agriculture Organization

FTF - Forest Trust Fund

GDP – Gross Domestic Product

KFS – Kenya Forest Service

NTFP – Non-Timber Forest Products

OLS - Ordinary Least Squares

RUM – Random Utility Model

TCM – Travel Cost Method

WTP – Willingness to Pay

DEFINITION OF KEY TERMS

Non-Timber Forest Products is used in this study for biological materials of forest plants and animals excluding timber resources, and is specifically medicinal plants, foods and fibres, firewood, mushrooms, vegetables, forest fishing, honey and livestock fodder.

Household total income is defined as Cavendish (2002) as the sum of cash income from various economic activities (e.g. crop and livestock production, non-timber forest products, small-scale activities) and the monetary equivalent of a household's subsistence use of the output of these activities.

Forest Income (or **NTFP income**) means income from Non-Timber Forest Products.

Index of Income Diversification is a diversity variable which expresses households' level of constructing various portfolio of income activities.

Farm Income is that income generated from agriculture and livestock activities.

Off-farm Income expresses the income from sources outside farm and forest incomes.

Regular (Formal or Normal) Income is combination of Off-farm and Farm incomes exclusive of forest incomes. This is equivalent to the Household total income.

CHAPTER 1

INTRODUCTION

1.1 Background to the Study

Forests cover 26% of the Earth's land surface and are home to over 80% of world's terrestrial biodiversity (The World Bank, 2008). Africa has about 16% of global forests and East Africa contributes only 13% of this figure, while over 65% of Africa's forest resources is concentrated in Central and Southern African regions (Kowero, 2008). Tropical forests around the world suffer high degradation and deforestation rates of about 17 million hectares or 1% of total forest area each year (Illukpitiya et al., 2010). Forest degradation is associated with the loss of valuable ecosystem resources and services (Börner et al., 2009). One of the prime causes of declining forest cover in Africa is conversion of land for agricultural activities (Shone et al., 2006). Forest goods are important sources of livelihoods for forest fringe households (Das, 2010) and hence are under pressure to provide production and environmental benefits (Mutenje et al., 2011). Poor people often depend heavily on the productivity and environmental services of natural resource ecosystems for as much as 30 to 50% of total incomes (The World Bank, 2004). As the availability and quality of such resources decline, these livelihoods are threatened.

Non-timber forest products contribute to household income economy in three major ways: First, they provide domestic subsistence and consumption requirements (Vedeld et al., 2007; Heubach et al., 2011) such as vegetables, medicinal herbs, firewood, wild-foods and fruits, which are primarily consumed within the household. These NTFPs acts as substitutes to marketed commodities and therefore, their use increase disposable income to the household. Second, they serve as insurance premium in times of economic hardships (Nasi et al., 2002; Shackleton et al., 2004; Paumgarten et al., 2009). Forests provide useful products and services during periods of financial distress among households. In times of agricultural shocks like sudden collapse of milk demand, unexpected decrease in prices of key sources of income like tea, coffee, maize crops and livestock products or drought, the forest resources become providers of natural insurance. Third, NTFPs contribute to direct monetary benefits through sales. Some of the commercialized products whether *ad hoc* or full time include honey, fish, medicinal plants and livestock that graze throughout or partially in the forest (Shackleton et al., 2004; Heubach et al., 2011). NTFPs have been defined as encompassing all biological materials of forest plants and animals excluding timber resources, which include medicinal plants, foods and fibres, firewood, mushrooms, vegetables, resins, game, honey and livestock fodder (Mutenje et al., 2011; CIFOR, 2011; Heubach et al., 2011).

In sub-Saharan Africa, rural households are generally involved in income diversification strategies to improve domestic income and to meet other livelihood needs (Vedeld et al., 2007; Tesfaye et al., 2011). Income diversification is defined as the process by which rural families construct a diverse portfolio of activities in order to survive and improve their living standards (Ellis, 1998). Households that depend on forest resources have agriculture, non-farm or/and forest products as primary income sources (Illukpitiya et al., 2010). Forest resource activities have been used by peripheral communities in constructing diversification programs whose goals range from risk reduction, reaction to crisis, to wealth accumulation (Valdivia et al., 1996; Ellis, 1998; Barret et al., 2001). Globally, the demand for non-timber forest products (NTFPs) reached 4.7 billion U.S dollars per year by 2005 (The World Bank, 2008). NTFPs have contributed significantly to incomes in developing countries (Heubach et al., 2011).

Despite the contribution of NTFPs to total household income ranging from about 20% to over 50% (Cavendish, 2000; Shackleton et al., 2005; Kamanga et al., 2009; Illukpitiya et al., 2010; Das, 2010), the value of these forest goods and services has, for many years, been neglected or underestimated and have not been factored in household or national income accounting (Emerton, 1997). Apart from NTFPs improving human welfare among forest margin communities, the forest is important in biodiversity conservation, carbon sequestration, hydrological services, cultural services, provision of scenic beauty and the critical role in supporting other production systems (The World Bank, 2008). On the one hand, most of forest benefits have no market price, while those with market price the marginal costs of environmental service provision are often below the marginal benefits, and hence the beneficiaries normally do not bear the real cost of their consumption in the private market environment. On the other hand, the adjacent communities incur opportunity costs as custodians of continued provision of these benefits not only to themselves but other distant economic units.

The challenge facing management of forest products in many developing economies is internalization of forest benefits by the consumers of these resources. Proper pricing of NTFPs and effective payment mechanisms help efficiently allocate these resources. An effective pricing system discourages overexploitation and illegal resource extraction while ensuring that the prevailing value of the products is reflected in access and consumption of the forest goods and services (Börner et al., 2009). Local communities' involvement in the pricing of these goods, if properly managed to avoid it becoming a means of devaluing high value NTFP resources, can potentially bring about better livelihoods of the poor, equitable distribution of forest benefits and sustainable extraction of the forest-based resources (Dhakal et al., 2009).

Proper pricing of NTFPs that adequately reflects local environmental and economic values serve the purpose of discouraging excessive exploitation of resources (Börner et al., 2009) and also contributing to the better livelihoods of the local poor. This also enhances equitable distribution of forest benefits and encourages sustainable extraction of the forest resources. Studies by Emerton (1997) in Kenya shows that non-timber forest products account for nearly 40% of the overall value of quantified household forest use and sometimes provide additional value for local people over and above the market price. The role of non-timber forest products has been demonstrated in the monetary quantification of the resources, as well as their contributions to total household incomes (Campbell et al., 2002). The economic valuation of these goods not only assist policy makers use environmental market-based instruments such as taxation, subsidies and marketable permits but also assist them make objective judgment on the worth and sustainability of forest projects (Kula, 1994). Hence, the development of net streams of NTFP benefits is important for policy formulation, planning and prioritizing scarce financial assistance to conserve these resources.

Economists have developed several valuation methods of environmental goods. Vedeld et al. (2007), Heubach et al. (2011) and Mutenje et al. (2011) have used market-based approaches in valuing non-timber forest products. Non-market approaches to the valuations of forest goods have increasingly been appreciated and used in recent years (Amirnejad et al., 2006; Delang, 2006; Venn et al., 2007). The income benefits and domestic consumption functions of NTFPs can be measured by revealed preference methods like random utility method (RUM), but the option values of forest products can only be generated through stated preference estimation such as contingent valuation method (CVM). Price-based approaches require non-market valuation (Venn et al., 2007) and hence, CVM assists where better pricing NTFPs is policy goal. The primary purpose of RUM estimates for forest products is to compute benefits measures (Herriges et al., 1999) and distribution of the NTFP income benefits among the users. RUM and CVM methods both are based on consumer theory and hence reflect the same choice process (Brown et al., 1989; Whitehead, 2000). This means that, ideally, the RUM and CVM estimates should yield the same results. In practice, however, factors such as cultural impacts on valuation, risk aversion, environmental awareness, range of options available to respondents and other socio-economic drivers of human behaviour may cause inherent differences in the magnitude of values obtained from the real and hypothetical markets (Urama et al., 2006).

This study presents a comparative analysis of random utility model and contingent valuation method estimates of NTFP incomes. The study assesses the importance of the forest resources in household income in South Nandi of Kenya. South Nandi forest is one of the few fragments of tropical rain forests in the country that are under constant threat of degradation due to market and institutional failures, resulting from the poor pricing of forest goods and ineffective payment system. The majority of the households in the South Nandi area are smallholder subsistence farmers who depend on one to less than a hectare farm plots for food production and income generation (Republic of Kenya, 2010). Since this area is agriculturally rich (fertile soils, receives adequate rainfall etc) the opportunity costs of conserving the forest, which accrue mainly from the forgone incomes from agricultural productivity, is high. The area's rural residents rely directly, like other forest peripheral households in developing countries, on the services of natural capital stocks and intricately interdependent on forest resources for their daily livelihood needs (The World Bank, 2004). The main challenges facing development and forest managers in the South Nandi region are poverty and inequality reduction among the forest-adjacent rural households and the protection of forest ecosystems, which provide NTFP services for an increasing growing population. In order to adequately price NFTPs and design efficient payment mechanism, economic valuation of these resources is required. Comparison of RUM and CVM valuation estimates assists in incorporating both the marketable and non-market resource benefits of NTFPs in efficient policy management of forest goods.

1.2 Problem Statement

Non-timber forest products are commodities that are not under the control of any of the households while the formal pricing mechanism does not determine the amount consumed. Since NTFPs exhibit non-competing consumption among the forest-fringe dwellers and lack market-driven excludability, these commodities become open to unsustainable overexploitation. The extraction and utilization of non-timber forest goods and services are economic activities that send signals to the formal market system which when not appreciated distort the prices of these goods and create a shadow market system that is adversarial to efficient allocation of forest resources (Common, 1988; Perman et al., 2003; The World Bank, 2008). In order to avoid overuse and undersupply the forest resources need to be priced adequately (Börner et al., 2009). But efficient pricing system is realized only if the prices of NTFPs reflect the local values (Börner et al., 2009) and nearby households are involved in the pricing (Dhakal et al., 2009). Pricing of forest goods are not only important for allocation efficiency but also has a vital role in indicating the relative scarcity of the resources (Barbier, 1989). Hence, the extraction and consumption (directly in the household or through sales) of non-timber forest products in Kenya have been allocated at sub-optimal price within the market economy from the production source through to the consumer leading to over-extraction and degradation of the natural resources.

The economic benefits of non-timber forest products are shared among the rural users and economic units depending on the household's specific characteristics. Contextual attributes may also influence the use of these resources at the household level (Mamo et al., 2007). When peripheral communities do not enjoy the full benefits of forest ecosystem services they are not motivated to conserve them either (Arnold et al., 2001). The Kenya's national economic survey does not recognize economic valuation of forest resources as a policy instrument for enhanced income growth and management of the scarce natural assets (see Republic of Kenya, 2010). By ignoring the role of NTFPs in household income diversification strategies, as evidenced by exclusion in national or county income accounting, policy planners not only distort the economic values of these resources but also send a misleading message that whatever is not marketed, or have a market price, does not have economic value and hence not worthy of protection (Delang, 2006). In the process policy planners would distort the actual functioning of rural economies and the extent of rural poverty and income inequalities (Babulo et al., 2009). This definitely would lead to incorrect development plans and forest management policies. Hence, lack of monetary valuation of the contribution of NTFPs to welfare improvement understates the economic importance of forest goods and services to the household, local and national economy. Concomitant to this is unregulated extraction and overutilization of forest resources resulting in irreversible environmental impacts and endangering rural livelihoods.

The traditional income sources in the study area are variable/fluctuate and therefore risky. With poverty rates of over 46% (Republic of Kenya, 2011) people in South Nandi resort to forest goods to offer an alternative source of income as an income diversification strategy. The income diversification is to even income throughout the year, reduce consumption risks, cope with weather variability and to meet anticipated future domestic needs. However, its contribution in South Nandi is not known and hence the need for estimating the value of NTFP in the area of research. Most of these products do not have a conventional market, hence the need to use valuation techniques. Some valuation studies have quantified economic values of non-timber forest products (see Godoy et al., 2000; Emerton et al., 2001; Gavin et al., 2007) using various methods. Some of these are;

participatory environmental valuation, opportunity costs method, exchange value method, contingent valuation and random utility method (Delang, 2006; Amirnejad et al., 2006; Venn et al., 2007; Börner et al., 2009; Tesfaye et al., 2011). The monetary value of the non-market forest resources can be inferred from prices paid in real monetary exchange in the market place in which the revealed preference value for the NTFPs can be represented in a random utility model estimates. Here, the consumer willingness to pay for the improved commodity provision is depicted by the household investment decisions. The summation of the value of investments already undertaken reveals the preference for the forest goods occurring. This study uses random utility model because of its ability to handle forest products' substitutes and direct measurement of economic welfare, while retaining the strength to test the economic consistency of the revealed and stated preferences (Boxall et al., 2003).

Most NTFPs are traded in informal market while others used for subsistence are not available in the market place and hence their prices may not easily be revealed. In this regard contingent valuation method (CVM) is an important instrument for estimating non-use ecosystem goods and services. The monetary value of forest service improvement is represented in a contingent market. There is an increasing use of combined stated and revealed preference models among environmental economists (Hanley et al., 2003) due to the fact that it increases the amount of information available (Adamowicz et al., 1997) and the possibility of including more variables in models. This study compares random utility model and contingent valuation estimates of non-timber forest products' income in South Nandi. It also determines the impacts of NTFPs on income improvement and reduction in wealth disparities in South Nandi. The results of welfare evaluation in the compensating variation can be used to guide policy makers in determining compensation measures in situations where forest dependent households are deprived of this source of income for example, cattle owners are required to destock from the forest or a massive forest project that alters peoples' consumption patterns.

1.3 Objectives of the Study

The overall objective of this study is to compare random utility model and contingent valuation estimates of non-timber forest products' income in South Nandi of western Kenya.

The specific objectives of the study are:

1. To examine the importance of non-timber forest products to rural households in constructing portfolio programs among income diversification strategies.
2. To evaluate the determinants of forest income dependency.
3. To compare revealed and stated preferences for non-timber forest products.
4. To assess the benefits of non-timber forest products in the rural household welfare, and in the local economy of South Nandi.
5. To model the demand for non-timber forest products

1.4 Hypotheses of the Study

The six hypotheses that were tested are:

1. The NTFP income does not influence income diversification index.
2. There is no significant relationship between the household socio-economic factors, which are, off-farm income, index of income diversification, forest

proximity, educational level, farmland size, number of cattle, and NTFP dependency.

3. The households' stated (CVM) and revealed (RUM) demand for improved provision of NTFPs is not statistically significant and uncorrelated.
4. Forest dependency variables do not affect benefits sharing measures of NTFP in RUM compensating variation.
5. Non-timber forest products do not have an income equalizing effect among the households in South Nandi.
6. Non-timber forest products do not play any function as a natural insurance premium in South Nandi.

1.5 Significance of the Study

Economic contribution of NTFPs to rural incomes in developing countries has been under-researched (Shackelton et al., 2006). The efficiency of the present policy instruments for addressing the allocation and extraction of non-timber forest products in Kenya among the adjacent communities is a source of increased concern (Emerton et al., 2001) yet many rural households derive significant income from forest resources (Cavendish, 2000; Shackleton et al., 2005; Paumgarten et al., 2009; Illukpitiya et al., 2010). The continued unsustainable extraction of these natural resource goods shows its sub-optimal allocation. Despite the enormous positive externalities generated by the forest ecosystem in Kenya most of the beneficiaries of these resources do not pay for their consumption in the market place. Currently, there exist substantial gaps in our understanding of the actual functioning of rural economies and the extent of rural poverty and income inequality because conventional household income accounting does not incorporate income from environmental sources (Babulo et al., 2009). Hence, due to their exclusion from income accounting the real value of non-timber forest products in improving income levels of rural families is underestimated.

The pricing, or lack of it, of natural resource goods and the resultant outcomes of non-involvement of local communities in the pricing decision-making of forest products and services in Kenya has affected their sustainable management. For accurate policies and development plans the true value of these resources should be recognized (Börner et al., 2009). The true value can be used in pricing these services for internalization and better sharing of benefits (Dhakal et al., 2009). An efficient price system affects the equitable sharing of benefits and income improvement through optimal resource allocation for poverty reduction policies and sustainable management of the forest resources. For the rural economy to operate properly the market system should be able to correct most of the inefficiencies and externalities must be internalized (Perman et al., 2003). Doing so ensures sustainable development and long-term availability of these natural resources.

The main reasons for choosing forest income in measuring environmental income in this study are: forest-related income contributes significantly to rural income in many poor areas (Cavendish, 2000; Shackleton et al., 2005; Paumgarten et al., 2009; Babulo et al., 2009; Illukpitiya et al., 2010); external effects associated with impacts of forest product pose great concern to policy makers compared to many other environmental resources; although there is available literature on income from forests than other natural resource sources (Vedeld et al., 2007) such information is limited in developing countries where environmental resources have no market price. The bulk of valuation literature to date has mostly concentrated on tropical forests in Latin America, but there is growing interest in NTFPs valuation in Africa (like Turpie et al., 2003; Croitoru, 2007Falco, 2010; Heubach et al., 2011).

In Kenya permit fees are charged for extraction of forest pasture, beekeeping, and firewood collection but herbal plants, mushroom and vegetable collection are accessed for free. Since these forest services are supplied to the households for free or at the point where the marginal costs of provision of environmental resource are less than the marginal benefits then over-exploitation can occur. Hence, the market value of NTFPs can be achieved through economic valuation of these goods. In this regard economic valuation of natural resources can help link economic policies to environmental outcomes, and assist policy makers in formulation and evaluation of natural resources (Amirnejad et al., 2006). It also provides opportunity to adjust national income accounts aggregate like the GDP (Bishop, 1999).

Further, valuation of NTFPs help determine the income that forest-peripheral households derives from the forest and the extra-amount of money they require to remain in the same utility if, for any reason such as change in forest access policy, the people no longer extract NTFPs (Delang, 2006). This is important in designing compensation schemes for forest related projects. This study will assist in assessing impact of NTFP income on wealth distribution among the rural households. Economic valuation of forest resources not only helps to assess its qualitative contribution to rural livelihoods and household dependency on forest products, but also provides a realistic estimation of rural poverty (Babulo et al., 2009). Valuing forest products provides better appreciation of the policy implications of land use policy, management option of the forest resources and designing management schemes which safeguard environmental assets for poverty alleviation and reduction of inequalities (Sjaastad et al., 2005; Babulo et al., 2009). Finally, estimating the value of NTFPs helps ascertain the wholesome value of the forest ecosystem (Bishop, 1999; Delang et al., 2006). Economic valuation of forest goods provides means of monitoring the value of natural resources (natural capital) and their efficient allocation. Hence, this study will be important for designing an effective economic policy tools for sustainable forest management and poverty reduction among the rural communities.

The Kenyan government has increasingly recognized the role of natural forest resources in economic development of rural communities, as evidenced by the enactment of the Forest Act 2005, which stresses the role of surrounding communities in sustainable forest management. Because of this the need of economic valuation of NTFPs for better policy and management decisions becomes even more important. Parsons et al. (1992), Cropper et al. (1993), Greene et al. (1997) and Herriges et al. (1999) have all used RUM in Travel Cost Method (TCM) on recreational fishing sites in developed countries especially United States. However, environmental economics literature post relatively few studies on comparative analysis of random utility model and contingent valuation estimates of forest resource valuations. Due to distorted (or lack of) pricing of forest resources as a result of institutional failures, such as corruption and ineffective payment mechanism, economic valuation in Kenya may yield different results compared with that of developed economies like the US. So far, very scanty literature exists that compares the RUM and CVM valuation estimates of NTFPs in a developing economy like Kenya, and this study attempts to bridge the gap.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews theoretical and empirical literature on household diversification strategies, forest income valuation and the comparison of the stated and revealed preferences of non-timber forest products' estimates. Many studies have been carried out on income diversification strategies among rural households in developing countries (Valdivia et al., 1996; Ellis, 1998; Vedeld et al., 2007; Tesfaye et al., 2011) and the effects of these diversification programs on household incomes. There is an increasing consensus in literature that the livelihoods of forest-fringe households in Africa, Asia and other developing countries depends significantly on a variety of forest based goods (Illukpitiya et al., 2010). Non-timber forest products have been recognized as an important source of income for rural households (Godoy et al., 2000; Babulo et al., 2009; Tesfaye et al., 2011; Heubach et al., 2011). And the poorer sectors of society are more reliant on forest resources than the wealthy households (Cavendish, 2000; Kamanga et al., 2009). The main challenge facing policy makers and managers in Sub-Saharan Africa is finding balance between contribution of forest goods to poverty alleviation and conservation of forest ecosystems (Arnold et al., 2001) in the face rapid population growth.

In developing countries, like Kenya, non-timber forest products exhibit non-competing consumption among forest-margin households. Also due to lack of market driven excludability forest resources are often open to uncontrolled access which leads to resource overexploitation. In order to avoid overuse and undersupply the forest resources need to be priced adequately (Börner et al., 2009). Efficient pricing system may not be easily realized due to the problem of excludability that makes it difficult to allocate property rights and protect the forest resources from unpaid use (Keyzer et al., 2006). Knowledge of the market price of forest goods helps policy makers to recognize their economic values and their worthiness of protection (Delang, 2006).

The importance of NTFPs in household income diversification strategies has been neglected with net effect of underestimating and distorting the economic value of this income activity to the rural economy (Godoy et al., 2000; Emerton et al., 2001). Insufficient knowledge regarding the importance and value of NTFPs has limited its appreciation (Croitoru, 2007) and inclusion in formal policy formulation. Economic valuation of NTFPs is necessary in order to estimate the contribution of forest resources to household income, to assess the extent of dependency of forest products (Babulo et al., 2009) and develop policies that encourage efficient resource allocation. Research studies have been done to quantify economic values of non-timber forest products (e.g., Godoy et al., 2000; Emerton et al., 2001; Delang, 2006; Amirnejad et al., 2006; Venn et al., 2007; Vedeld et al., 2007; Börner et al., 2009; Tesfaye et al., 2011) but very few studies (for example, Urama et al., 2006) have applied multiple valuation methods to test for convergence of natural resource preferences in developing countries. Since multiple valuation help diminish individual weakness while enhancing their strengths and quality analysis results, economists have increasingly turned to this approach to this approach to assess environmental values (Hanley et al., 2003; Eom et al., 2007).

2.2 Household Economic Activities

Several studies (for example Vedeld et al., 2007; Tesfaye et al., 2011; Heubach et al., 2011) show that rural households in sub-Saharan Africa are generally involved in income diversification strategies to improve domestic income and to meet other livelihood needs. According to Valdivia et al. (1996), Ellis (1998), Barret et al. (2001), Paumgarten et al. (2009) and Mutenje et al. (2011) forest resource activities have been used by peripheral communities in constructing diversification programs for the purpose of risk reduction, reaction to crisis, to wealth accumulation.

2.2.1 Income Diversification Strategies

Several empirical studies have identified and determined the various diversification behavioral activities but the main ones are farm income, off-farm and non-farm incomes like forest income. Ellis (1998) defines livelihood diversification as the process by which rural households construct diverse portfolio of activities in order to survive and improve their standard of living. To the rural households more income diversification sources help cope with unpredictable changes in different income activities so that shortages from a single income source become easier to cope with (Heubach et al., 2011). The other importance of diversification of portfolio of income activities is that it allows the utilization of all available income sources.

In constructing the index of diversification, many studies (e.g. Valdivia et al., 1996; Illukpitiya et al., 2010; Heubach et al., 2011) have applied the inverse Simpson Index of diversity (Hill, 1973). The diversity variable is constructed from data on all the household income sources and Ordinary Least Squares (OLS) regressions are done where the diversification is dependent variable while independent variables are the income from the various sources and the incomes between the different sources. According to Valdivia et al. (1996) a diversity index close to the number of income sources indicates a more uniformly distributed income from each of the sources.

Households have used various portfolios of income activities as diversification strategies in the rural economy (Valdivia et al., 1996; Ellis, 1998; Vedeld et al., 2007). Research findings of Kamanga et al. (2009) indicated that off-farm income had a positive and significant effect on diversification index but results of Illukpitiya et al. (2010) and Heubach et al. (2011) showed that off-farm income had negative influence on diversification. Analysis of the effects of farm income on index of diversity by Illukpitiya et al. (2010) and Heubach et al. (2011) revealed a positive and statistically significant influence. Results of Tesfaye et al. (2011) indicated that younger households with smaller cropland were more likely to choose forest-based strategy than crop-based strategy in diversifying income activities. Shone et al. (2006) showed that the less educated had significantly high diversification index. The positive and significant effects of income sources on index of diversity can be explained by the fact that these income sources are considered erratic and insecure, hence motivating people to increase consumption (or investments) of the resources of diversify for better incomes. The negative effects show that increased income from any source reduces dependency on that portfolio of activity as an income source. This means that the effects of various income activities on diversification index are varied depending on the socioeconomic conditions of study area.

2.2.2 Share of NTFP Income to Total Household Incomes

Forest income is an important household income portfolio in forest-based, business-related and diversified strategies in many sub-Saharan countries (Tesfaye et al., 2011). According to Heubach et al. (2011), in a study of the economic importance of NTFPs for livelihood maintenance of rural western African communities, the average income share from NTFP was 39% of the total household income with crop production constituting 44 percent and off-farm income 7%. In South Africa 50% of households considered NTFPs as an important or very important livelihood strategy (Shackleton et al., 2005; Paumgarten et al., 2009). Babulo et al. (2009) found that the share of NTFP income in total income share to be 27% while crop income contributed 43%. Kamanga et al. (2009) enumerated a 15% income share of NTFPs. Godoy et al. (2002) reported an average of 39% of NTFP contribution to household income. Mamo et al. (2007) show that the contribution of forest income was 39% while farm income provided 40% and off-farm activities 21% of the total household income. From these results NTFP income contributes between 20% and 50% of the total household income. This demonstrates the important role forest resources play in the dynamics of household economy and that NTFPs contributes to the household incomes in varied proportions.

Therefore, the variations on forest income contribution to total household income could be due to differences in the opportunity costs of time and the availability of domestic labour, which in turn vary propensity to extract forest resources. Also varied levels of income inequalities in study areas, household productive capabilities, response to challenges beyond their control and diverse consumption motives are some of the factors affecting adaptive characteristics in forest resource utilization in different regions.

2.3 Non-Timber Forest Product Income Dependence

The concept of forest dependency has been referred to by some authors as the total share of income from forest products (Fisher, 2004; Illukpitiya et al., 2008). This measure shows the magnitude of forest products' utilization compared across households (Heubach et al., 2011). More researchers (for example Mamo et al., 2007; Kamanga et al., 2009; Heubach et al., 2011) have applied the ratio of the NTFP income to the total household income. Relative NTFP income, on the other hand, captures the share of forest income in relation to other household income sources and overall incomes (Heubach et al., 2011). According to Heubach et al. (2011) results of forest dependency can be said to be reasonable if majority of the relative NTFP income lies between 0.2 and 0.8, which portrays a linear curve. Hence, in this study forest income dependence is measured as the share of NTFPs' income relative to the total household income. This is because this measure provides a clearer understanding of forest contribution and dependency on household income.

2.3.1 Factors affecting Forest Dependency

Heubach et al. (2011) measured forest dependency as function of formal education of household head, sex, gender, off-farm income, farmland size, number of cattle per household, proximity to forest and index of diversification. In Quang et al. (2006) the determinants of household's dependence on NTFPs were geographical location, gender balance, food security, other income sources and poverty levels. Hence, the common NTFP dependency variables are: Off-farm income, Education, Index of Diversity, Number of household Cattle, Farmland size and Proximity to forest.

2.3.1.1 Off-farm income

Illukpitiya et al. (2010) found that profitable off-farm activities had a negative and statistically significant relationship with forest dependency. That is, increased off-farm income reduced NTFP dependency. Adhikari et al. (2004), Fu et al. (2009) and Heubach et al. (2011) registered similar results. The negative effect of off-farm income on forest dependency is due to the fact that this source of income enhances household wealth creation opportunities. This increases opportunity costs of NTFPs extraction (Illukpitiya et al., 2010) and hence, leading to reduced extraction of forest products. According to Bluffstone et al. (2001) more household wealth reduces extraction of forest-related activities. Results of Mamo et al. (2007) indicated significant and negative correlations between forest income dependence and income from other sources, showing that households with lack of other income options appear more dependent on forest products.

2.3.1.2 Formal education

Illukpitiya et al. (2010) found that formal education had a negative and significant effect on forest dependency. Mitra et al. (2011) also found education to be negatively and significantly related to forest consumption. This indicates that better educated households may have better earning opportunities outside the forest resources so that forestry activities are less attractive for those households due to high opportunity costs. However, the results of Mamo et al. (2007) and Heubach et al. (2011) indicated that household education had no effects on NTFP dependency and hence it was not important regarding forest extraction activities. The negative effects shows that education is instrumental for creating access to greater diversity of income opportunities (Adhikari et al., 2004; Fisher, 2004), especially off-farm income generation. Also, the more educated are more likely to be aware of effects of forest degradation. This agrees with economic theory which postulates that the higher formal education, the lower NTFP dependency.

2.3.1.3 Proximity to forest

Studies by Mamo et al. (2007), Kamanga et al. (2009) and Mitra et al. (2011) demonstrated that the distance of the household homestead to the forest negatively and significantly associated with forest dependence. Household location relative to the forest strongly influences the households' ability and willingness to engage in forest extraction activities (Kamanga et al., 2009). Further, Quang et al. (2006) found that location was negatively correlated to the dependence of farmers on NTFPs. The households who live in or near the forests collect forest products to supplement livelihood shortages. Although distance displayed negative effect on forest dependency in Illukpitiya et al. (2010), however, the relationship was not statistically significant. Getachew et al. (2007) also showed that distance from the household homestead had negative influence on forest dependency. The negative relationships from the above studies illustrate the fact that households' likelihood of depending on NTFPs significantly reduces with increased distance from the forest edge.

2.3.1.4 Farmland size

Results of Godoy et al. (1997), Fu et al. (2009), Mamo et al. (2007) and Heubach et al. (2011) showed that farmland size had inverse and statically significant effect on NTFPs dependency. Heubach et al. (2011) found a significant correlation between farmland size and crop income. Since the size of the household land directly affects agricultural production, then with increased farm income people are likely to decrease extraction of non-timber forest products. But Mitra et al. (2011) indicated that the size of household land holdings was positively related to the benefits from community forest. The findings of Mitra et al. (2011), which is contrary to other studies, means that the economic effects of land to the household needs to be explained beyond conventional theoretical construct. Normally, in the rural economy land size is an important factor affecting household income and the farmland size determines the extent of crop production and therefore, crop income. It is generally expected that increased agricultural productivity from bigger land size is likely to decrease NTFP extraction.

2.3.1.5 Diversification Index

The findings of Coulibaly-Lingani et al. (2009), Illukpitiya et al. (2010) and Heubach et al. (2011) showed that diversification index had a significant and negative effect on NTFP dependency. In theory and studies, it is expected that index of diversification would have an inverse relationship with forest dependency, indicating that greater diversity lessens the dependence on NTFPs. The reason for this is that the greater the possibility of using different income sources the less the share of a particular income source in total household income. This, therefore, reduces the likelihood of demand for extra income generating activity.

However, the results of Vedeld et al. (2007) and Kamanga et al. (2009) indicated a positive and significant relationship between index of diversification and forest dependency. The increasing reliance on forest incomes raised the index to near equality with agriculture and off-farm incomes. This can be explained by the fact that rural households depend on forest resources either for coping or risk insurance and wealth accumulation (Barret et al., 2001 and Tesfaye et al., 2011) in domestic diversification programs, especially among the poor. Results from Shone et al. (2006) also showed that households practicing sustainable agro-forestry and collection of non-timber forest products had significantly higher levels of diversification. From these findings, it can be concluded that the effect of index of diversity on forest dependency varies across studies depending on socioeconomic dynamics, especially demand for diversification of income sources, of the area of research.

2.3.1.6 Number of household cattle

The number of household cattle is expected to be positively and significantly related to NTFPs dependency. In many rural households peripheral to tropical forests, livestock fodder forms an important NTFP income strategy (Heubach et al., 2011) and therefore greater number of household cattle reflects higher NTFP dependency. Heubach et al. (2011) reported a positive and significant relationship between the number of cattle and NTFP dependency.

2.3.2 Economic Benefits of the Forest

Since many of the rural poor depend on forests for their livelihoods (Babulo et al., 2009), forest products can play an important role in meeting the Millennium Development Goal (MDG) of reducing the number of people living in absolute poverty and income inequalities to half by 2015 (The World Bank, 2006). According to National Well-Being

Statistics of 2009 South Nandi had 46.4% of individuals below poverty line (Republic of Kenya, 2010). The findings of Shackleton et al. (2004) indicated that 85% or more of South African households depended on non-timber forest products while FAO (1997) estimated that 80% of households in developing countries depended on NTFPs for income subsistence and sustenance. Household inequalities motivate dependency on forest resources (Bluffstone et al., 2001 and Illukpitiya et al., 2010). Hence, forest income can be harnessed to address two major economic problems; poverty reduction and income inequalities.

The relationship between poverty and environmental income have been investigated in different ways; using Gini-coefficient analyses inclusive and exclusive of environmental income (Fisher, 2004; Vedeld et al., 2004: Kamanga et al., 2009; Heubach et al., 2011), income quintile analyses (Vedeld et al., 2004; Cavendish, 2000) or absolute or relative Kuznets ratios which measures the relationships between the 20% most wealthy and least wealthy share of total and environmental income (Vedeld et al., 2004; Kamanga et al., 2009). Inequality analyses involves examining the distributional effects of NTFP income across households in which Gini coefficients, showing the income inequalities, is computed for total household income with and without including forest income. And the two coefficients are then compared to determine the NTFP equalizing effect on income distribution among the households.

2.3.2.1 Multiple functions of non-timber forest products to the rural economy

The economic benefits of environmental resources have traditionally been considered for their extractive values – be they direct or indirect – and therefore, this limited approach have had adverse ramifications for the development and conservation decision-making processes for their management (Shone et al., 2006). According to Vedeld et al. (2007) and Cavendish (2000), poverty reduction strategies among developing countries that do not capture the important sources of poor people's income, such as environmental income, will result in flawed estimates. But there is an increasing focus on the potential role of forests and NTFPs in economic development and poverty reduction strategies (Shackleton et al., 2007; Puamgarten et al., 2009).

In literature, there are three major functions of forest income among rural households: First, according to studies done by Cavendish (2002), Vedeld et al. (2007), Babulo et al. (2009) and Heubach et al. (2011) forest products are important to maintain the current level of consumption and cushion households from sliding into deeper poverty. Non-timber forest products provide domestic subsistence and consumption requirements such as vegetables, medicinal herbs, firewood, wild-foods and fruits, which are primarily consumed within the household. These NTFPs acts as substitutes to marketed commodities and therefore, their use increase disposable income to the household. Second, the findings of Nasi et al. (2002), Shackleton et al. (2004), Paumgarten et al. (2009) showed that forest products serve as insurance premium in times of economic hardships in the rural economy. Forests provide useful products and services during periods of financial distress among households. Forest products are used to overcome unexpected income shortfalls or cash needs (Babulo et al., 2009). They provide valuable safety nets in times of emergency. In times of agricultural shocks like sudden collapse of milk demand, unexpected decreased prices of key sources of income like tea, coffee, maize crops and livestock products or drought, the forest resources become providers of natural insurance. Finally, Shackleton et al. (2004), Babulo et al. (2009) and Heubach et al. (2011) demonstrated that forest resources help improve household income. NTFPs contribute to direct monetary benefits through sales. Some of the commercialized products whether *ad hoc* or full time include forest honey, fish, medicinal plants and livestock that graze throughout or partially in the forest.

2.3.2.2 Effects of NTFP income on household wealth distribution

In assessing income inequalities some economists have decomposed income sources into factor components which provide meaningful estimates of the contribution of each income activity to total inequality as quantified by the Gini coefficient (Fisher, 2004; Babulo et al., 2009; Das, 2010). Others (like Heubach et al., 2011) have applied the direct Deaton (1997) definition of the Gini coefficient, as an equation, instead of deriving from the Lorenz curve. In this model a weighted ranking is done where the highest income household is ranked as 1 and the poorest ranked N. This is in order to satisfy the transfer principle where the measured inequality should decrease when income is shifted from the high to low income household (Heubach et al., 2011).

In study results of the economic importance of NTFP in North Benin, Heubach et al. (2011) indicated that the inclusion of NTFP income in total household income considerably reduced inequality from a Gini coefficient of 0.61 to 0.23. The strong Gini reduction could have been due to the even participation of households in NTFP collection. Although these results might be overestimating the equalizing effect of forest income, it shows that NTFP might assist in diminishing income disparities between the rural dwellers. In another study of the incidence of forest income on reduction of inequality in India, Das (2010) showed that if forest sources of income are excluded from the analysis, the estimated Gini coefficient increases from 0.47 to 0.59, demonstrating that forest income reduced inequality by about 12% (expressing Gini index- which is the coefficient in percentage). But Kamanga et al. (2009) found a moderate increase of Gini coefficient when forest income is omitted from the analysis from 0.41 to 0.45 with a greater positive effect of 0.10 for villages with better access to the forest reserve.

The findings of Mamo et al. (2007), in the economic dependence on forest resources in Ethiopia, indicated that income inequality reduces from a Gini coefficient of 0.41 to 0.28 when forest incomes are included in computation for total per capita income. The results also showed that the income inequality among households in the study area was not pronounced compared to the national Gini coefficient index (0.40). In a collection of various studies on forest environmental income and the rural poor in developing countries Vedeld et al. (2007) showed that, on average, the Gini coefficient increased by 0.10 (from 0.41 to 0.51) when forest environmental income was excluded from the calculations. According to Babulo et al. (2009) forest income was the lowest unequally distributed with least own Gini (0.27), yet its percentage to inequality (19%) was smaller than its percentage contribution to total income (28%). This same study also indicated that with the relative effects of a marginal increase in each source, a 1% increase in income, *ceteris paribus*, resulted in a 0.1% decrease in overall income inequality.

Hence, although there is variation in magnitude of the effects of NTFP income on income disparities, the general trend from these studies indicate that forest income have considerable potential for equalizing distribution of wealth in the rural economies. Generally, NTFP income reduces income inequalities between the rural households and therefore can become an important economic instrument for bridging income disparities.

2.3.2.3 Benefit Sharing of NTFPs in Welfare Measures.

Random Utility Models (RUM) has been used to model the choice among various policy alternatives as means of assessing welfare measures (Parsons et al., 1992). The estimated RUM measures the welfare implications of changing the choice set by either the individual set of alternatives or attributes of the available alternatives. For changes in environmental quality it is the characteristics of the available alternatives. Random utility theory was developed by McFadden (1974) and Domencich and McFadden (1975) to analyze discrete consumer choices and measure the welfare implications of changes in demographics and/or attributes of the available choice set (Herriges et al., 1999).

In a RUM compensating variation model Parsons et al. (1992) analyzed random draw approach as an alternative for dealing with large opportunity sets. Using boaters, anglers, swimmers and viewers to estimate benefits for water quality improvements for lake recreation in Wisconsin State, U.S.A, the study concluded that the RUM approach is applicable because the opportunity sets are large for water quality improvement measures which can be estimated with reasonable confidence. In a study on recreational benefits of improved water quality in Stockholm, Archipelago, water quality improvements is estimated using random utility model (Soutukorva, 2004). The research applies RUM to travel cost method for the benefits estimates. The research concluded that water quality improvement have an effect on recreational choice. In other words, provision of environmental improvement influences consumption of natural resource goods or services.

RUM coefficients are used to provide welfare estimates for changes in attribute levels in which the ratio represents WTP for a unit increase in the quantity of the socioeconomic attributes (Colombo et al., 2009) such as education levels, off-farm income, forest proximity and farmland size. In a study on biased valuations, damage assessments and policy choices, Knetsch (2007) concluded that contrary to conventional economic analyses and traditional cost-benefit assessments, projects that prevent or reduce losses are valued more highly than ones that provide gains. Zander et al. (2008), in using choice model scenarios to value cattle breeds in East Africa, showed how the application of “what-if” scenarios can be adapted to stimulate the predicted utility that livestock-keepers would assign to a certain combination of attributes. It concluded that it is most cost-effective to conserve *in situ* the Ethiopian Borana subtype in Ethiopia and the Somali Borana subtype in Kenya.

Bateman et al. (2006), in the analysis of the effects of distance decay on welfare measures, used compensating variation scenarios to show that for resources with use values, like non-timber forest products, it would be expected that overall values to reduce with increasing distance from such sites. But changes in the choice of welfare measure would determine effects of distance decay on those who are currently non-users. Also, Ruto et al. (2008) applied a choice modeling approach to investigate buyers' preferences for indigenous breeds in Kenya in valuing animal genetic resources.

Hence, to investigate the effects of socio-economic variables on the distribution of NTFPs among the households in South Nandi a compensating variation in the random utility model is a good predictor to compute the welfare impacts in NTFPs utility due to changes in household characteristics.

2.3.2.4 Role of NTFPs as natural insurance premium

The total economic value of natural resources like the forest is an aggregate of use and non-use values which include direct, indirect, option, bequest, and existence values (Amirnejad et al., 2006; Mamo et al., 2007: Babulo et al., 2009). Option value, sometimes referred to as natural insurance, can be defined as individual's (or household's) willingness to pay to guarantee the continued availability of the environmental service for future consumption (Perman et al., 2003; Turpie et al. 2003). Since the 1980s the concept of natural insurance has received much attention among economists (Takasaki, 2011). Few studies have applied valuation techniques to quantify option benefits. Option demand theory has been used to understand the yield of social benefits of environmental commodities to an economy (Kula, 1994). Hence, the household desire to retain forest goods available for future use is demonstrated by willingness to provide extra financial contribution to the maximum willingness to pay amounts in the contingent market.

In a study on the importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa, Shackleton et al. (2007) identified the insurance function of forest resources as involving: first, the consumption of forest goods previously not used by the household; second, increased household consumption of forest products which are already an important component for livelihood, for example increased use of wild vegetables or increased use of firewood instead of paraffin. This, generally, involves substitution of purchased products; third, household commercialization of forest goods for improved incomes like firewood vendors, herbal medicine dealers and forest beekeeping. MCsweeney (2005) investigated indigenous community households in Honduras on the rural poor's ability to self-insurance using forest resources following Hurricane Mitch. Results of this study showed that household attributes such as land wealth strongly determine the use of forest resources as safety nets for the rural economy. According to Baland et al. (2005) since the low income dwellers generally depend on natural property resources, the ecosystem resources especially forest products tend to provide informal and self-enforcing consumption insurance for the very poor.

Findings in a study on the role of environmental income on rural livelihoods in Zimbabwe, Cavendish (2000) reported a 40% of total income from environmental income to the lowest income quintile that, generally, use the income to fill gaps in times of income shortages. The forest income also acts as insurance in periods of unpredictable economic shocks (Babulo et al., 2009), that is unexpected income shortfalls or cash needs (Vedeld et al., 2007). Fu et al. (2009), from research on the role of non-timber forest products in China, found that NTFPs retained the important role of alleviating risk associated with agricultural price fluctuations and hence, absorbing the price shocks. The insurance role of forest goods mainly occur with a shock or sudden changes in the economic, social or climatic environments in which households exist and function (Shackleton et al., 2007; Kamanga et al., 2009). According to Takasaki (2011) the rural poor rely on local commons not only for self-insurance but also for mutual insurance.

Brookshire et al. (1983), in a modification of CVM techniques, estimate the option and existence value of wildlife resources in Wyoming by measuring the willingness to pay for licenses to hunt grizzly bears and born-horn sheep. Stevens et al. (1991) assessed existence values for the bald eagle, Atlantic salmon, wild turkey and coyote in North America using CVM techniques. In another study to quantify the aesthetic and quality of life values placed by urban dwellers on maintaining environmental quality in Batangas Bay, Philippines, the contingent valuation was also used. Dixon et al. (1990) estimates the existence benefits of Virgin Islands National Parks to be approximately US$ 5million per annum using the nearby land values. Coulibaly-Lingani et al. (2009) developed logistic regression models to examine the determinants of access to forest products in Southern Burkina Faso. The results of this study showed that access to forest products is a function of individual characteristics and that the forest goods play an important role in managing risks associated with weather, crop losses and other unpredictable events.

Völker et al. (2010), applied probit models in a study on the role of forest extraction as a response to adverse socio-economic shocks among rural dwellers in Vietnam, found that illness among household members, household wealth status measured in tangible assets, location factors, formal education of household heads are some of the factors that had significant effect on forest extraction in times of crisis. Results indicated that health shocks had a significant effect on a household's decision to extract if economically active household members were affected by illness. Further, the value of a household's tangible assets had a significantly negative effect on forest labour supply. On the other hand, households whose heads had more formal education allocated significantly less labour to forest extraction during these times of economic shocks. Hence, weather shocks and human health shocks, according to this study, drive households into allocating labour to the extraction of forest products suggesting that the probit regression models developed correctly predicted the socio-economic variables that influenced the option demand for forest resources. In another study on the links between income shocks and forest use, Fisher et al. (2005) indicated that households most dependent on forests for natural insurance are those located near woodlands and headed by an individual who is relatively young and male.

Fisher et al. (2010), in a study on the role of forests in rural household adaptation to climate variability in Malawi, found that increase in age of the household head more likely increased reliance on forests for shock coping. It also indicated that households that are relatively risk averse, as measured by a household's investment in a game of chance, are less likely to use forests to smooth consumption when crops fail. Results showed that households headed by an individual who has at least a primary education and who is in very good health are 46% and 27%, respectively, less likely to use forests for coping with weather-related crop failure. And that households who have easy access to forest resources as represented by distance to forest edge are more reliant on forests for shock coping. Takasaki et al. (2004) investigated the various strategies used by Peruvian smallholders to cope with covariate and idiosyncratic shocks, and one of the major shock-coping mechanisms include extraction of forest products. In this study 22% of sample households reported forest gathering as a coping mechanism. The researchers, using a two-stage Tobit model, found that households who employed forest resource extraction to cope with covariate flood shock possessed relatively few physical assets and had relatively more adult household members.

2.4 Economic Valuation of Non-Timber Forest Products

The value of forest goods and services has, for many years, been neglected or underestimated and have not been factored in household income accounting (Emerton et al., 1997; Börner et al., 2009). The economic benefits of non-timber forest products (NTFP's) services are shared among economic units (Campbell et al., 2002; Dhakal et al., 2009) and cannot easily be marketed and priced (Venn et al., 2007; Illukpitiya et al., 2010). For this reason, these services have a distorted market mechanism and hence cannot be adequately provided. To compare and improve valuation methods, economists have increasingly turned to multiple valuation approaches to assess environmental values (Eom et al., 2007).

2.4.1 Problem of environmental commodities

Access to the forest has made forest products a main source of income for most forest-fringe rural households (Tesfaye et al., 2011) in developing countries. These products provide opportunities for the poor to diversify livelihoods. In a study on poverty alleviation through community forestry, Sunderlin (2006) concluded that communities living adjacent to forests in Cambodia, Laos and Vietnam have characteristically high levels of poverty and limited livelihood opportunities. Mogaka et al. (2001) and Shackleton et al. (2007) also found that the forest dependent peoples in the tropical forests in Eastern Africa and woodlands in Southern Africa are often marginalized and hence, not only pose developmental but also environmental challenges to policy makers. The economic activities of these peoples present environmental challenge due to the fact that the spectre of resource depletion always looms as they continue extracting the forest resources. Studies by Ruiz-P′erez et al. (2001), Sunderlin et al. (2005) and Shackleton et al. (2007) showed that the use of forest resources offers potential economic returns (in cash, direct-use or indirect use) which means that sustainable utilization of these resources provide an opportunity for development and conservation goals (Arnold et al., 2001; Kamanga et al., 2009).

According to findings of Shone et al. (2006), Börner et al. (2009) and Das (2010), in tropical Africa, where livelihoods are limited and insecure, forest management regimes have long denied communities legitimate opportunities to use forest resources for household economic gain. But because forest activities have high economic benefits, if communities are provided opportunities to conserve the resources or to use them sustainably the forest resources would not be degraded. Undervaluation of forest resources can lead to flawed decision-making and substantial misallocation of these products. Also opportunities for growth and development of the forestry sector and the whole economy would be missed. The challenge of environmental commodities are compounded by poorly defined property rights, open access (Turpie et al., 2003), institutional failure and poor pricing mechanism.

2.4.2 Importance of valuing forest goods

The potential of non-timber forest products (NTFPs) in rural economies, in developing nations, as an important source of livelihood and sustainable development has been widely appreciated and yet, surprisingly little effort have been made to value this resource (Croitoru, 2007). Most of the valuation efforts have focused on products traded in the formal markets (Grimes et al., 1994; Kumari, 1995) and it is only recently that some researchers have sought to value those NTFPs consumed for subsistence or informally traded (Godoy et al., 2000; Shone et al., 2006: Babulo et al., 2009). The bulk of valuation literature to date has mostly concentrated on tropical forests in Latin America, but there is growing interest in NTFPs valuation in Africa (such as Turpie et al., 2003; Croitoru, 2007; Vedeld et al., 2007; Babulo et al., 2009; Falco, 2010; Heubach et al., 2011). The estimation of the potential extractive value of the forest is a method which has been explored in environmental and ecological economics literature for the estimation of the value of NTFPs (Shone et al., 2006).

According to Babulo et al. (2009), economic valuation of forest resources helps to assess its quantitative contribution to rural livelihoods and household dependency on forest products. The valuation provides a realistic estimation of rural poverty. Moreover, empirical studies by Cavendish (2000) and Fisher (2004) indicates that non-monetary income and consumption among the rural households may contribute more to livelihoods than cash income. In another study, Cavendish (2002) showed that exploring the role of forest income in rural livelihoods assists to understand the economic incentives and challenges that may lead to conservation or degradation of environmental resources. Valuing forest products provides better appreciation of the policy implications of land use policy, management option of the forest resources and designing management schemes which safeguard environmental assets for poverty alleviation and reduction of inequalities (Sjaastad et al., 2005; Babulo et al., 2009). In other words, economic valuation helps to integrate business and economic opportunities in conservation management, and to develop mechanisms that ensure costs and benefits of forest resources are equitable shared among the various stakeholders.

2.4.3 Revealed preference valuation

Revealed preference valuation techniques seek to elicit preferences derived from prices of goods and services in real monetary transactions. Preferences for environmental goods are usually revealed indirectly, when an individual purchases a market good to which the environmental good is related in some way (Nijkamp et al., 2008). There are many revealed valuation methods (e.g. travel cost method, hedonic pricing method and random utility model) that have been applied in valuing environmental commodities. In a study by Hecht (1999), market prices were used to value the goods yielded by mangrove ecosystems in the Indus River Delta, Pakistan. Fuelwood and fodder use rates by adjacent villagers were quantified, and values were ascribed according to prevailing prices of commodities in local markets. Emerton et al. (2001) found, in an economic valuation of Kisite Marine National Park and Mpunguti National Reserve, administered by the Kenya Wildlife Service (KWS), that the marine park and reserve was generating income in excess of US$ 1.6 million per annum in net revenues from tourism and a further US$ 39,000 from fisheries.

Travel cost demand model has been the most widely applied framework in describing households' use of recreation sites for the last five decades (Smith et al., 1986).Travel Cost Method (TCM) has been used in valuing recreational distinct sites affecting the demand for each site in Tampa Bay, Florida (Greene et al., 1997), the value of viewing wildlife in Nakuru, Kenya (Navrud et al., 1994), and the economic value of elephants also in Nakuru, Kenya (Brown et al., 1989). Cropper et al. (1993) compared hedonic pricing model with random utility model estimates of welfare measures for given known household preferences in the Baltimore housing market in the U.S.A. The study concluded that for non-marginal changes in housing attributes, the RUM provided more accurate estimates of the welfare measure than the hedonic price model. In spite of the success of TCM, random utility framework has offered a credible alternative to it in recreation decision-making, especially for discrete choice models. Many economists have questioned the validity of the travel cost model, arguing instead that the random utility model is a superior method for valuing recreational site attributes, as the two methods emanate from a similar utility theoretic framework (Smith et al., 1986). According to Pendleton et al. (2000) the way in which each method estimates preferences for site attributes depends critically on the method and the functional form of the underlying utility function. RUMs are used in treating individual behaviour within the TCM framework (Soutukorva, 2004).

Although the use of market prices can be used, environmental resources often have no market or the prices are highly distorted. Godoy et al. (1993), Gunatilake et al. (1993) and Mamo et al. (2007) used forest resource substitutes or alternatives as proxies for resource values. Several studies have shown that the market prices for forest products influence rural households in extraction and consumption decisions on these forest goods (Cooke, 1998; Kohlin, 2001; Illukpitiya et al., 2010). Researches of Vedeld et al. (2007), Mamo et al. (2007), Kamanga et al. (2009), Heubach et al. (2011) and Mutenje et al. (2011) applied the market-based approach in valuing non-timber forest products. So far, most of the valuation studies that estimate the forest benefits have focused only on products traded in the formal markets (Grimes et al., 1994; Croitoru, 2007). More recent literature have shown increased attempts to capture the value of some NTFPs that are consumed for subsistence or informally traded (Godoy et al., 2000; Shone et al., 2006; Croitoru, 2007).

The challenge of valuing NTFPs using market prices is that even where the market of these goods are available, people might find it difficult to give a monetary value to goods that have never been sold or purchased (Delang, 2006). In some communities, NTFPs might be bartered for marketed products rather than sold directly in the market system and hence, some economists have used the marketed products as proxy for the value of NTFPs themselves (Delang, 2006). Mahapatra et al. (2005) used the retail sale price of exchanged commodities (such as oil, salt, and rice) to estimate the monetary value of NTFPs that were bartered for these products. Other studies have used the time needed to collect the NTFPs from the forest and giving a cash value to the time (Delang, 2006). In a research on the Utilization of non-timber forest products from Mount Elgon National Park, Uganda, Scott (1997) observed that the value of the forest resources to the local communities can be measured by labour time spent on collecting the products, which in effect is calculating the opportunity cost of the time expended in gathering the forest goods.

While using use values or the actual harvest of goods estimated at current market prices, Godoy et al. (2000) in a study on the valuation of consumption and sale of forest goods in Central America rain forest, found the forest value ranging from US$18 to US$24 per hectare per year after accounting for inflation and purchasing power parity. In an assessment of methodological shortcomings of economic valuation of forest products, Gram (2001) posted economic values of between US$9 and US$17. Shone et al. (2006) estimated the average income per hectare for NTFP as about US$17 and the harvest value of US$35. In studies on the valuation of non-timber forest products in the Mediterranean region, Croitoru (2007) found livestock fodder and firewood each contributing 27% of total NTFPs value, while Vedeld et al. (2007), in a meta-analysis of forest environmental incomes and the rural poor among several countries as case studies, showed that forest income contributed 22% of total household income while wild food and fuelwood were the two most important forest products for the households as they contributed an average of 70% of all the value of forest income. Fisher (2004) estimated that 30% of the total income of rural households in Malawi originates from forest income. Mamo et al. (2007) showed, in a study in the Dendi district of South Western Ethiopia, that forest income contributed a mean per capita income of US$344 which was 39% of average household income while Godoy et al. (2002) have estimated that, on average, 17-45% of household earnings in Bolivian and Honduras villages is generated from environmental products.

2.4.4 Stated preference valuation

In many cases environmental goods have no market price, and no close substitutes or alternatives, yet they often have a high economic value to people. Stated preferences techniques are based on the simulation of the market (Nijkamp et al., 2008) and thus are based on asking people valuations of environmental improvement. The best known stated preference method is the contingent valuation technique (Mitchel et al., 1989). Contingent valuation method has been used to estimate the value people place on environmental goods and services by asking them their willingness to pay for them (or willingness to accept compensation) under a hypothetical market scenario (Perman et al., 2003). Brown et al. (1989) used the contingent valuation method to estimate the value of Kenya's elephants. Contingent valuation techniques have also been used to assess option and existence values of natural resources (Kula, 1994; Amirnejad et al., 2006; Vö lker et al., 2010). Several studies (Darling et al., 1993 and Creel, 1998) have used the logit model to estimate the mean WTP.

In the studies of Munasinghe et al. (1993), Wasike (1996) and McConnel (1997) income was not only positively related but had great significant effect on WTP. In a valuation study of water quality in the Philippines, income had a statistically positive and significant effect on water quality improvement (Choe et al., 1994). Other studies by Whittington et al. (1993) and Hammitt et al. (2001) also showed a strong positive and significant relationship between household income and willingness to pay values for improved environmental services. In a contingent valuation of Taiwanese wetland, Hammitt et al. (2001) found that education levels of respondents had a positive and significantly related with willingness to pay. Shultz et al. (1998) and Whittington et al. (1993) showed that the education of tourist visitors and demand for improved water services, respectively, were not significantly related with willingness to pay.

Contingent valuation studies of a Taiwanese wetland by Hammitt et al. (2001) found that the age of respondents was significantly negative. Wasike (1996), in a study on the WTP for control of water pollution in River Nzoia and domestic water supply in Nzoia, Kenya, found that age also had negative relationship. Whittington et al., (1993) in a study on household demand for improved sanitation in Kumasi, Ghana, observed that age showed little significance in respondents' CV bidding. Chopra (1998) used a logit regression in the analysis of linkages between land degradation, deforestation and population movements as dependent variables in Rajasthan, India. The independent variables were participation in common land resources and common water resources, ownership of cattle and defense on commons for grazing.

Pouta (2005) applied contingent valuation in measuring the environmental benefits of a forest regeneration cutting policy in Finland. In a sensitivity analysis the study found that the dichotomous choice between status quo and environmentally-oriented cutting is found to be insensitive to the scope of the environmental alternative, as the scope variable was insignificant in the logit model. In a study on the importance of forest attributes in the willingness to pay for recreation in Ireland, Scarpa et al. (2000) found that the value estimates from the contingent valuation methods exhibit theoretically consistent relationships with important forest attributes. Abdullah et al. (2011), in a research on willingness to pay for rural electrification connection in Kisumu District, Kenya, showed that respondents were willing to pay more for grid electricity than photovoltaic (PV) electricity and households favoured monthly connection payments over a lump sum amount. In this study, most households were willing to pay a minimum of Ksh. 32,500, yet the average monthly income level was less than Ksh. 10,000.

2.4.5 Comparing Contingent Valuation and Random Utility Model Estimates

There is an increasing use of combined stated and revealed preference models among environmental economists (Hanley et al., 2003). The advantages of combining revealed and stated preferences data include an increase in the amount of information available (Adamowicz et al., 1997) and the possibility of including more variables in models. The appeal of the RUM is its ability to handle forest products' substitutes and direct measurement of economic welfare, while retaining the ability to test the economic consistency of the revealed and stated preferences (Boxall et al., 2003). Hanley et al. (2003) summarizes the main reasons for combining stated and revealed preference approaches as: stated and revealed data from the same sample can be compared, in a convergent validity test, to see whether the same underly model of preferences; as a way of improving sampling efficiency; and, in order to combine the desirable features of the two approaches.

In a study on a comparison of contingent valuation method and random utility model estimates of the value of avoiding reductions in King Mackerel bag limits, Whitehead (2000) demonstrated that the RUM estimates were greater than the CVM estimates, although ideally the two preference methods should be equal. The results showed that the CVM estimates tended to be biased downwards while RUM estimates biased upwards. When the different valuation methods give equal results then they have convergent validity. This would provide policy makers with confidence on whether to use either CVM or RUM value estimates. Generally the RUM estimates are expected to be higher than CVM (Whitehead, 2000) because respondents normally tend to underbid in contingent valuation questions due to valuation biases below their revealed preferences.

In a study on recreational benefits of improved water quality in Stockholm, Archipelago, water quality improvements is estimated using random utility model (Soutukorva, 2004). The research applies RUM to travel cost method for the benefits estimates. The recreational RUM benefits were found to be lower than estimates using the contingent valuation method in a similar study. The reason given was that CVM studies include non-use values. Delang (2006) compared two valuation methods of NTFPs, time needed to collect wild-food plants and substitute products value, and concluded that the two techniques give very different values to the NTFPs extracted from the forest. Whitehead et al. (2010) analyzed the convergent validity of several demand models using beach recreation data in North Carolina, USA, and found that the trip change estimates from two of three models are similar and convergent valid, though the willingness to pay estimates differed in magnitude.

Urama et al. (2006), in a study on convergence between stated and revealed preferences in southeastern Nigeria, showed that the farmers' preferences in the preventive expenditure method (revealed preference) and contingent valuation method were positive and significantly correlated but with different means at 5% level. Shaikh et al. (2007), in a research on treating respondent uncertainty in contingent valuation and comparing with empirical results of certainty RUM model, showed that by comparing the results from the various valuation methods the impact on the empirical results of respondent uncertainty is analyzed since there is no one method which is superior in treating uncertainty in the CVM studies. The study concluded that caution needs to be taken when making systematic judgments about effect of uncertainty on contingent valuation respondents compared with measures under certainty models.

Results of Eom et al. (2006), in a study on improving environmental valuation estimates through consistent use of revealed and stated preference information, found that relevant economic variables such as price, in both travel costs and contingent valuation bids, and income had significant influence on both recreation demand and WTP for water quality improvement as expected in economic theory. In valuing the health risks related to recreational shellfish harvesting, Beaumais et al. (2010) showed that people significantly value risks despite the substantial benefits of recreational shellfish harvesting. Results of this study rejected the hypothesis that the observed (revealed) and contingent trips follow the demand structure. Whitehead et al. (2008), in a revealed and stated preference study of recreation demand for Southern North Carolina, USA, beaches, had results showing that stated preference recreation data, may be suitable for estimation of consumer surplus per trip but not consumer surplus per season.

Morgan et al. (2011), in a study on the use of revealed and stated preference data to estimate the scope and access benefits associated with cave diving in Florida, USA, found that divers use different travel cost preferences when assessing their revealed and stated preference trip counts but a single preference structure to evaluate site quality changes. Whitehead et al. (2000), in a research on measuring recreation benefits of quality improvements with revealed and stated behaviour data, demonstrated that using revealed and stated recreation trips with current quality as the baseline, there would be significant changes in trips, consumer surplus per season, and the cross-price elasticity of demand due to the improvement in quality. Colombo et al. (2006) analyzed the benefits of programmes to mitigate the off-site impacts of soil erosion for a watershed in Andalusia, Spain, using contingent valuation and choice experiments. Results of this study showed that the welfare estimates between the two approaches did not differ markedly and concluded that employing the two methods allowed the undertaking of convergent validity test and thus provide more defensible social benefits estimates.

Hanley et al. (2003) used a combined stated and revealed preference approach to value coastal water quality improvements. They showed that a combined revealed preference and contingent behaviour models do not suffer from the hypothetical market bias often associated with contingent valuation and help in the study of welfare effects of environmental changes beyond the range of existing data, and yet are grounded in actual behaviour. Von Haefen et al. (2008) developed a combined revealed and stated preference approach to identify discrete choice demand in the presence of unobserved determinants of choice which the empirical results indicated that there are potential gains from fusing the two preference approaches.

Hence, there are few available studies (like Delang, 2006) in environmental economics literature that have combined (and compared) revealed and stated preference data sources to examine forest income. Except for Urama et al. (2006) most comparative studies have been done in either USA or other developed economies and majority of these are recreation demand models. The advantages of combining RUM and CVM preferences data, in a rural poor economy like Kenya, for analyzing valuation estimates of NTFPs help increase in knowledge available and enhance the possibility of improving and adapting these models for better management of environmental commodities in developing countries.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In analyzing the demand for non-timber forest products (NTFPs) in South Nandi both revealed and stated preference valuation methods were used. Random Utility Model was used to measure the use values, and both the use and non-used values were estimated using Contingent Valuation Method of the non-market benefits of forest resources. The contingent market assesses the willingness to pay (WTP) for improved provision of non-timber products of the forest ecosystem. Random utility model estimates were obtained by providing a surrogate market for use values where the price of commodity substitute or that of the best alternative are estimated.

In this study direct interview schedule was used. A questionnaire was constructed to obtain information on the contribution of NTFPs to household income and to estimate the economic value of the forest resources for efficient allocation through better pricing mechanism. Secondary data was also collected and utilized in this study. Statistical Package for Social Sciences (SPSS) version 17.0 was used to manage and analyze the data. In the random utility model we presume that the utility provided to the households by the forest products is composed of a deterministic monetary component, which can be calculated based on the household's expressed preferences in the actual market. This study attempted to answer the following main questions: What are the effects of the various income portfolio activities on the household income diversification? What are the socio-economic factors affecting the household mean share of NTFP income? Do household estimates of stated preferences and revealed preferences converge? What are the factors affecting option demand for NTFPs, and how are the benefits of NTFPs shared? Do NTFP earnings reduce income inequality among households?

This research provides an in depth investigation of the estimates of main income sources namely farm, off-farm and forest incomes. The farmland size, an important determinant of farm income and a measure of wealth, number of animals owned, education levels and occupation of the household characteristics were enumerated. Forest extractive activities and resultant incomes, household uses of forest resources and the economic valuation of non-timber forest products using both random utility model and contingent valuation method were some the of variables measured. The information generated by this study will be useful for households in terms of policy decision making regarding NTFP allocation efficiency for better poverty and inequality reduction measures in the rural economy.

3.2 Theoretical Framework

Rural households maintain diversified livelihood strategies (or income sources) due to insufficient income from any single strategy and also to reduce consumption risks (Sunderlin et al., 2005; Vedeld et al., 2007; Tesfaye et al., 2011) and to stabilize or smoothen, or both, income variability over time. Improving diversification opportunities give households more capabilities to enhance livelihoods security and raise standards of living (Ellis, 1998). Most forest peripheral households are smallholder farmers involved in on-farm, off-farm and forest activities for daily livelihoods or/and as coping mechanism in the face of economic variability and environmental shocks (Fisher et al., 2010). Since non-timber forest products complement rural household incomes (Vedeld et al., 2007) economic valuation of NTFPs assist in financial equity, efficient allocation and sustainable management of these resources. It also contributes to better understanding of threat to natural ecosystems as a result of pressing livelihood needs.

This study used both consumer theory, in which consumers are assumed to be motivated by utility maximization rational in their rational consumption decisions, and utility theory where consumers are able to rank their preferences even though the utility in itself may be impossible to measure. Therefore concept of economic valuation is founded on welfare economics (Nijkamp et al., 2008) where people are motivated by utility maximization of goods and services. In economic theory people have preferences for environmental goods that are revealed by their consumption in the market system. These preferences are often hidden and are capable of translating into monetary units if the appropriate market scenario is provided. Hence, economic valuation of these goods is important in showing that the resources are not finite and free even in the absence of efficient market (Kula, 1994).

The validity of a measure of an economic value such as RUM and CVM willingness to pay is the extent to which these estimates measure the true value (Chambers et al., 1996). The most prominent validity tests are criterion validity, convergent and construct validity (Mitchel et al., 1989). A criterion validity tests for the consistency of an economic value of an environmental commodity and a criterion variable such as an actual market transaction (Chambers et al., 1996), while convergent validity tests compares the values from two valuation preference methods such as random utility model and contingent valuation techniques (like in Whitehead et al., 2000; Urama et al., 2006; Whitehead et al., 2010). Construct validity, also called theoretical validity or internal validity, tests the degree to which a dependent variable (such as willingness to pay amount) is measured against variations of explanatory variables in which consistency with theoretical expectations is assessed (Schläpfer, 2008). That is, it assesses the robustness of the empirical model to the underlying theoretical construct (Urama et al., 2006). For example, theoretical validity tests the effect of socioeconomic variables like income, age, sex and education on WTP for NTFPs. This research applies all the three validity tests.

The economic valuation of non-timber forest products in this study is based on the assumption that environmental goods can be expressed as arguments in a well-behaved utility functions (Perman et al., 2003) in which the demand for these services can be expressed in a utility function of the general form:

$$d = f(P, C, H) \qquad \text{Equation 3.1}$$

Where;

d = is the utility of the NTFPs as expressed in household demand

P = expresses the price of the commodity to be purchased (stated and revealed WTP estimates)

C = is the consumption of substitute and complementary marketed goods to forest products

H = shows household utilization of improved environmental service.

3.3 Conceptual Framework

Non-timber forest products have non-competing consumption and non-market driven excludability among the forest-fringe dwellers. NTFPs need to be priced adequately for continued supply and improved management of natural ecosystems (Bö rner et al., 2009). This study attempts to estimate the monetary value of use and non-use values of forest-based products in South Nandi. As stated earlier as well, random utility model and contingent valuation method were used to capture both the marketable and non-market benefits of NTFPs. These methods are both based on consumer theory, and their theoretical framework are similar except that CVM involves directly asking people, in a survey, how much they would be willing to pay or willing to accept compensation for improved or reduced, respectively, environmental goods or services while RUM estimates WTP from the peoples revealed preferences in the conventional market situation. In the following subsections we elaborate more on each of these methods.

3.3.1 Random Utility Function

Random utility theory has been developed to analyze discrete consumer choices and measure welfare implications of changes in demographics and/or attributes of the available choice set (McFadden, 1974; Domencich and McFadden, 1975; Herriges et al., 1999). The random utility model presume that the utility U_{ij} provided to *i*th household by $_j$th forest product is composed of a deterministic component y_{ij}, which can be calculated based on revealed market prices of the forest goods or the substitutes in the market. Households' choice of utility maximizing strategy is a function of household specific characteristics and other alternative income strategies (Tesfaye et al., 2011). This study uses random utility model based on consumer utility maximization where forest-adjacent households choose to extract NTFPs as means of diversifying portfolio of income activities (Ellis, 1998).

Dependency on forest income, as revealed in willingness to pay for the forest goods in the market place, is a function of several factors that can be expressed mathematically as:

$$Y_{ij} = \beta_0 + \beta_1(X_{1i}) + \beta_2(X_{2i}) + \beta_3(X_{3i}) + \beta_4(X_{4i}) + \beta_5(X_{5i}) + \beta_6(X_{6i}) + \beta_7(X_{7i}) + \varepsilon_i$$

Equation 3.2

Where:

Y_{ij} is RUM valuation of forest goods in Kenya Shillings, (X_{1i}) is off-farm income, X_{2i} is the educational level of household head (1 indicates primary education, 2 secondary education and 3 college and above education), X_{3i} is the index of diversification (section 3.4.3 below shows how this variable is measured), X_{4i} is the number of cattle owned by the household (since fodder forms a major part of NTFP income. Goats are not allowed into the forest by KFS and most sheep rearing households practice tethering near the homesteads), X_{5i} is the household farmland size (which determines the farm incomes, and is generally a measure of wealth), X_{6i} is the household proximity to the forest (measured in km from homestead), X_{7i} is the years lived in the village, β_{is} are parameters not known but are to be estimated and ε_i is the stochastic term. Tests for multi-collinearity showed no correlation between any of the explanatory variables.

The utility each household derives from the extraction of forest products is expressed as

$$U = f(NTFPs, C) \qquad \text{Equation 3.3}$$

Where U is the utility function, *NTFPs* are the non-timber forest products and C is the costs of extraction (including time, money and labour). The NTFP income revealed in the RUM values:

$$Y = f(P, F, B, V, M, H, W) \qquad \text{Equation 3.4}$$

Where Y is the total household NTFP income, P is livestock pasture income, F indicates firewood income, B is honey income from beekeeping, V is vegetable income, M income from mushrooms, H is income from herbal medicines and W is income from wild-fruits.

In extracting non-timber forest products households are constrained by the independent variables in equation (3.2) above;

$$Y = f(X_{1i}, X_{2i}, X_{3i}, X_{4i}, X_{5i}, X_{6i}, X_{7i}) \qquad \text{Equation 3.5}$$

Maximization of NTFP utility subjects to the constraints yields the indirect utility function:

$$V = V((X_{1i}, X_{2i}, X_{3i}, X_{4i}, X_{5i}, X_{6i}, X_{7i})k, l) \qquad \text{Equation 3.6}$$

Where

$V(.)$is the indirect utility function which is decreasing in household education level (X_{2i}) index of income diversification (X_{3i}), household farmland size (X_{5i}), proximity to the forest (X_{6i}).The more education level of the household head creates better access to a greater diversity of income opportunities (Adhikari et al., 2004; Fisher, 2004; Heubach et al., 2011) and therefore, the higher the formal education, the lower the utility derived from forest products expressed in reduced dependence on NTFPs. Farmland size determines agricultural production, which influences farm income, and hence with increased farm income NTFP extraction is likely to decrease (Vedeld et al., 2007; Heubach et al., 2011). The proximity of the forest from the household homestead affects opportunity costs of time and hence reduces utility of extracting forest resources (Godoy et al., 1997; Mamo et al., 2007). The utility function increases with off-farm income X_{1i}, number of household cattle X_{4i}, years lived in the village X_{7i}, household capital (k) and labour (l). The reason for this is that increase in all these variables would increase the utility in extracting more of forest products (see section 3.6.3 for detailed explanation of the effects of these explanatory variables on forest products' dependency).

The marginal utility of the constraint variables is equal to the marginal utility of NTFP income (Y) multiplied by the marginal product of constraining variables, that is:

$$\frac{\partial V}{\partial X} = \frac{\partial V}{\partial Y}\frac{\partial Y}{\partial X} \qquad \text{Equation 3.7}$$

This means that limiting the extraction of NTFPs affects only the utility of the households in which the marginal product of the constraining variables X which is X_{ij} is positive. In other words, the marginal contribution of a unit of forest-based product to household income is equivalent to the marginal products of positive constraints.

The willingness to pay (WTP) for the NTFPs is equal to the marginal utility of NTFPs divided by the marginal utility of X_{ij}

$$\text{WTP} = \left(\frac{\partial V}{\partial Y} \Big/ \frac{\partial V}{\partial V} \right) \quad \text{Equation 3.8}$$

Hence, the willingness to pay for consuming non-timber forest products, as revealed in their market prices or that of substitutes, is a function of household utility derived in extracting forest products as an income activity as constrained by explanatory variables (which are household specific characteristics and alternative income strategies). In other words, as shown in equation 3.8 above, the RUM willingness to pay is based on the marginal contribution of NTFP income to household income as constrained by the forgone marginal utility of dependent variables.

3.3.2 The Contingent Valuation Function

In attempting to maximize utility, the households are constrained by socio-economic factors like income, age, sex, and distance from the forest. We bundle these variables and derive total utility function:

$$U_{ij} = \alpha + f(f_e, S_{ec}) + \varepsilon \quad \text{Equation 3.9}$$

Where:

α = is constant term in which each utility is assumed to be a linear function of:

f_e = is willingness to pay for forest products like livestock pasture support, beekeeping, medicinal plants, firewood etc in the contingent market.

S_{ec} = is socio-economic characteristics such as household income, age, education level, land size, occupation, sex etc, and

ε is the random component (or term)

According to economic theory the total maximum utility of the variables should be equal to the total maximum stated preference values by the households for the provision of the forest products. Hence,

U_{ij} = Maximum WTP_{ij}

and

Max. $WTP_{ij} = \alpha + f(f_e, S_{ec}) + \varepsilon$ Equation 3.10

should in principle be equal. That is, the Pareto Optimal level is equal to the maximum willingness to pay for the resources. Since we want to maximize improved income levels of the household, then improved income function is;

$Y^* = (Y_{ij} - Y_{fe})$ Equation 3.11

where Y^* indicates improved household income due to investments in forest-based products, Y_{ij} is income from conventional (i.e. non-forest) sources like farm and off-farm activities, and Y_{fe} is income resulting from engaging on forest business.

We consider income in CVM because the other socio-economic variables are explained by it.

Let us now substitute equation (3.11) into equation (3.10)

Max. $WTP = \alpha + (Y_{ij} + Y_{fe}) + \varepsilon$ Equation 3.12

We now find the derivative of the above equation to obtain:

$\frac{\delta Y_{ij}}{\delta Y_{fe}} = Y^* = \delta WTP$ Equation 3.13

This means that the equilibrium is where the marginal rate of substitution between conventional income sources and income from extracting NTFPs are equal. This is the level of households' maximum WTP amounts in the contingent market for improved provision of forest products. The maximum WTP value indicates the total price households are willing to place on the environmental improvement service and express utility derived from the forest goods. According to Pareto optimality theory maximum willingness to pay – as a stated preference - in an improved service market is equivalent to Pareto optimum level, and hence, marginal $WTP = Y^*$. That is, the marginal utility of income is equivalent to the marginal willingness to pay.

Where, $\frac{\delta WTP}{\delta Y^*} \neq 0$, and, say it is positive, in the market equilibrium which means that a small increase in the supplies of forest products available for consumers (or forest resource extractors) will improve household welfare.

And, where, $p(\frac{\delta WTP}{\delta Y^*}) = 0, p$ being the present income level, which means that a small increase in the value of forest service will leave the income improvement of the household and availability of the forest products unaffected.

3.4 Description of the Study Area

The study was conducted among Kenya's rural households living adjacent to South Nandi Forest Reserve in Nandi County. South Nandi forest, located about 320 km west of Nairobi, is among Kenya's few remaining tropical forests and is an extension of the Kakamega forest (Fig 3.1 below). South Nandi lies within Latitudes 0^0 and 0^0 34 North and Longitudes $34^0$45 and $35^0$25 East and occupies an area of 498 km^2. The South

Nandi forest of about 18,000 hectares was designated a national forest reserve in 1936 as part of the government's forest conservation efforts and is surrounded by a densely populated agricultural landscape with over 301 inhabitants per km^2 (District Statistics, 2011). The forest is rich in a large variety of rare species of birds and butterflies, and small population of wild animals especially leopards and primates. These bird and animal species are managed by Kenya Wildlife Service (KWS), who does not allow any extractive activities.

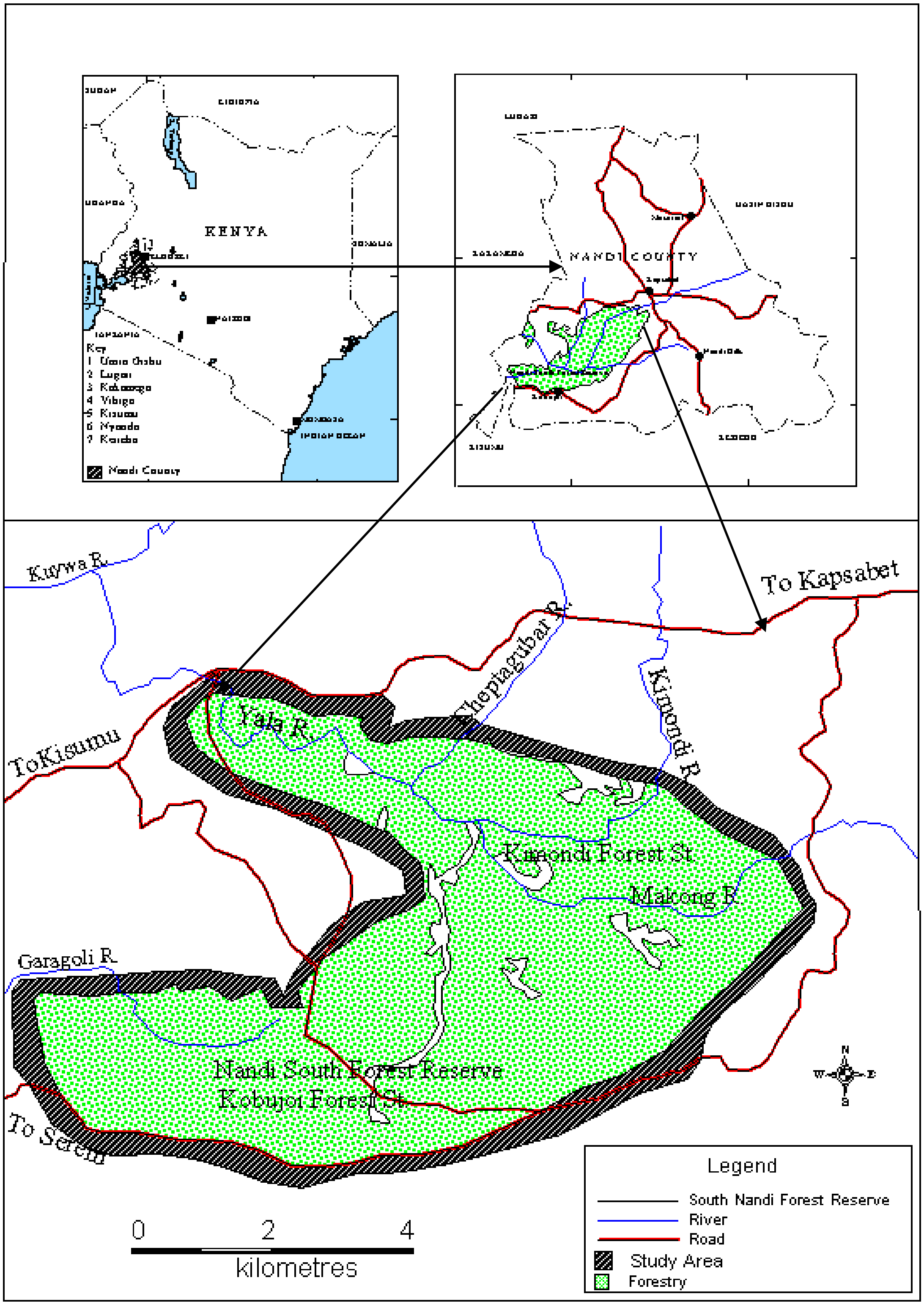

Figure 3.1: Map of Nandi County showing south Nandi Forest Reserve.

Source: Author

The area is generally hilly with thick layers of red soil anthills that are favourable to the growth of natural forests, which serve as watersheds for the major rivers and streams in the region. South Nandi has a cool and moderately humid climate with mean temperatures ranging between 18^0C and 23^0C. Its mean annual rainfall is between 1500mm and 2000mm per annum and the altitude ranges from 1300 metres and 2500 metres above sea level (Republic of Kenya, 2009). The long rains start in early March and continue up to the end of June, while the short rains start in September to November. It is in these months that households generally collect wild-fruits and mushrooms because they are seasonal products. During the off-season period of December to March more people depend on the forest for animal pasture, water and vegetables. Over 70 % of the forest is disturbed, with 30% heavily disturbed (Forest Officer, 2011) and due to increasing unemployment rates and population growth of 2.9% per annum (Republic of Kenya, 2009) growing demand for forest commodities are likely to put extraction pressure on the forest.

The Kenya Forest Service (KFS), which was given the mandate to manage and conserve the forest, is currently in process of partnering with the local community in the forest management under the premise of 2005 Forest Act. This parliamentary Act allows local communities to extract designated forest resources, under Community Forest Association (CFA) and User groups' organizations, and participate in the sustainable management of the forest. The KFS allows free access to the forest for both local population and visitors but require permits to be purchased for any kind of forest extractive activity e.g. livestock grazing on forest pastures, firewood extraction and beekeeping.

Despite the installation of the permit system people, who are primarily small-scale farmers, continued to make use of forest resources, both legally and illegally (Börner et al., 2009). Apart from recreational and other non-use forest values, like protection of water catchments and preservation of overall ecological system, forest goods are considered by the local community as important economic commodities. Knowledge of the real (and also surrogate) market price of forest goods helps policy makers to recognize their economic values and their worthiness of protection (Delang, 2006). It is therefore desirable to improve the current forest products management systems through better and efficient pricing mechanism.

The dominant livelihood sources in the area are rain-fed crop production, forest-related activities and animal husbandry. The main agriculture activities being tea growing, maize, beans, potatoes, horticultural crops, fruit trees, bananas, Irish potatoes, sugarcane, pyrethrum and beans production. Livestock husbandry in the region ranges from cattle over medium-sized livestock (cows, goats, sheep) to poultry (chicken, guinea fowls). Forest-related activities include extraction of woodfuel, building materials and non-timber forest products like livestock fodder, medicinal plants, and edible fruits. Other income sources are wage earnings, and business activities, both formal and informal. It is estimated that over 60% of the region’s household incomes are from the agriculture sector (Republic of Kenya, 2009). However, data for the magnitude of these incomes are not available, yet these economic activities are the opportunity costs that the farmers forgo for forest conservation. Incomes from forest-based products are not mentioned in the district development plan yet their contribution to community welfare is immense (Kamanga et al., 2009; Das, 2010). Hence, poverty estimates and its reduction strategies in South Nandi without the capture of the important sources of poor people's income, such as environmental income, will result in flawed results and policies as also observed by Cavendish (2000) and Vedeld et al. (2007).

3.5 Sampling Design

This research conducted from January to April, 2011 and households adjacent to the South Nandi forest were interviewed. An original survey design was constructed to solicit participants' responses on household income diversification strategies, forest resource use and the valuation of non-timber forest products in study area. A pre-testing of the survey instrument was conducted among ten randomly selected households prior to implementation of the survey and then the questions were adjusted accordingly. A structured questionnaire survey was used in twenty-four villages adjacent to the South Nandi forest. The selection of the villages was based on their proximity to the forest from information provided by chiefs of the six locations in periphery of the forest. The villages are, on average, within four kilometres radius of the forest edge.

In selecting the number of respondents for this study the cost and time for the research enumeration was considered. There are several criteria for selecting sample size in general, but for this study the formula below was used in arriving at the representative sample size,

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where $n =$ Sample Size, N is Population Size, C is Coefficient of Variation (30%), e is Standard error of 2%.

Households were sampled from 2009 national census survey data which provided a list of totals of households in the study area. Using the above formula a total of 224 households was chosen representing 16% of the household population of the selected villages in South Nandi.

In order to provide every household within the research area equal chance of being interviewed sampling was done in two levels: multi-stage stratified sampling and systematic random sampling. In multi-stage sampling the area Chief was asked to provide the number and names of villages in the location. An average of four villages adjacent to the forest was selected for sampling in each location and then the village elder was asked to provide the list of all the households in the villages chosen. Finally, to get the number of households per village to be interviewed, the target number of respondents in the location was divided by the number of villages.

Systematic random sampling procedure was used to identify the households to be interviewed. The total number of households from the list given by the village elder was divided by the number of households required in the village. This was used to pick every number of a household from the total households list starting from a random number between 0 and the interval number. The randomly picked household was interviewed.

The households and not individual respondents were used as decision units in the data analysis since forest resources are often extracted to meet family needs and most of the products serve the household as a consumption unit like livestock pasture support. Most people in the rural areas are farmers who treat land as a household commodity. Also, income improvements from investing in forest products are experienced as a household. The other reason is that household's responses give a more objective assessment of the natural resource use than on an individual basis. Hence, the household's characteristics were measured and used as explanatory variables instead of individual responses.

The head of the household or a delegated person was the respondent to the questionnaires administered. The household head was a person who was the most senior member of the household - responsible for every day decision-making and whom the rest of the members were answerable to. This person can either be male or female and in the event that person was not able to answer well the questions asked, then this responsibility was delegated to another person of households' choice who is over 18 years of age. For the purpose of this study a household is defined as a person or group of persons who live, share a common food source and are answerable to the same head (Casley et al., 1988; Mamo et al., 2007). Hence, this research applied this definition of the household in determining what constitutes a household or not in sampling design.

3.6 Survey Instruments and Procedures

In this study questionnaire survey was the main instrument for the collection of household data. The interviewer gave a general introduction to the respondent on the intentions of the research and sought interview identification information of the residential area and notes the date of the interview. The questionnaire instrument had three sections. They are; socio-demographic characteristics of the household, forest resources and household income, and economic valuation of non-timber forest products. Interview schedules were used to get data on the management of non-timber forest products. The officer of Kenya Forest Service in-charge of South Nandi forest station was interviewed on the strategies and constraints in managing the forest resources. In the second part of interview, schedule survey on community participation in management through community forest association (CFA) was done. Interviews were used because they are efficient in information collection and cost effective.

3.6.1 Data on Socio-Demographic Characteristics

The households in these villages consist mainly of farmers depending on agricultural crops like maize, small-scale tea production, and animal husbandry. Like other tropical forests where adjacent communities depend on forest resources (Babulo et al., 2009, Coulibaby-Lingani et al., 2009, Heubach et al., 2011) the people on the edge of the South Nandi forest rely on NTFPs for both full-time and *ad hoc* income. Also off-farm income activities are used as secondary sources of income. The forest is managed by the Kenya Forest Service (KFS), which is a government agency, on behalf of the central government. KFS is mandated to protect and conserve the 18,000 hectares of forested area. But there is an on-going negotiation on policy agreement between the local communities, through community forest association (CFA), and KFS on the operationisation of the 2005 Forest Act. This Act encourages community involvement in forest management through Community Forest Associations (CFAs). It encourages small and medium sized NTFPs enterprises for improved livelihoods as means of sustainable forest management.

Since socio-economic and demographic information provides a benchmark data on the economic and social variables that are used to measure the effects of the independent variables on the dependent variable, the respondents were asked to reveal their socio-economic characteristics. Some of the socio-economic characteristics are household income level, farmland size, age of the respondent, proximity of forest from homestead, sex of the respondent, educational level of the respondent, main occupation, number of livestock owned and household size. Socioeconomic data was used to verify the authenticity of the responses of the interviewees to the questions.

The questions on income level, land size and distance to the forest were structured to encourage confidence in responding to the questions because some people take such issues as sensitive to be revealed. During the survey the age and sex of household members were recorded differently in order to verify the authenticity of the responses of the interviewees. This is to minimize mistakes during the survey exercise on the enumeration of household members.

The socio-economic and demographic data is important for verifying the validity of economic valuation amounts and explanations for the reasons for willingness to pay values bided in the multivariate analyses. Before the analyses of willingness to pay (WTP) responses were undertaken, the data was ‘cleaned’ by removing ‘protest responses' of respondents who reject the hypothetical market scenario and those who refuse to give meaningful answers (Pearce et al., 1994). This was done by seeing if respondents bidding very high or very low have the socioeconomic characteristics that one would expect to be associated to such response. Household characteristics are also important for RUM valuation to determine the prices of forest goods in the normal market system and of their substitutes.

3.6.2 Regular Household Income Data

Formal or regular household income (exclusive of forest income) is the aggregate of total farm and off-farm incomes or the income from portfolio of activities that are formal in the sense of national income accounting. Information on income from the major farm activities, that is agricultural production and animal husbandry, was collected. The unit output per month, year or season of the main crops like tea, maize, beans, horticulture, bananas were obtained and the respondent asked to estimate market prices of the commodities. The prices of these crops varied depending on the buyers (tea is mainly bought by multinational corporations and Kenya Tea Development Authority), location of household from urban centre and means of communication. Cattle, sheep and goats are the main livestock reared in South Nandi and their incomes included the sales and products consumed within the household. The forest pasture is included within NTFP incomes as it is consumed almost for free (section 3.6 below explains in detail economic valuation of NTFPs). Poultry like chicken and turkey are also kept. The total household income from these sources was obtained from enumerating unit sells and prices fetched in the market. The prices quoted were verified using key informants and Ministry of

Agriculture officials. This was important to reduce information biases. An in-depth analysis of crop and animal production inputs was not conducted in the study because the main focus is general income estimates of the farm activities vis-à-vis forest incomes.

Off-farm income was calculated mainly from off-farm activities that did not involve forest extraction. These activities include; retail trade, salaried employment, casual work, craftsmanship, brick making and *Boda boda* (bicycle and motorbikes transport) business. The income amounts from these activities were direct as the respondents easily provided monthly or yearly earnings. The total (formal) incomes were counter-checked with the socio-economic data like land size, formal education and occupation to authenticate the results.

3.6.3 Measuring Index of Diversification

Generally rural households, especially in developing countries, are involved in income diversification strategies to improve domestic income, cope with income changes and to meet other livelihood needs (Vedeld et al., 2007; Illukpitiya et al., 2010; Heubach et al., 2011; Tesfaye et al., 2011). Diversification theory suggests that any decreases in total production may be outweighed by the decrease in risk associated with producing a variety of goods (Shone et al., 2006). In this study, a diversity variable, for diversification levels of income, was constructed from household's all sources of income, namely; off-farm income, farm income, and non-timber forest product income (in RUM estimates). An inverse Simpson index of diversity was used (Hill, 1973) as applied in Valdivia et al. (1996), Illukpitiya et al. (2010) and Heubach et al. (2011):

$$\text{Index of Diversity} = 1 \Big/ \sum_{i=1}^{N} P_i^2 \qquad \text{Equation 3.14}$$

$$\text{Where} \sum_{i=1}^{N} P_i^2 = \left(\frac{Y_1}{Y_T}\right)^2 + \left(\frac{Y_2}{Y_T}\right)^2 + \left(\frac{Y_3}{Y_T}\right)^2 \qquad \text{Equation 3.15}$$

N represents the number of household income sources

P_i is the proportion of household income from activity i

The income source (Y_1) is off-farm income, Y_2 represents on-farm income, Y_3 is income from non-timber forest products in random utility valuation and Y_T is the aggregate household income from all the sources. The diversification index is affected both by the income sources and the distribution of income between the different sources (Valdivia et al., 1996). The inverse index help to understand the effective income sources used in diversification in which the squared term allows for non-linearity. A diversity index of 1 means there is no diversification at all. A diversity index close to the number of income sources (3) indicates a more uniformly distributed income from each of the sources.

3.7 Economic Valuation of Non-Timber Products

Non-timber forest product incomes are from households engaging in forest related activities reflected in the products for sale and the monetary equivalents of those consumed within the household whether directly like firewood and vegetables or indirectly like livestock pasture. NTFPs such as livestock fodder, firewood and beekeeping are priced, mostly below their market values, but are generally consumed almost for ‘free’. Other products like vegetables, medicinal herbs and mushrooms, although marketable, are not priced at all and hence are extracted and consumed for free.

Economists have developed a number of techniques which can be used to assess the economic benefits contributed by non-timber forest-based products to household income.

Multiple valuation methods are important for the convergent validity of the economic estimates to the extent that when revealed preferences are close to stated preferences (that is, they converge), then the results confirm the validity of each measure (Mitchel et al., 1989; Whitehead, 2000). However, convergent validity does not verify the accuracy of the RUM or CVM means as to the true estimation of the population preferences of the respondents (Urama et al., 2006), unless the CVM money choices would be implemented via actual payments in exactly the same conditions as RUM. A comparative study assists researchers to understand the impact of respondent uncertainty on valuation of forest-based products. The use of the two methods help diminish individual weakness while enhancing their strengths and hence, improving quality of analysis results. A comparative consumer willingness to pay estimates for forest goods from random utility model and contingent valuation method provides the identity of various instrumental value responses of economic signals revealed by the forest products to the households. For example, option valuation is only possible in CVM study while index of income diversification, Gini coefficients computations and compensating variation analyses work in RUM valuation. Finally, the CVM information assists in new forest management policies and strategies such as analysis of current user fees and payment mechanism and effects on valuation on NTFPs. That is, it would incorporate conditions beyond the current managerial experience. Therefore, a combined RUM and CVM analysis assists policy makers to be confident when using the results from either methods and more importantly, understand the effects of resource pricing in the consumers' valuation dynamics. This section explains the application of Random Utility Model and the Contingent Valuation Method in estimating the economic values of NTFPs in South Nandi.

3.7.1 Random Utility Model (RUM) Valuation

RUM assists to analyze consumers' trade-off decisions that are consistent with the household utility framework. The RUM valuation estimates is based on observed economic behaviour (Heal et al., 2005; Freeman, 1993) that reflects how much individuals are willing to pay to get environmental goods or services. It is a market-based approach.

In valuing the household income from forest firewood, the quantity extracted per day per head-load (the unit used by the KFS) by each household was computed. The market price, the price of a head-load in the nearby market or that of hawkers, is used. The firewood extracted legally or illegally was quantified for each household irrespective of the purpose for the collection of the wood, whether for sale or domestic consumption. The values of wild-foods and fruits were deduced by asking the respondents to recall the approximate quantities extracted (because these are seasonal products), the extraction trips and the prices of close substitutes are estimated. These products are mostly picked when people are engaged in extraction of other forest goods such as livestock grazing, firewood and vegetables.

Vegetables are generally grown in areas where charcoal had been burned or the forest tree cover is minimal. Some residents cultivate vegetables in the forest for commercial use although this is usually not allowed. The respondents' estimates of quantities (i.e. the units and the price of each unit) harvested on weekly basis and the prices fetched in the market were calculated. Mushrooms collected were quantified based on recall information and the local prices, or the prices of their close substitutes, estimated. In valuing forest honey harvested, the number of beehives and the average quantity of honey produced by the hives are calculated against their market prices.

In estimating the value of medicinal plants the quantities extracted are calculated and the incomes from the local herbalists are used to estimate the prices. The herbs used for treating livestock diseases are valued using their shadow prices: the market price of similar goods which are, for this case, the prices of alternative formal livestock drugs administered by veterinary specialists or quoted by the local veterinary chemists (e.g. the value of a quantity of herbs for treating foot and mouth disease is the price of the formal chemist drug prescribed by the veterinary specialist for treating the disease). Similar procedure was used for valuing the human consumption of herbal medicines by households. The local herbalists had knowledge of the quantities, prescriptions and substitutes of the medicinal plants for both human and livestock use.

In the valuation of livestock fodder the value-equivalent substitutes (Mamo et al., 2007) of the fodder was calculated by converting grazing land rental fees into the yield equivalent. The number of animals, including goats and sheep, grazing in the forest and the average stocking rates in acreage was calculated. The quantity of pasture consumed per day for all the livestock is assumed to be the same in a location. The local land rents for livestock pasture are calculated (rent differ for various crop fields). This method has advantage of being dynamic as the price of fodder depends on the local land rents, the type of livestock species and rates of pasture regeneration in the household land.

Labour costs were calculated as the total time allocated to an activity multiplied by the value of the time spent on that activity. The costs of materials and equipment used in collection and processing of products were approximated. The forest user charges were included among the costs. The mean RUM values express the household valuation of the forest goods. A regression analysis was carried where the independent variables are forest products and the socio-economic demographic characteristics. Analysis of variance (ANOVA) tests, chi-square and student t-tests were the test statistics used.

RUM was chosen from the market-based approaches because of the following reasons: Random utility model is an important instrument in solving the problem associated with effects of substitution between formal income and income from forest products. This model can be used to value changes in income due to specific characteristics of the forest products, and it is also able to capture the value of benefits of introducing a new forest product use. This latter advantage is especially important due to the 2007 operationalisation of the 2005 Forest Act, allowing for consumption of products that before were considered illegal. Finally, the value losses from limiting access to and harvest of certain products (for example, when there is over consumption and resource replenishment is required) are incorporated within the RUM framework.

3.7.2 Contingent Market Survey

Contingent valuation is used in this study for comparative purposes against the RUM estimates. The CVM is a direct, rather than an indirect, method of valuation and is essentially a survey-based approach in which individuals are asked in a structured designed survey questions about their valuations of changes (i.e. improvement or deterioration) in the availability of the environmental resources; and in this case of forest products. The economic theory upon which the CVM is based assumes that the respondent is rational in decision-making, has perfect knowledge of the good, aware about the circumstances in which product is supplied and the substitutes available.

The CVM survey was administered to the households, concomitantly with the RUM survey, to elicit their maximum willingness to pay for an improved provision of forest products and services' scheme. A forest trust fund (FTF) was proposed to finance the scheme and the households' willingness to contribute to the trust fund were elicited. The households currently pay monthly for livestock fodder and firewood collection while other NTFPs are extracted for free, as earlier noted. During focus group discussions it was noted that the local residents had a long-standing quest for measures that would mitigate the rate of forest degradation for continued provision of economic and environmental benefits to the adjacent communities.

3.7.2.1 The CVM survey design

There are three stages followed in the development of the CV questionnaires: information gathering, scenario setting/framing the hypothetical market and finally pre-testing/re-designing. Focus group discussions and key informants were conducted to provide relevant information on the changes in the availability of NTFPs and impacts of forest degradation on livelihoods and other environmental benefits like rainfall patterns, carbon sequestration, soil erosion arrest and biodiversity conservation. The findings of the discussion groups informed the selection of the appropriate payment vehicle, elicitation format and the scenarios for valuation. The questionnaire comprised: introductory framing and information, scenario setting and monetary valuation.

3.7.2.2 Introductory framing

This section of the contingent market survey dealt with concerns for public policy issues and the environment. In the initial stage of the questionnaire general issues related to the quality and quantity of selected public environmental services of primary concern in the study area were framed, including questions about respondents' understanding of the issues related to NTFPs. This was for the purpose of preparing them for the creation of the contingent market.

3.7.2.3 Scenario setting and description of the payment vehicle

In eliciting the willingness to pay values in the CVM survey a hypothetical market scenario was described. The hypothetical scenario was based on annual contributions to a trust fund proposed to finance the improvement in provision of forest goods and services.

The impacts of the improved provision of the forest goods were explained. The respondents were informed that to increase the flow of environmental services from the forest some experts have argued for the establishment of an independently managed Trust Fund to finance the management of the Nandi Forest and that all the community stakeholders were expected to contribute to and influence the management of the Fund. There was a unanimous agreement among the respondents that the proposed project was important for sustainable production and management of forest resources.

The study provided the contribution toward independently managed trust fund as the payment vehicle by which the respondents were to make the payments for improved environmental service. The purpose of the hypothetical fund was to enable realization of the surrogate market scenario in which the payment mechanism would reduce the prospects of protest bids. The trust fund has several advantages; one, since it operates through market-based transactions it was easily trusted by the respondents to manage the common forest resources. Two, it has the ability to achieve dynamic efficiency and sustainability. Three, the fund would reward forest products regeneration activities. Four, the income of the poor households would rise as their share of income from natural resources is high and hence solve problems of community wealth equity. Five, and more importantly, all the community stakeholders would influence the management of the fund and support efforts to conserve the forest ecosystem.

The respondents were explicitly informed that the new project could only succeed if they contributed in monetary terms for the forest product management and that the service would start soon. The way to contribute to the Fund was through payment for accessing the forest products. When the households were presented with the market scenario some wanted an elaboration of the working of the system while others associated it with information they had about the 2005 Forest Act. But majority of the respondents were willing to participate in the survey.

3.7.2.4 WTP elicitation method

After understanding the hypothetical market mechanism presented respondents willing to participate in the survey were asked to place a maximum yearly monetary value for continued provision of the forest products while those not willing to participate were asked to give a reason. The reasons for the "no" responses were classified as: "Not able to pay for improved forest products management", "Not willing to place a shilling value on the exercise", "Not well informed about it", "Simply don't want to participate in the survey" and "Non-timber forest products management is of no value". Each response was probed to understand the reasons behind each preference category. Finally, in order to estimate the monetary option value of NTFPs the respondents were asked to state their extra willingness to contribute money above the normal maximum WTP amounts to guarantee continued availability of the resources for future consumption.

The contingent valuation surveys investigated the validity of WTP bids by incorporating validation questions (for example, "In addition to contributing money for the forest products management would you also like to have a say in decision-making of the forest and the funds? How much more money would you be willing to contribute to the fund?", option valuation questions and socio-economic data), into the questionnaire that can be used to examine the effects of the theoretical determinants of the explanatory variables in the commodity demand function and the WTP valuation (Urama et al., 2006; Lienhoop et al., 2007; Bett et al., 2009).

This survey used the direct open question in obtaining the willingness to pay for the forest-based commodity. The advantage of the open-ended procedure is that it provides a bid variable that is continuous, and therefore allows an econometric analysis to be done. In general, different methods can be used for eliciting values in contingent valuations surveys. For instance, the hypothetical values can be elicited using single-bid games or multiple games. This study applied the single-bid games method in order to eliminate starting point bias associated with multiple games method (Freeman, 1993; Carson et al., 1996).

3.7.3 NTFP Dependency Model

In recent literature, forest dependency in regression models has either applied total forest income of households (Fisher, 2004; Illukpitiya et al., 2008) or relative forest income (Heubach et al., 2011). According to Mamo et al. (2007), Kamanga et al. (2009) and Heubach et al. (2011) forest dependency refers to the ratio of the NTFP income to the total household income. Relative NTFP income as forest dependency captures the share of forest income in relation to other household income sources and overall incomes, whereas absolute total forest incomes show magnitude of forest products' utilization compared across households (Heubach et al., 2011). In other words, relative income is the most appropriate measure for the forest dependency model as it determines the importance of forest income among other portfolio of income sources. Therefore, NTFP relative income is used in this study as the forest dependency. Forest dependency data are from the RUM valuation estimates. If majority of the NTFP dependency data lies between 0.2 and 0.8, in the linear section of the sigmoid curve, the results are considered reasonable good (Heubach et al., 2011) for dependency model. On the other hand, the impact of the economic contribution of NTFP income to overall household income is not significant if more processed data lies below 0.2.

The forest dependency is used as the dependent variable in the OLS regression model in which socio-economic variables were tested. The independent variables tested are off-farm income, level of formal education, land size, index of diversification, household proximity to the forest, number of cattle and years of residence in the present village. These variables were selected on the assumption that they are the main determinants of forest dependency in the rural areas of South Nandi.

3.7.4 Measuring Forest Benefits

Households receive direct benefits from the South Nandi forest by selling NTFPs and other forest goods, which act as a natural insurance premium, and also have indirect social benefits.

3.7.4.1 Logistic Regression of Option Demand for NTFPs

The future benefits of forest functions (or the future costs of their degradation) are uncertain and not fully captured by established markets (Chambers et al., 1994) and hence, with uncertainty of future conservation and effects of economic development, tropical forests assume an option value which if not included in the valuation of forest products would lead to current inefficient extraction of forest goods. Contingent valuation techniques have also been used to assess option and existence values of natural resources (Kula, 1994; Turpie et al., 2003; Amirnejad et al., 2006; Völker et al., 2010).

The option demand data for assessing the natural insurance value of NTFPs was obtained through contingent market. This involved obtaining the monetary option value of NTFPs as the household extra willingness to pay for the improved provision of forest products to guarantee continued availability of the resources in the future (Perman et al., 2004; Mcsweeney, 2005; Völker et al., 2010).

A logit regression model was used to determine the factors affecting option demand for NTFPs as expressed in extra WTP in the contingent market scenario. The independent variables were age of household head, formal education levels, number of own children, farmland size, information on forest products, number of cattle in forest, use forest as source of income (a binary variable), direct social benefits and indirect social benefits (respondents were asked to enumerate the various direct and indirect social benefits they receive from the South Nandi forest environment). The direct social benefits are bundles of direct benefits like employment, rainfall, recreation services, eco-tourism, cultural and religious benefits, and aesthetic value society enjoy. Indirect benefits include climate regulation, genetic resources capacity, bio-diversity, soil erosion arrest and carbon fixing. The dependent variable is option value responses gauged in an ordered scale score in which respondents reporting “yes” received one on the variable (and coded 1) and “no” zero (coded 0) on an acceptance or rejection point scale of the explanatory variables.

A logit regression was then performed with the choice variable. The basic logit probability of 'yes' or 'no' responses were estimated in the form of a logistic function:

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots \beta_n X_n + \mu_i \qquad \text{Equation 3.17}$$

Where:

Z is the log of Yes response divided by the probability of No response.

β_0 to β_n are the coefficients of the parameters of the explanatory variables.

X_1 to X_n represents independent variables.

μ_i is the stochastic term.

Thus, the functional form of the model is,

$$\text{Log NTFPs} = \text{Z} \qquad \text{Equation 3.18}$$

Where;

$$\text{Log NTFPs} = \frac{P}{1-p}$$

and

P = probability of independent variable influencing the option demand for NTFPs

NTFP = odds of demand (i.e. a Yes or No response logit prediction) for non-timber products.

3.7.4.2 Assessing Benefits Sharing of NTFPs using a RUM Compensating Variation Approach

Policy makers may want to determine welfare changes to forest peripheral households by imposing specific limits on household socioeconomic characteristics. The measure of welfare loss or gain can be calculated using compensating variation (Parsons et al., 1992;

Feather, (1994); Herriges et al., 1999; Zander et al., 2008). Varian (1990) defines compensating variation as the “change in income necessary to restore the consumer to his original indifference curve” (p.248). Reliable estimates of compensating variation can provide forest managers with more complete information regarding the economic implications of their policies, and may help in designing more effective policy measures (Thomas et al., 2002). Resource managers can also benefit from knowing which groups of forest users derive higher values from management decisions, such as changes in forest products access or resource quantity and quality (Colombo et al., 2009).

In order to assess the distribution of local benefits of NTFPs among the households in South Nandi a compensating variation in the random utility model was used to measure the changes in NTFPs utility attributed to changes in household characteristics. This analysis is an investigation of how socio-economic characteristics seem to account for the spread of forest incomes across households. It is an estimation of welfare effects of changes in explanatory attributes and to predict the share of resource benefits and costs among recipients of forest goods and services (Colombo et al., 2009). The compensating variation measures of a change in welfare (benefits of NTFPs) was based on an initial state as the reference point for valuing the change in welfare caused by the change in NTFP income (Knetsch, 2007). The variables with significant effect on the forest dependency (that was obtained from RUM estimates) were considered for policy variations. These include formal education, distance of household homestead to the forest, index of diversity, off-farm income, farmland size, and number of cattle.

For easy computation of RUM's compensating variation a welfare loss (negative) and welfare gain (positive) scenarios (Perman et al., 2003; Bateman et al., 2006) of alternatives were used to model the benefits of NTFPs income that would leave the household indifferent between gaining an improvement and remaining at the present reference point or a loss, which is a move to an inferior position to the reference point, in which the household is indifferent between avoiding the loss or accepting it (Knetsch, 2007) due to changes in FOREST PROXIMITY, EDUCATION, OFF-FARM INCOME, NUMBER OF CATTLE, and LAND SIZE characteristics. These factors are considered because they significantly influence the calculation of aggregate RUM willingness to pay values. Policy makers may wish to determine the welfare change to households by imposing restrictions on these independent variables and hence demonstrate the effects of the changes on redistribution of NTFP income. The compensating variation (CV) used in calculating the welfare policy changes in this analysis is given as:

$$CV = 1/\beta_f \left[\sum_{i=1} (V_1 - V_1^*) \right] \qquad \text{Equation 3.19}$$

Where

V_1 is utility of good with improvement

V_1^* is utility of good without improvement

$1/\beta_f$ is the RUM coefficient in the OLS regression model

The β_f expression gives a measure of the marginal utility of income. In practice, a marginal utility of incomes ratio closer to one shows a good performance of the explanatory variable in relatively equitable distribution of NTFP benefits among the users'.

In the income improvements and loss associated with aggregation and variation of the household characteristics, an OLS RUM regression analysis was performed and the ratios of the marginal utility of incomes (coefficient on the RUM price) of each RUM measure of NTFPs after loss and gain adjustments were calculated. The directional changes of the variables are not necessary in the analysis because they are basically dependent of each other (Parsons et al., 2002).

Two sets of policy scenarios are considered in the welfare analysis, which are; improvement and loss of benefits associated with extracting NTFPs. A welfare policy scenario for loss and improvements were computed for the percentages of the households within the threshold of loss and improvement envisaged for each explanatory variable. Also calculated are the percentages of the remaining households to be considered for adjustment (in a "what if" scenario, Zander et al., 2008) for both policy loss and improvement from a reference point already selected. The households are assumed to be indifferent to various points above or below the threshold level (reference position). For farmland size 1 hectare (equivalent to 2.5 acres) was set as the threshold point of adjustment so that a loss scenario occurs when the households (54.5%) with land holdings above 2.5 acres are made to have to this amount of land. This is because a farm size of 1 and above hectares is the recommended minimum land for efficient agricultural productivity (Ministry of Agriculture officials, personal comm., 2011). Hence, a policy improvement scenario occurs when all households who have less than 2.5 acres of land were adjusted upwards by setting the values of household farmland size to have the minimum farmland size (2.5 acres). For off-farm income, the number of cattle a household owns and years of residence in the village, policy scenarios were set at the average of off-farm income, mean total cattle a household owns and average number of years of residence in the village as points of threshold adjustment. 1 km was set for distance to the forest as 59% of households are within this point because for a closer distance to the forest we would expect more intensive extraction of NTFPs (see Mamo et al., 2007; Illukpitiya et al., 2010). The formal level of education was set at primary level as 68% of households are already within this threshold since this educational level and below is generally considered basic by Ministry of education officials (Personal comm., 2011).

3.7.4.3 Gini Coefficient of Income Inequality

Gini coefficients, which measure income inequality distributions, for household income were calculated to examine the equalizing effects of non-timber forest income among the households in South Nandi. A Gini coefficient was first computed for the total household income as defined, directly instead of deriving from the Lorenz curve, by Deaton (1997) and applied by Heubach et al. (2011). Then NTFP income was deducted and a new Gini coefficient was calculated (Mamo et al., 2007). The two coefficients are compared to determine the NTFP equalizing effect on income distribution across the households. In this analysis, the Gini coefficient is defined following Deaton (1997) as;

$$Y = \frac{N+1}{N-1} - \frac{2}{N(N-1)\mu}\left(\sum_{i=1}^{n} P_i X_i\right) \qquad \text{Equation 3.20}$$

Where Y = a measure of Gini coefficient

μ = Population average income

P_i = Income rank P of person i with income X

In order to satisfy the transfer principle, which effectively gives higher weight to households with lower income in the income distribution, where the measured inequality should decrease when income is shifted from the higher to lower income household given the original order of income ranks, a weighted ranking was done where the highest income household is ranked as 1 and the lowest income (or the poorest) household ranked N (Heubach et al., 2011). It is expected that NTFP income would reduce income inequalities between the rural households (Vedeld et al., 2007; Kamanga et al., 2009; Das, 2010; Heubach et al., 2011).

3.7.5 NTFPs Perceptions, Demand and Supply Data

To measure the households' perceptions of the forest products, respondents were asked set of questions concerning forest use activities, supply of NTFPs, demand for non-timber forest products and challenges faced in extracting forest goods. Using a four-point scale with "0" indicating *Not informed*, and "4" for *Informed*, the participants indicated how informed they were on the opportunities provided for in the 2005 Forest Act on forest-based enterprises and sustainable forest management. The supply of products to household was categorized as "1" *Abundant*, "2" *Moderate* and "3" *Scarce* and the quantities (and the participant provided the units which were corroborated with information from others and key informants) consumed by the household per month/season. Kenya Forest Service officials were asked to provide the supply trends from the 1980s to date and forecast upto 2030 using a scale from 0 to 8, where "0" indicates forest product *Not available at all* and "8" *Abundant supply* of NTFP, and a supply curve illustrating the trends of NTFPs from 1980 to 2030.

The household demand for NTFPs was formulated using the cumulative forest extraction trips to the forest (Kilchling et al., 2009). The number of extraction trips for each product per day or season was obtained from the participant. The respondent estimated the distance of the household homestead from the forest with the help of research assistants. The number of trips and distance to the forest help understand the economic and social values attached to the forest products. The relationship between the access trips and extraction of (secondary) forest goods by the household was determined using Chi-square tests. Establishing this is important for designing policies for restricting or promoting use of certain non-timber forest products on sustainable basis. Therefore, household frequency of forest visits to access the forest resources underscores the extent of demand and extraction pressure exerted on forest products.

3.8 Data Collection, Sources and Analysis

The household survey collected information on extraction and consumption of non-timber forest-based products in South Nandi area. Due to lack of reliable secondary data on forest-based products, especially information on household forest income, from government census and national or county income accounts, primary data was the main source of information. Primary sources provided information on the household consumption of non-timber forest products and forest management issues, community participation information, and household socio-economic and demographic data. The main sources of these primary data were interview surveys, questionnaire designs, physical observations, group discussions and key informants. Primary data was collected from January 2011 to March 2011. The secondary data was continually collected and updated during the entire research period, and during writing up process of this work. The data for the study was collected with assistance of two assistants who were trained on administering questionnaires and interviews.

Secondary data used were mainly from Ministry of Agriculture on general crop incomes, changes in commodity prices, rainfall patterns, and other household income sources in Nandi South. Data on forest user charges, rate of forest degradation, population of livestock in the forest, number of beehives, quantity of wildlife for hunting, seasons of the year when forest products experienced extraction pressures, forest map and information about investment opportunities in the forest according to 2005 Forest Act were obtained from Kenya Forest Service (KFS). The Ministry of Livestock Development and Ministry of Planning and National Development provided information on livestock products like milk, and relative price changes of the same sources of income, and population of households for sampling, respectively.

Once the various data types had been collected and coded exploratory analysis was done to reveal the simple structures and patterns in the data. One of the main purposes of exploratory analysis was to detect gross errors in the data which, if not dealt with before formal analysis, might lead to incorrect conclusions regarding both the range and shape of the distribution of a variable and the relation between variables. The other objective of data exploration was to help select the right tool for data analysis. The Statistical Package for Social Sciences (SPSS version 17.0) was used in the analysis of the willingness to pay from both the CVM and RUM value estimates of NTFPs.

Descriptive statistics tables were tabulated and percentages used as tools of analyses. Means, frequencies and standard deviations of the variables were calculated to better understand the data set and thus the issues under investigation. For bivariate analyses chi-square, F-test and student t-test were used to determine whether there are statistical mean differences between various explanatory variables. Correlation analyses were used to establish relationships between the estimated values from non-timber forest products to household income from the formal income sources, sex of the household head and contribution of NTFPs to total household income, among other variables. Multivariate statistical analysis was employed to establish any empirical relationships between various parameters of interest.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Overview

This chapter reports the study results and discussion. There are four sections in this chapter. The first section presents socio-economic and demographic data survey and discussion of the household profile. The second section analyses the link between forest resources and household income. The third section deals with the economic valuation of non-timber forest products where revealed and stated willingness to pay values are estimated. The fourth part presents the multivariate analysis of forest income dependency, sharing of NTFPs benefits among the households and convergence of random utility and contingent valuation preferences of non-timber forest products.

4.2 Socio-Economic Characteristics of Sampled Households

4.2.1 Socio-Demographic Survey Analysis

Majority of the South Nandi's forest-fringe households are headed by males (63 %) with an average family size of 7 persons. About 91% of the household heads are married and the few singles are women who are in the poorer section (Clark, 1996) of the society. The males work far from the homes either in formal employment or casual labour. The female-headed (37%) households depended generally on firewood, vegetable sales, wild fruits, and herbs for supplementing incomes since many of them have few alternative sources of income. Cavendish (2000) showed that female-headed households generally relied on sales of wild fruits, palm wine and grass thatching for income. Some forest income generating sources like beekeeping and livestock production are generally male dominated activities in the rural areas (Illukpitiya et al., 2010) and hence, indicating possibility of high demand for male-related forest activities.

Most (67%) of the respondents are in the most productive ages of between 26 and 55 years. The percent dependence in the households was high (74%) with household's own children below 16 years and unemployed relatives comprising 49% and 25%, respectively. The respondents (28%) who are in the ages of 56 years and above are beyond formal employment category, hence look for self-employment. Some of the elderly are dependent on their children for sustenance. The average number of years the household heads have lived in the village was 30 years, showing that the respondents could make relatively middle to long-term investments like livestock grazing in forest and beekeeping. Fishing, herbal medicines and firewood collection are products that are affected by longevity of stay in the area. Thus, with opportunities for food and incomes dwindling elsewhere, the household high dependence ration increases demand for the forest products by pressure within the household to use forest products to supplement incomes.

The average distance of the forest from homesteads is 2.2 kilometres, with the population density increasing with decreasing distance from the forest edge. The main reason is that people sold their land near the forest in smaller portions for fear of wild animals, which are no longer there (Forest officer , 2011, personal communication). Also due to lack of infrastructure land is generally cheaper near the forest and the poorer buy in small portions.

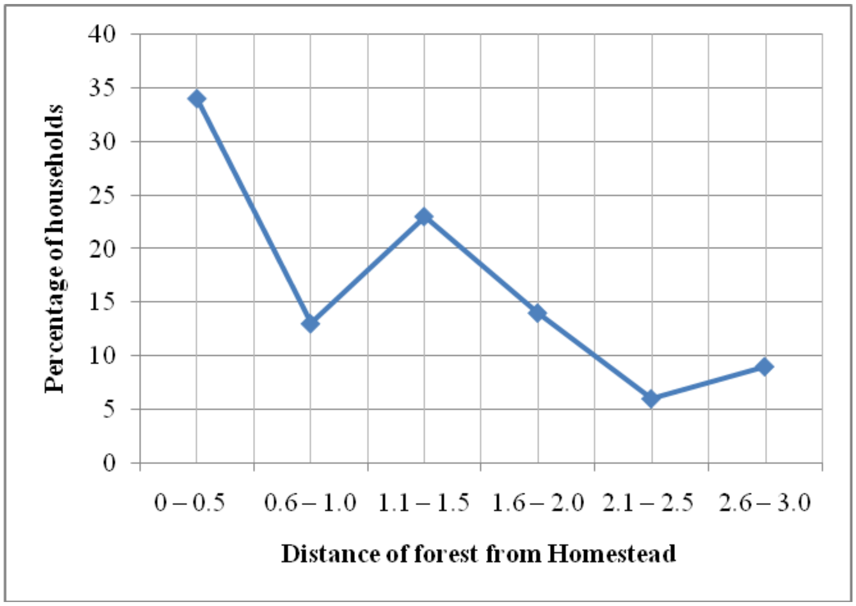

Figure 4.1: Distance of forest from household homestead

Source: Field survey

From Figure 4.1, 33% of households surveyed lived within a radius of 0.5 kilometres (km) from the forest edge while 13% of the households lived between 0.6 and 1.0 km. The distance of 23% of the homesteads was between 1.1 to 1.5 km from the forest edge while 14% of them were on a radius of between 1.6 and 2.0 kilometres. The remaining 15% households were between 2.1 and 4.0 kilometres from the forest. The Pearson correlation coefficient between the homesteads' proximity to the forest and both livestock pasture use and firewood collection was -0.8. This means that as the distance from the forest increases households reduce the use of forest pasture for grazing livestock and also the extraction of firewood. Opportunity costs for extracting forest resources reduces with reduced distance to the forest edge.

4.2.2 Economic Conditions of Sample Households

Although 82% of the respondents has formal education most of them (68%) has primary education and below. Those who completed secondary school are 23% while only 9% of the respondents had college and above education. Microeconomic theory suggests that the education of the household members positively influence awareness about impacts of forest resource use. The less educated people are also the poor in society who often depend heavily on the productivity and environmental services of ecosystems and natural resources for as much as 30 to 50% of their total income (The World Bank, 2004). Table 4.1 illustrates the household socio-economic and demographic characteristics.

Table 4.1: Socio-economic and demographic characteristics of the respondents

Variable	Percentage of households
1. **Household Gender**:	
Male	63
Female	37
2. **Age of Household head**:	
25 years and below	6
26-40	30
41-55	37
56 and above	28
3. **Education**:	
No Education	18
Primary Education	50
Secondary school	23
College and above	9
4. Occupation:	
Formal Employment	6
Businessman/woman	24
Farmer	100
Casual	16
5. Size of Household members:	
Age 0-16:	**49**
Males	(51)
Females	(49)
Age 17 and above:	**51**
Males	(52)
Females	(48)
6. Household period lived in village:	
i) 1-20 years	34
ii) 21 and above	66
7. Land size Distribution (in Acres):	
i) 0.1-2.4	46
ii) 2.5-9	48
iii) 10 and above	6

Source*: Field survey*

From Table 4.1 households in South Nandi did farming with other income generating activities like business (21%), formal employment (6%) and casual work (14%). Households basically depend on small-scale rain-fed farming for subsistence. The dominant crops are maize and tea, while beans and horticultural crops are grown during off-season periods. The area receives a bi-modal rainfall pattern which peaks in April – July and September – November. Since the average land size among the households sampled is 3.9 acres (equivalent to 1.6 hectares), supporting 94% of residents that have unreliable income puts pressure on them to look to the forest for supplementing the meager earnings like *ad hoc* sell of firewood and herbs. During the off-season period of December to March more households depend on the forest for animal pasture, wild-fruits, water and vegetables. Tropical forests generally help rural households adapt to climate variability (Fisher et al., 2010; Shackleton et al., 2007; Kamanga et al., 2009).

About 47% of households use free range method for feeding the cattle while 59% of them graze cattle in the forest. The households who use the forest to feed their sheep and goats are 16% and 28% respectively. Grazing of goats in the forest is not allowed by the Kenya Forest Service. With the high population growth rate of the areas of 2.93%/annum (district statistics) demand for increasing household incomes may require households to increase stocking rates, and thus, a higher demand for the forest to supply pasture. The same farm land (3.9 acres) is used for crop production especially tea and maize, and residential homesteads leaving an average of 1.5 acres for livestock pasture. This means that without the forests the family land may not support all the livestock under open grazing, with an average household herd of 4 cows. Indeed this poses environmental problems given that overstocking is a major threat to soil conservation (Tisdell, 2005; Croitoru, 2007) that cause siltation of downstream water structures. Hence, the preservation of the South Nandi forest provide watershed services that can have a number of positive externalities through regulation of hydrological flows that improves the quantity and quality of water flows downstream, reduction in sedimentation and flooding.

Table 4.2: Livestock Purpose and Feeding Methods

Household Livestock owned:								
	Feeding Methods (%)				**Purpose** (%)			
(Number)	A	B	C	D	I	II	III	
i. Cattle (969):	2	15	47	59	99	22	73	
ii. Sheep (95):	0	54	31	16	79	62	36	
iii. Goats (36):	0	22	11	28	67	47	58	

Notes: A is Zero Grazing
B is Tethering
C is Free Range
D is Forest Pasture

I is Sale
II is Consumption
III is Insurance

Source: Field survey

Most (73%) of the respondents keep livestock for insurance purposes. Cattle, as an investment, are driven into the forest for many months for the purpose of sale (22%) and to assist meet future household obligations like school fees payments, emergency financial demands such as hospital bills and debts. As more people send children to school and with reduced disposable domestic incomes due to rising consumer prices households would increase the number of livestock in the forest to serve as insurance premium. Forest income in many developing countries acts as insurance in periods of unpredictable economic shocks (Babulo et al., 2009), that is unexpected income shortfalls or cash needs (Vedeld et al., 2007).The poor also rely on forests not only for self-insurance but also for mutual insurance (Takasaki, 2011).

4.3 Link Between Forest Resources and Household Income

This section analyses the link between forest products and regular household income. Formal income (that is exclusive of forest income) sources in rural households in Kenya, as in other developing countries, are mainly from the farm and other off-farm activities.

Non-timber forest products contribute to household income economy by providing domestic subsistence and consumption requirements such as vegetables, medicinal herbs, firewood, wild-foods and fruits, which are primarily consumed within the household. NTFPs also act as substitutes to marketed commodities and therefore, their use increase disposable income to the household (Heubach et al., 2011). Apart from serving the role of insurance premium in times of economic hardships (Nasi et al., 2002; Shackleton et al., 2004; Paumgarten et al., 2009), NTFPs have contributed to direct monetary benefits to household through sales (Shackleton et al., 2004; Heubach et al., 2011). In other words, rural households have used forest goods for diversifying their incomes (Tesfaye et al., 2011).

4.3.1 Farm and Off-farm Household Economic Activities and Income Amounts

Households in South Nandi are typically farmers obtaining their income from crop growing, livestock production, and tree planting. Farm and off-farm income sources are mostly contributed by tea (51% of farm income) and salaried employment (52% of off-farm income) respectively. These two sources of income combined contribute 51% to the total regular household income. Tea farmers (62%) receive each an average of Sh.82, 416 per annum. The lowest amount earned from tea was Sh. 3,600 and the highest was Sh. 1,440,000. About 54% of the tea farmers earn below the average amounts. Huge income inequalities among households give incentives to the poorer sectors of society to engage forest products for income improvement (Illukpitiya et al., 2010). Also low opportunity cost of time and abundant domestic labour among poorer households increase their propensity to extract forest resources (The World Bank, 2006) to meet domestic subsistence and consumption requirements (Vedeld et al., 2007; Heubach et al., 2011).

Most of the households (98%) depended on maize production as source of income with an average yearly earning of Sh. 20,589. Income from maize production is statistically the same, in a paired t-test of 5% level of significance, as income from milk and livestock sells (Table 4.3). Respondents (51%) that grew horticultural crops earned an average of Sh. 10,338 which is not statistically different from milk production and livestock sells (62%) with an average of Sh.18, 097 per annum. Farmers in this area sell raw maize whose producer prices extremely fluctuate from an average of between Sh. 70,000 to Sh. 15,000 per acre in three months. These findings indicate that maize, livestock and milk production equally contributed to the average household income. Price fluctuations of maize imply that farmers have to increase investments in milk production and livestock sells to stabilize domestic incomes. This leads to increased demand for forest pasture and medicinal plants for treating the livestock. The Table 4.3 shows the various farm and off-income activities and their incomes.

Table 4.3: Farm and off-Farm household income activities and amounts

Variable	Sample size	Average income (Shs.)
1. **Farm activity**:		
i) Tea	62	82,416 (51)
ii) Maize	98	20,589a (13)
iii) Milk	73	19,927ab (12)
iv) Beans	74	4,934 (3)
v) Horticulture	51	10,338bc (6)
vi) Livestock sells	62	18,097ac (11)
vii) Bananas	34	3,443 (2)
viii) Cassava, arrowroots and sugarcane	9	811 (0.5)
ix) Tree sells	3	703 (0.5)
2. **Off-farm activity**:		
i) Retail trade	15	88,855d (21)
ii) Brick making	10	41,174fg (6)
iii) Casual labour	20	26,663deg (8)
iv) Salaried Employment	19	177,488 (52)
v) Boda boda	4	139,500ef (8)
vi) Craftsmanship	6	46,908 (4)
vii) Brewing	3	30,000 (1)

Source: Field survey

Note: 1. The figures in parenthesis show the average percentage income contribution of the activity to total income accruing to the households.
2. Values followed by the same lower case letter in a column are statistically equal.

A single t-test, at 5% level of significance, showed that even though tea posted the highest income amounts, maize, milk, livestock and horticulture were the most significant contributors to the total mean incomes. This is because tea had the greatest disparities between the lowest and highest income earners. Retail trade and casual labour are statistically equal with each contributing 21% and 8% of total household income respectively. Casual labour with average yearly income of Sh. 26,663 and boda-boda (motorcycle transport business) is also statically equal (Table 4.3 illustrates). Results from this study shows that due to low off-farm incomes many households would invest in forest resources to supplement domestic income. Forest products, hence, is a major fallback revenue source in times of financial stress during depressed farm output and increased commodity prices. Findings of Bluffstone et al. (2001) and Illukpitiya et al. (2010) indicated that off-farm income had negative and statistically significant effect on reliance on NTFPs, meaning that increased household off-incomes reduce forest extractive activities.

4.3.2 Household Income Diversification

Rural households have involved forest resource activities in their diversification programs that range from risk reduction to wealth accumulation (Valdivia et al., 1996; Barret et al., 2001; Tesfaye et al., 2011). Diversification, by engaging in various economic activities, helps even domestic disposable income throughout the year. In South Nandi, majority (77%) of the households have had increased income in the last ten years from several income portfolio strategies. For many economically marginalized rural people natural resources is a major source of income, and consequently these resources come under pressure to supply both environmental and livelihood benefits (Mutenje et al., 2010). In South Africa 50% of households considered NTFPs as an important or very important livelihood strategy (Paumgarten et al., 2009). Therefore, the forest resources play important role in dynamics of household incomes.

A diversification variable was constructed using the inverse Simpson index of diversity (Hill, 1973) and as applied by Illukpitiya et al. (2010) and Heubach et al. (2011) in order to understand the effective income sources used in diversification. Results showed that the inverse Simpson index of income diversification had mean of 1.94. This means that, from the Figure 4.3, 60% of the participants are likely to engage in two income sources, equivalent to households with diversification indexes of between 1.50 and 2.49, for spread of consumption and income risks. Also 19% of respondents had diversification index above 2.5, closer to 3 which is equivalent to the number of income activities, indicating a more uniformly distributed income across farm, off-farm and NTFPs sources. Results (t-values in the parenthesis) of the effects of the three main household diversifications strategies are:

$$\text{DIVERSIFICATION} = \underset{(39.014)}{1.845} + \underset{(3.470)}{0.218}\ \text{OFF-FARM} \underset{(-6.362)}{-0.405}\ \text{FARM} + \underset{(6.258)}{0.308}\ \text{NTFPs}$$

F value = 22.163, and R^2 (adj.) = 0.622.

Off-farm income had a positive and significant effect on index of income diversification. Thus statistical evidence indicates that off-farm income is not associated with reduced diversification of household income sources among residents of South Nandi. Since off-farm income had a strong significant ($p<0.05$) effect on diversification, it means that it contributed to household diversification strategies for improved income. It also indicates that households with off-farm income sources consider these sources unstable and unreliable economic activities to be depended on as the only domestic source of income. Results of Kamanga et al. (2009) similarly showed a positive relationship between off-farm and index of income diversity but Illukpitiya et al. (2010) and Heubach et al. (2011) found that off-farm income had negative influence on diversification.

Farm income, on the other hand, had an inverse effect on level of diversification. Thus, the statistical evidence indicates that more farm income reduces income diversification strategies among the households. These residents consider this income source as more financially secure and hence, are less likely to diversify income outside farming, which is concomitant with results of Illukpitiya et al. (2010) and Heubach et al. (2011).

NTFPs had an unexpected positive and significant effect with index of diversification. This means that the higher the income from forest sources the more likely is the household to diversify income. The unexpected influence may be due to low household income levels so that people used the forest resources as means of diversification to reduce consumption and income risks. That is, NTFPs are an important diversification strategy and therefore, revealing the importance of NTFP income to the households. This also indicates that people use forest income to diversify to other streams of income due to uncertainty of period of forest dependency and hence can fuel current resource over extraction. Households using NTFPs had higher levels of diversification than those involved in off-farm income levels indicating the people prefer to diversify more their income in forest activities than diversifying off-farm enterprises. This means that returns from forest sources are likely to be greater.

Majority (81%) of the respondents diversified their income sources as a coping strategy in the face of unpredictable consumer prices, weather variability and anticipated future domestic needs. Of these, about 21% had an inverse Simpson index of diversification of between 1.0 and 1.49, meaning that the distribution of income between the different sources was not even (Valdivia et al., 1996) or that they did not diversify their incomes at all. Higher diversification index shows more income generating activities and better distribution of income in between sources, which makes it easier to cope with risks associated with a single income source (Heubach et al., 2011). Figure 4.2 shows the household index of diversification trends.

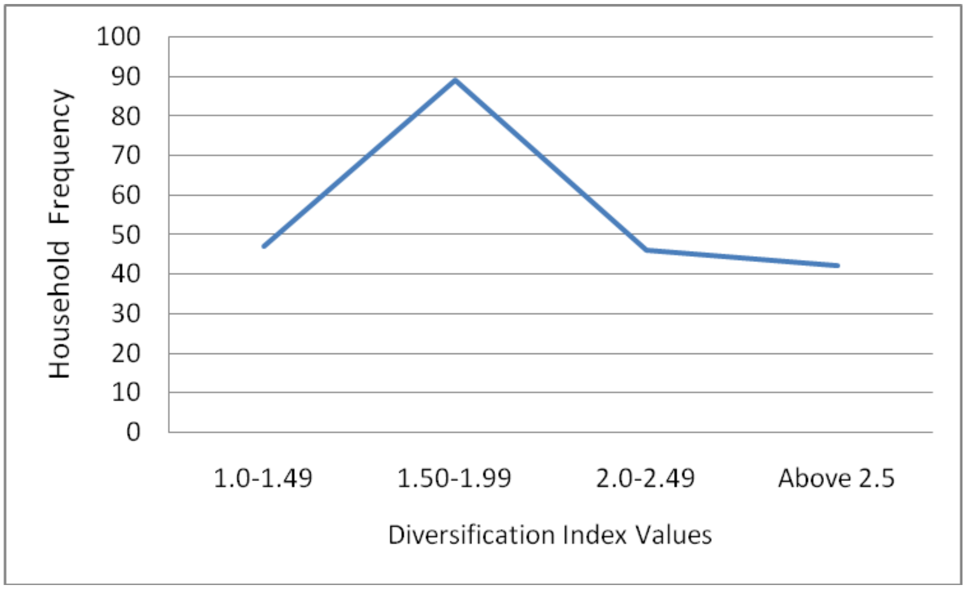

Figure 4.2: Inverse Simpson Index of Diversification Trends

Source: Field survey

Tea income had a strongly negative and significant (t-value of -3.102, $p<0.05$) effect on diversification index, meaning that increased income from tea growing reduces household propensity to diversify incomes. Milk and livestock incomes had negative but insignificant effect on diversification while maize and horticultural incomes had positive and a not significant influence on income diversification. These findings show that people are not likely to construct other income portfolios if these activities provide financial security throughout the year. The more the reason why maize and horticultural incomes had positive effect, indicating that they are seasonal crops that require other diverse activities to fulfill household income needs. Hence, farmers who depend on maize and horticulture incomes are likely to extract forest goods.

All off-farm income sources had positive effect on diversification index. Casual income (t-value of 7.399, $p<0.05$), boda boda income (t-value, 2.212, $p<0.05$) and artisan (2.453) had significant influence on income diversification, indicating that more income from these activities are likely to increase household portfolio of income sources. These income sources are considered erratic and insecure, hence motivating these people to extract NTFPs for domestic sustenance, even domestic disposable income throughout the year, and meet other livelihoods needs like insurance premium.

NTFP incomes from firewood and animal fodder had positive and significant ($p<0.05$, t values of 2.911 and 2.858 respectively) influence on income diversification. Incomes from medicinal plants, beekeeping, vegetables and water had insignificant effect on diversification. This shows that the more incomes from firewood and livestock fodder a household gets from the forest the more they would increase their diverse portfolio of activities. Hence, these forest incomes encourage households to design wealth accumulation strategies.

The upward increasing line in Figure 4.3 below indicates increasing diversification with forest income but at a decreasing rate. This demonstrates that household reliance on forest income raises the diversification index (DI) up to the level where NTFP income is approximately equal to income from farm and off-farm activities (about DI 3.0) when the diversification index declines. Hence the result suggests, as in Vedeld et al. (2007), that diversification of portfolio activities increase with greater NTFP income dependence to a maximum of about 45% (between 0.3 and 0.6) and thereafter declines (Figure 4.3). This declining measure of diversity indicates uniform contribution of farm, off-farm and NTFPs income sources to the total household income.

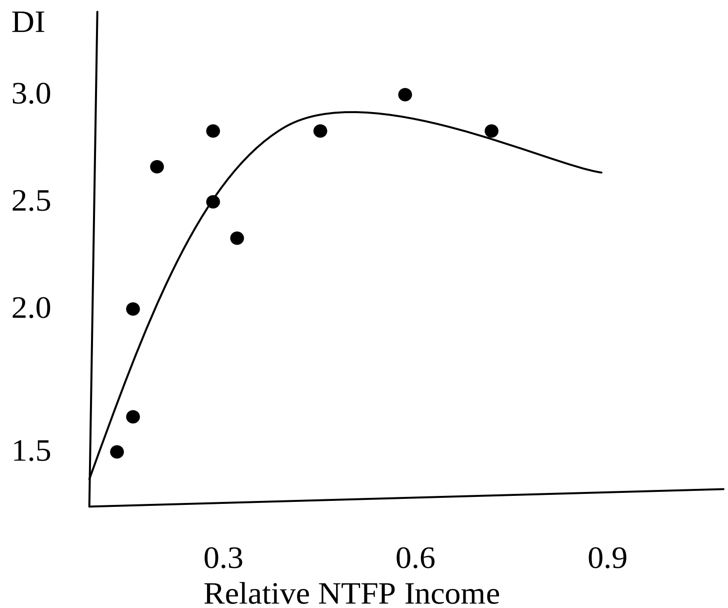

Figure 4.3: Relative forest income and diversification index (DI)

Source: Field survey

The relationship between forest income and DI also reveals that income diversification decrease with very high relative forest income. This may indicate that beyond a certain maximum point households experience limited income options and this is especially among small or landless households.

4.3.2.1 Non-Timber Forest Products Dependency

Forest dependency was measured as the NTFPs' income, in random utility model valuation, share of the total household income. For the 40% of the households who had a forest dependency of less than 0.2, about 32% of them did not depend on the forest at all. More than 69% of the respondents who depended on the forest resources had relative NTFP income of between 0.2 and 0.8 in total household income. The results can be said to be reasonable if majority of the processed relative NTFP income data lies between 0.2 and 0.8, which portrays a linear curve (Heubach et al., 2011). The Figure 4.4 below shows that this was the case in South Nandi NTFPs dependency ratio. The forest dependency mean is 0.29, indicating that on average NTFPs contributed 29% of relative household income compared to other income sources. This means that the average household dependency on NTFPs income is higher than the ratio (24%) of total NTFPs incomes across households.

Results of the effects of household characteristics on forest dependency revealed that formal education of household head (-0.285, $p<0.01$), farm income (-0.375, $p<0.01$), off-farm income (-0.356, $p<0.01$) and distance of households' homestead from the forest (-0.253, $p<0.01$) all had negative and significant correlation with dependency on forest resources. This indicates that these variables influence household dependency on NTFPs as source of income. Although household age had a negative correlation with forest dependency, its relationship is not statistically significant. Adhikari et al. (2004), Fu et al. (2009), Illukpitiya et al. (2010) and Heubach et al. (2011) also found a negative effect of education level, farm income and off-farm on forest dependency and hence, the results are cogent.

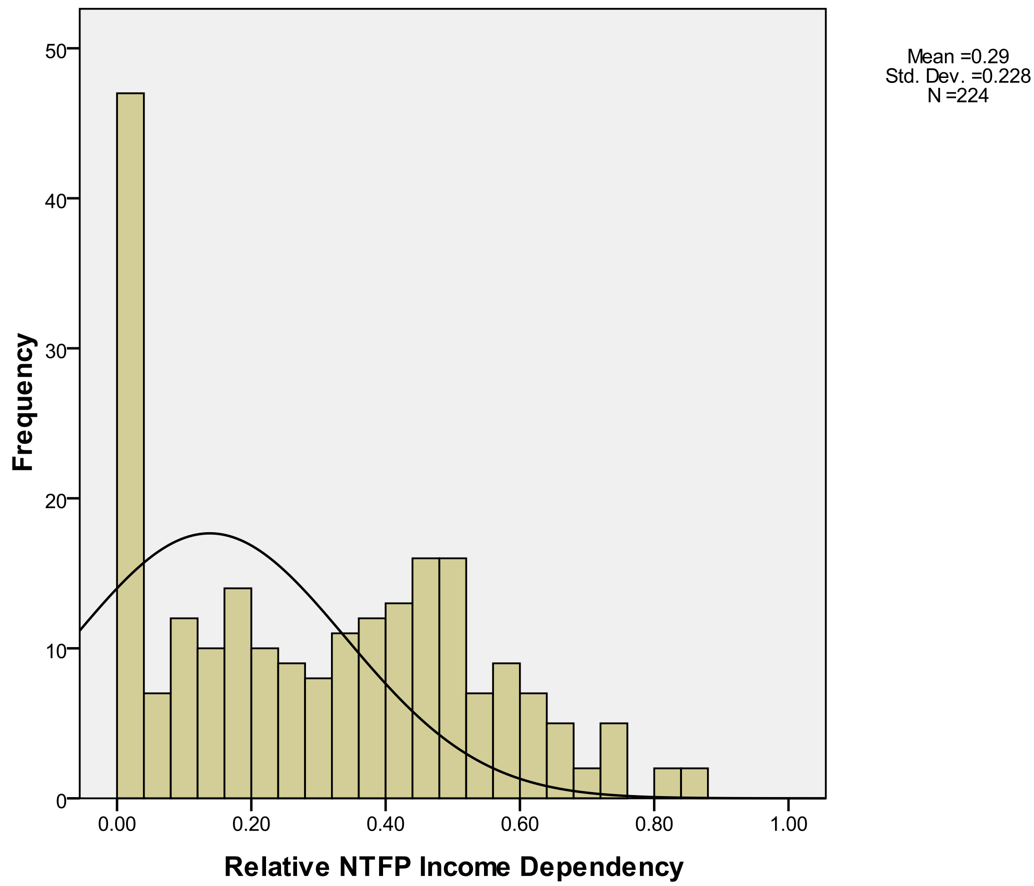

Figure 4.4: Households Forest Dependency Curve
Source: Field survey

The households (13%) who did not depend on the forest at all had the following reasons for not engaging in forest products for livelihood improvement: there was lack of accessibility to the forest from household homesteads, some had enough resources especially land, arbitrary arrests by forest guards, past loss of property like cows and honey made others consider forest incomes as risk investments, and the uncertainty about government official policy on these resources especially when contradictory statement are given by top government leaders breeding fear. This was evident in Ndurio and Mugen locations. Like in all the locations very little information on NTFPs has been disseminated to the households adjacent to the South Nandi forest.

4.3.2.2 Role of Non-Timber Forest Products as Natural Insurance Premium

Since the 1980s the concept of natural insurance has received much attention among economists (Takasaki, 2011). It is now accepted that non-timber forest products acts as natural insurance cover among households during the period of income or consumption risk/and uncertainty such as times of economic stress like drought, financial difficulties or depressed agricultural output prices. NTFPs not only supplement primary income during difficult times but are also sold in response to loss of other income sources (Cavendish, 2000; Vedeld et al., 2007; Paumgarten et al., 2009; Babulo et al., 2009).

This study shows that 80% of the respondents depended on the South Nandi forest for reducing household income or consumption risk during times of economic stress, like famines, retrenchment or death of household head, unprecedented rise in foods prices, periods between crop harvests and emergencies. When respondents were asked to enumerate the ways in which NTFPs support the household during difficult times most (89%) of them are supported by more than one method. This means that forest resources cushions the households adjacent to the forest ecosystem when livelihoods are threatened and also help rural peoples survive in periods of uncertainty (Nasi et al., 2002; Shackleton et al., 2007).

The respondents supported by more than one way during difficult times combined the various means with extraction of medical plants, wild fruits and water. Medicinal plants are used by 67% of the households as natural insurance premium. Livestock pasture and mushroom collection support 58% and 17% of the respondents respectively. Sell of these resources like honey and cattle in times of financial stress to meet household needs supported 63% of the respondents. Water for human/animal consumption during these stressful moments assists 56% of the residents. Hence, the households turn to forest resources and even sell these resources to supplement incomes during financial deficits as a result of increased scarcity of arable land and economic stress from changing market conditions for agricultural produce. Medicinal plants are very helpful in treating livestock during disease outbreaks. These results are corroborated by studies of MCsweeney (2005), Baland et al. (2005), Shackleton et al. (2007), Babulo et al. (2009) and Kamanga et al. (2009). Table 4.4 shows the ways different NTFPs support households during difficult times.

Table 4.4: Option Demand for Non-Timber Forest Products

Insurance role of NTFPs	Percentage Households Supported
Livestock Pasture	58
Wild fruits	19
Mushroom	17
Medicinal Plants	67
Sell of Resources	63
Water	56

Source: Field survey

To test the insurance effect of NTFPs among local households a Pearson Correlation (0.208, $p<0.01$) showed a positive relationship between the role of NTFPs as a way of cushioning households from consumption risks/and uncertainty and option demand for forest goods. This means that the Nandi South forest assume an option value to the residents which if not included in management strategies would lead to current inefficient extraction of forest goods. Studies of Chambers et al. (1994), MCsweeney (2005), Baland et al. (2005), Shackleton et al. (2007) made similar observations.

Grazing of cattle in the forest is not only a full time business opportunity in the area but also serves as subsistence coping strategy especially to the poorer sector of society. There are two types of farmers grazing livestock in the forest: First, those that graze in the forest during the day and bring back the cattle into the homestead in the evening. This group uses the forest resources as an absorber of effects of current uncertainties in coping insurance. Some of these livestock grazers use the forest pasture only during dry seasons. Fisher et al. (2010) found that poor farmers in Malawi use forest resources to cushion themselves from climate variability. Baland (2005) agrees that the poor receive consumption insurance from common property resources and the insurance component of the forest resource improve societal welfare. This shows instrumental value of NTFPs in improving livelihoods. Forest resources not only provide self-insurance but also mutual insurance services especially to the poor (Takasaki, 2011).

Second, those that buys young bulls and cows, particularly the local traditional breeds which are more resistant to sicknesses and diseases, and take into the forest to graze and allow them to live on their own in the wild for long periods of time. These cattle stay in the forest until they are ready for sale in the local or far away markets, often directly from the forest. This category of users is those who invest livestock in the forest as a business venture, as risk insurance. Income effect of natural insurance implies that households increase cattle into the forest as an investment wealth accumulation strategy and also as an ‘education policy’ insurance plan. The fact that the residents are sufficiently informed about the poor enforcement for forest services, the local elite have capitalized on it to use the forest as a capital accumulation investment (Personal Comm. 2011). In a Pearson correlation tests, income from livestock was positively correlated (0.208, $p<0.05$) with sell of medicinal plants, indicating that the farmers not only use herbal medicines to treat their livestock but they do sell to supplement incomes preferably to buy formal chemist drugs in case of more serious outbreaks of livestock diseases and sicknesses.

Vegetable and honey incomes were not significantly correlated with pasture income (0.123 and -0.104 respectively at 0.05 level) while negatively correlated with fish and firewood sells. Hence, these households are not likely to sell vegetables and honey NTFPs (McSweeney, 2005) because in the event of income deficits or shocks they would sell the livestock in the forest or farm produce. On other hand, increased income from investing livestock in forest reduces the probability of selling fish and firewood, possibly because it is associated with the poor in society. It may also because of poor demand for forest fuelwood.

4.3.3 Economic Importance of Non-Timber Forest Products

There is an increasing consensus among environmental economists that forest income is an important component of household income among rural households and this income source is an important instrument that may help alleviate poverty (Godoy et al., 1997; Cavendish, 2000; Fisher, 2004 and Vedeld et al., 2007). Forest income is an important household income portfolio in forest-based, business-related and diversified strategies in many sub-Saharan countries (Tesfaye et al., 2011). Studies (for example, Mamo et al., 2007; Vedeld et al., 2007; Kamanga et al., 2009; Babulo et al., 2009; Heubach et al., 2011) have shown that NTFP contributes to the household incomes in varied proportions.

4.3.3.1 Relationship between Regular Household Incomes and NFTPs

Non-timber forest products in South Nandi contributed 24% of total household income, farm income (54%) and other sources of income (22%). This indicates that although farm income is the major income source NTFPs contributes a significant amount to the residents adjacent to Nandi forest. It is interesting to note that the difference between the percentage (70%) of those earning below the 1 dollar (exchange rates of Sh. 84) a day in formal incomes (regular incomes exclusive of forest income) and the poverty rates (46%) in the National Well-Being Statistics of 2010 (Republic of Kenya, 2010) is 24% and hence NTFPs is coeval to poverty reduction in the study areas (see equalizing effect of NTFPs, section 4.3.3.4 below). These results are corroborated by findings of Heubach et al. (2011) where the average income share of NTFPs in North Benin was 39%, off-farm income (7%) and Babulo et al. (2009) showed that NTFPs income (27%) was the second in the total income share. This shows that forest products, although not appreciated in conventional national income statistics, contributes to domestic incomes and thus reducing poverty rates. Figure 4.5 illustrates the per capita income distribution.

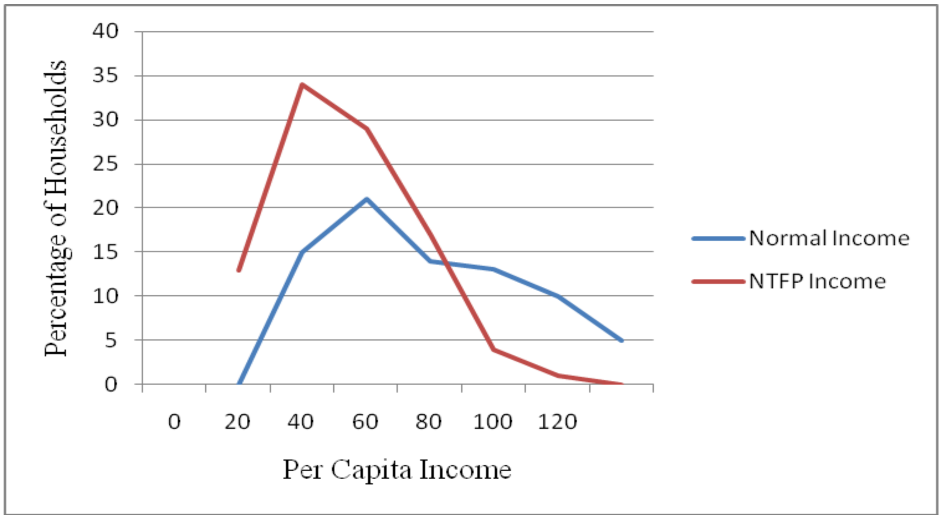

Figure 4.5: Per capita distribution of NTFP and Normal incomes

Source: Field survey

From the Figure 4.5 most of the households earn less than a dollar a day from the regular (normal) income and non-timber forest income. The average household formal income (both farm and off-farm) per annum was Sh. 234,658 translating into Sh. 93 per person per day. This is more than a 1 dollar (Sh. 84 at the current exchange rate) per person a day. While this amount may look impressive for rural households but the distribution of this income shows that only 30% earned above average and most (70%) of the respondents earned below the average. Forest income, on the other hand, was evenly distributed so that the average per annum household income was Sh. 68,261 and the households earning above average income was 49% while 51% of the respondents earned below the average amounts. Comparing formal household income and NTFP income gave a paired t-test of 8.99 ($p<0.05$), indicating that households obtained significantly higher formal income compared to income from NFTP.

The two incomes were also positively correlated (0.159, $p<0.05$) meaning that households with high regular incomes are likely to invest in accessing NFTP in order to generate additional income. It is imperative that forest products require households to invest in order to accrue the forest benefits. The main forms of investment costs in the forest include beehive construction, transportation of forest products and pre-payment for livestock grazing rights. The need for diversification of income sources as income increases are concomitant with results presented in section 4.3.2 above. Because the per capita income of the majority (70% as shown earlier) was less than a dollar a day, households would strive to increase their incomes in order to meet their domestic needs and provide an opportunity to generate additional income. These results demonstrate that households' reliance on NTFP income increases the diversification index to the point where forest income is approximately equal to income from farm activities. This is because index of diversification is positively related with forest income but negatively related with farm income, just like Vedeld et al. (2007) found.

Most (81%) households enhance their investment plans as results of increased income from engaging in non-timber forest products. Majority (87%) of these would expand their livestock herd while 46% expanded the areas under crop production (Figure 4.6 below). The expansion of the livestock herds may lead to increase in the future demand for forest fodder. This means that with increased income many households would increase livestock investments in the forest ecosystems. Some of the threats to the continued supply of NTFPs within the forest ecosystem include overgrazing due to unregulated livestock investment in the forest, commercial planting of vegetables and other illegal crops.

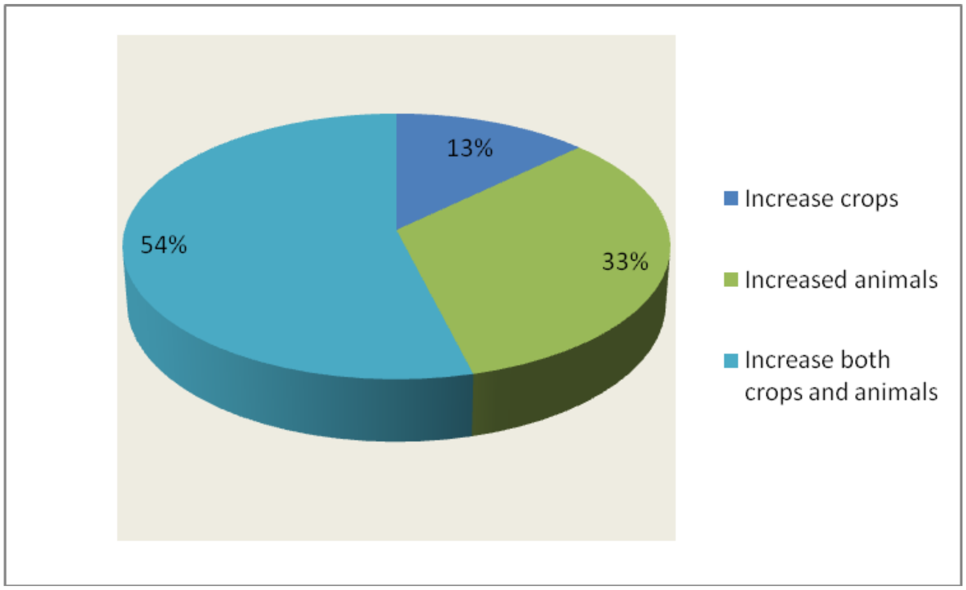

Figure 4.6: Percentage investment plans for increased income

Source: Field survey

Nine percent of the interviewees had their economic activities reduced over the 10 year period and 14% did not experience any change in income generating activities. Reduction in economic activities largely resulted from retirement from gainful employment, diminishing productivity and sizes of land, reduced producer prices of crops like maize, sicknesses and old age.

4.3.3.2 Demand for Forest Income

The main forest activities are firewood collection, livestock pasture support, harvesting herbal medicinal plants, and vegetables picking. The average household income from livestock pasture was Sh. 40,811 per annum which is 58% of total forest income. A chi-square ($\chi2$) results show that only livestock pasture (6.45, $p<0.01$) that is independently extracted from the forest while the other NTFP activities show that they are dependent on each other or other NTFPs to be extracted. This means that most residents are not grazing their livestock in the forest just as a result of engaging in other forest activities but as a way of diversifying income. Hence, the forest provision of pasture for households' livestock is a major contributor to income among the residents. For the other NTFPs, restriction or permission of one activity to be accessed affects extraction of other forest resources. These results show that valuing a single NTFP as Börner et al. (2009) suggested will most likely give erroneous results as households do multiple extractions of forest products beyond their primary purpose of visiting the forest.

Household forest visits had a positive and significant correlation (+0.973, $p<0.01$) effect on firewood incomes, with an average income of Sh. 10,286 per annum (14% of total forest income). A Chi-square test ($\chi^2 = 600.5$, $p<0.01$) shows that firewood collection is highly associated with extraction of other NTFPs, indicating that as the women and girls who are the main extractors access the forest they would also be involved in extraction of other products like vegetables, wild-fruits and mushrooms for the family. Because firewood collection is labour intensive and required 2 to 3 man-hours per week of labour, households would combine more than one activity in order to meet the required household labour demand for other activities. These results is corroborated by Kilchling et al. (2009) who showed, by using forest frequency visits to formulate potential demand for NTFPs, that the frequency of forest visits had a positive correlation with the demand for NTFPs. Table 4.5 below gives the details of income activities, cumulative forest trips and average yearly income (in Sh.) contribution of each activity.

Table 4.5: Average Contribution of each Forest Activity to Total Forest Income

Forest product	% household Extraction (% the forest product	Yearly Forest Trips (Cumulative)	Average forest income per household (KSh.)	% age contribution to total NTFP
Timber	0.4	2 (0.002)	7a	0.01
Post	9	284 (0.34)	713	0.98
Pasture	58	22,242 (26.75)	40,811bfgiko	55.98
Firewood	71	47,815 (57.51)	10,286ben	14.11
Fishing	2	148 (0.18)	2532f	3.47
Charcoal	2	144 (0.17)	3611	4.95
Beekeeping	21	48 (0.06)	1884aegjl	2.58
Mushroom	12	228 (0.27)	274cm	0.38
Herbal Plants	53	1987 (2.40)	9689chjkm	13.29
Vegetables	17	1,250 (1.50)	2437dhno	3.34
Water	11	9,000 (10.82)	658dil	0.90
Total			**72,902**	**100**

Source: Field survey

Notes: 1. The average (Av.) income was based on the sample size of 224. The averages measure the contribution of each activity to the total forest income earned.

2. One trip is entrance and extraction of resource, not the travels to and from the forest. The frequency of forest use per household, which are the number of trips made to access the forest resource, underscores the extraction pressure exerted on that particular product.
3. The parenthesis on yearly forest trips is the percentage of the cumulative trips.
4. Values followed by the same lower case letter in a column are statistically equal.

From Table 4.5 the residents' total cumulative forest resources extraction frequency was 183,148 trips per year. This means that on average each of the households make two trips per day for extracting NTFPs. Most (58%) of the forest access trips are made for firewood collection, livestock pasture (27%), water (11%), medicinal plants (2.4%) and vegetables (1.5%). Even though respondents make more forest trips to extract firewood for domestic use than for livestock pasture, its' income is four times less. The reason for this is that firewood is mainly extracted for domestic use and not for commercial reasons. Demand for medicinal plants is revealed by its contribution to forest income (13%) with an average of Sh. 9,689 per annum in revenues to these households. Hence, with increased population growth rates of 2.9% per year (Republic of Kenya, 2010) demand for forest goods is likely to increase leading to unsustainable resources extraction.

In a paired t-test ($p<0.05$) pasture income was positive and significantly different from the mean of all other NTFPs income, that is firewood income (8.440), beekeeping (10.913), medicinal plants (8.851) and vegetables (10.376). Income from firewood collection was statistically different, in a paired t-test, with average beekeeping income (10.324) and vegetable income (9.212). Herbal medicinal income was statistically different with incomes from beekeeping (7.288), mushroom (9.164) and vegetables (6.623). This indicates that all these forest incomes significantly contribute to the average household income. A Pearson correlation ($p<0.01$) showed that index of diversification had positive and significant relationship with pasture income (0.226), firewood income (0.240), and medicinal plants (0.199), indicating that these products are used by households to diversify their income sources. Hence, all the forest activities contributed to the 24% forest income of the total household income and are important for diversification programs to the people adjacent to the forest. These forest livelihoods strategies are important income household diversification programs that can be sustainably harnessed for meeting the Millennium Development Goals of absolute poverty reduction by 2015 (World Bank, 2006) and developed rural economy. This contradicts Coulibaly-Lingani et al. (2009) that found that the more diversified the source of household income the less likelihood of access to the forest for both grazing livestock and firewood collection.

4.3.3.3 Wealth Differentiation in Household use of NTFPs

Forest pasture, firewood, beekeeping, mushrooms, vegetables and edible herbs are used mainly to meet basic domestic needs. The t-values obtained from comparing household regular incomes with incomes from firewood (-12.124, $p<0.01$), pasture (-10.685, $p<0.01$), beekeeping (-10.685, $p<0.01$), mushrooms (-12.763, $p<0.01$), medicinal plants (-12.229, $p<0.01$) and vegetables (-12.521, $p<0.01$) indicates that the forest incomes gave significantly lower incomes compared to that from the formal incomes sources. Because these products were collected by the low income groups, it shows also that the poorer households were more reliant on NTFPs for livelihoods than the wealthy households. Hence, household wealth influenced the use of non-timber forest products as also demonstrated by other studies of Shackleton et al. (2005), Shackleton et al. (2006), Mutenje et al. (2010) and Paumgarten et al. (2009).

Income from non-timber forest products are used mainly for payment of fees, purchase household commodities, settle debts and pay hospital bills. Hence, the poorer households use the NFPs to meet immediate needs of purchasing household commodities and current school fees. Except for livestock pasture, all the other NTFPs had a negative correlation with formal household income. This shows that apart from forest fodder richer households are less likely to use the other NTFPs to supplement their formal incomes. Paumgarten (2009) found that households sell NTFPs to cover food and households expenses, supplement primary income, meet local demand, due to poverty and, in response to the loss of other income sources.

About 38% of the households use NTFP income to purchase household commodities while 42% of respondents use the income for both fees payments and to purchase household commodities. Also 59% of the households use forest resource incomes to meet domestic demand and other future needs like payment of fees, pay hospital bills and settle debts. Hence, domestic demand for NTFPs is the single most important reason for extracting forest resources. Increased costs of living lead to increased pressure among the forest adjacent communities to extract resources to supplement income from agricultural produce. Other forest investments include insurance premium for anticipated future expenditures. This agrees with option demand theory (Kula, 1994) where consumers are willing to invest for a resource to meet a future demand. Table 4.6 below shows the details of different household income uses.

Table 4.6: Household Wealth and Forest Resource Uses

Income Uses	**% of Households**
Payment of fees	4
Settle debts	0
Pay hospital bills	0
Purchase household commodities	38
Pay fees and purchase commodities	42
Pay fees, settle debts and purchase commodities	2
Pay fees, pay hospital bills and purchase commodities	6
Pay fees, settle debts, pay hospital bills, purchase commodities.	4
Settle debts, pay hospital bills, purchase commodities.	1
Settle debt and purchase commodities.	2
Pay hospital bills and purchase commodities	2
When to engage more forest resource use:	
During time of household financial stress	0.5
Household income is sufficient	0.5
Engage forest throughout financial seasons of household	99

Source: Field survey

Most (99%) of the respondents engage in forest extraction activities irrespective of seasonal fluctuations in household financial position. Only 1% of the residents exploit the forest resources on an *ad hoc* basis especially products like herbal medicine, wild fruits, mushroom and vegetables. This means that sustainable improved incomes are what motivate use of forest goods throughout the household financial cycle. Unemployment, poverty, increasing consumer prices of market goods and lack of alternative income sources are the main drivers to extraction and consumption or sale of forest products. Since most of the rural people adjacent to the forest are generally peasant farmers whose livelihoods constantly need improvement, their involvement in the management of the forest is crucial for sustainable supply of NTFPs. These findings agree with Paumgarten et al. (2009) and Quang et al. (2006) that households exploit and commercialize NTFPs to meet basic domestic needs.

4.3.3.4 Equalizing Effect of NTFP Incomes (Gini Coefficient)

Results of this study gave a Gini coefficient of 0.50 when NTFP income is excluded, but when forest product income is included in the total household income the Gini value dropped to 0.41, indicating considerable reduction in household wealth inequality. This means that NTFPs contributed to income equalizing effect among the rural households in South Nandi. Hence, forest products can be an important instrument for gapping income inequalities in the rural areas. Comparing this figure with the Kenya’s household total national Gini coefficient of about 0.57 and in the rural areas 0.55 (Chune, 2003; Githinji, 2000), this lower Gini coefficient in the area can be attributed to the contribution of forest resources to this community. This finding corroborates results of Vedeld et al. (2007)

who showed that the Gini coefficient increased from 0.41 to 0.51 when forest income was excluded from the calculations. Other findings that demonstrated reduced Gini coefficient due to inclusion of NTFP income in calculations include Mamo et al. (2007), Kamanga et al. (2009) and Heubach et al. (2011) in Ethiopia, Malawi and North Benin respectively.

Since 86% of the rural poor in South Nandi depend on forests for their livelihoods, the forest products cannot be underestimated and any policy changes that affect access to the forest products will have a significant impact in household incomes. According to National Well-Being Statistics of 2009 South Nandi had 46% of individuals below poverty line (Republic of Kenya, 2010). Hence, household inequalities motivates dependency on forest resources (Bluffstone et al., 2001 and Illukpitiya et al., 2010) and restricting access to forest goods would exacerbate poverty and income inequalities in South Nandi.

4.3.4 Supply, Consumption and Marketing of Non-Timber Forest Products

4.3.4.1 Supply of Non-Timber Forest Products

The quantity of forest resources available to the households vary according to the number of households that demanded the product and the geographic distribution of the resource within the forest. By categorizing the resources into three groups as abundant, moderate or scarce, the availability of the resources were analyzed (Table 4.7). Majority (90%) of the respondents viewed supply of medicinal plants as abundant, 7% of them moderately available and scarce to 3% of the interviewees. The findings indicate that supply of herbal medicines was constant throughout the year, a different situation as that in the temperate regions where edible herbs were least available in winter and abundant in summer (Shackleton et al., 2005). Herbal medicines are consumed for domestic and animal treatment while others sale for financial purposes. According to 99% of the households' livestock pasture supply is abundant. The livestock grazed not on grass, because there are little growth underneath the forest, but on fallen leaves and some undergrowth shrubs. Hence, it is important to conserve the forest ecosystem for continued supply of these products.

Firewood collections are abundant to 95% of the respondents and moderately available to 5%. It is only fallen and dry wood that is allowed for extraction per head-load once a month. Opportunities for beekeeping are abundant to 77% respondents, moderate to 14% and scarcely available to 9% of the households. Among the residents who extracted vegetables 43% of them said the product is abundant, 43% moderately available while 14% households said that it is scarce. The vegetables are more abundant in the months from April to November. As demand for domestic wood fuel keep rising pressure would be exerted on the forest to supply this product which can lead to forest degradation. Kenya Forest Service encourages investments in beekeeping as an effective way of preserving the forest. Theft of honey and hives are the major impediments to investing in beekeeping enterprises. Table 4.7 below shows the availability of the non-timber products.

Table 4.7: The household perception about the supply of Non-Timber Forest Products

Forest Product	Abundant	%age number of households Moderate	Scarce
1. Livestock	99	1	0
1. Medicinal Plants	90	7	3
2. Wild fruits	12	42	46
3. Mushroom	11	38	51
4. Fish	50	25	25
5. Beekeeping	77	14	9
6. Firewood	95	5	0
7. Vegetables	43	43	14

Source: Field survey

Wild fruits and mushrooms are mostly scarce (46% and 51% respectively) and moderately scarce (42% and 38% respectively). These are seasonal forest products and hence, are not heavily invested because of lack of adequate supply to the households. The condition for the growth of mushrooms requires fertile grounds. Decaying in forest is diminishing with many forest harvest rotations, opening canopies, and hence reduced humus. Fishing is available only in river Mogong within Kaboi location.

Figure 4.7 shows the supply of non-timber forest products from 1980 to date and a forecast to 2030. Before 1990 most of the forest products were abundant because of low population near the forest area, lack of access to the forest due to poor infrastructural facilities, and household land sizes was still big. After 1990 there was marked increased demand for the forest resources due to improved roads, increased population and closer urban centres to the forest leading to sharp decline in supply. If these trends do not change it is expected that by 2030 NTFPs will not be available for consumption.

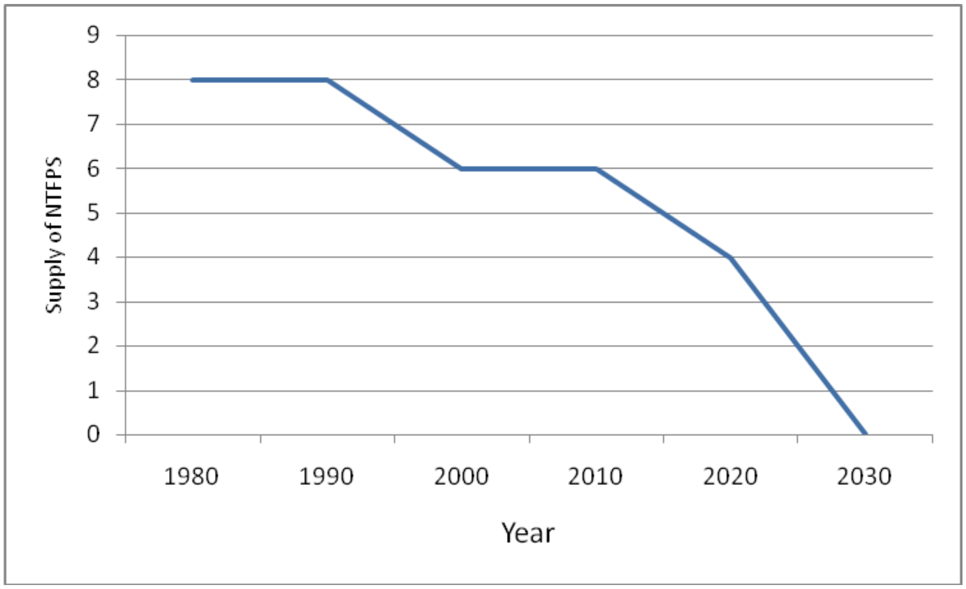

Figure 4.7: Supply trends of NTFPs from 1980 to 2030

Source: Field data

Note: 8 = Abundant NTFPs, 6= Available to meet current demand, 4= Moderately available where there is competition for the resources, 2 = Scarce resources, 0 = NTFPs not available at all (Forest Officer, 2011 in personal communication)

4.3.4.2 Marketing of Non-Timber Forest Products

Medicinal plants, fish, honey, firewood and vegetables are forest products mostly extracted for sell. Most (92%) of the participants who sale vegetables said Nairobi, more than 350 kilometres away, was a good market outlet. Medicinal plants and honey enjoyed good markets among the respondents (97% and 100% respectively) who extract the products for sale. The herbs are mostly sold to the local consumers. Honey, on the other hand, had most (60%) of respondents with far away market outlets. Fishmongers sale fish in the local market outlet. Hence, NTFPs are sold regularly as a means of livelihood or on an ad hoc response to household needs. Findings of this study corroborates with results of Shackleton et al. (2005) and Paumgarten et al. (2009) that except for vegetables and honey, most NTFPs were sold to markets within the local villages and the adjacent urban centres. The Table 4.8 below details the nature of market system interactions for the various non-timber forest products.

Table 4.8: Marketing of Non-Timber Forest Products

Forest Product	Perception about NTFPs Market			Market Outlet	
	Good	Moderate	Poor	Local	Far
Medicinal Plants	97	3	0	72	18
Fish	100	0	0	80	20
Honey Sells	100	0	0	40	60
Firewood	86	0	14	43	57
Vegetables	92	8	0	8	92

Source: Field survey

4.3.4.3 Commercialization and Domestic Consumption of NTFPs

Although KFS discourage commercialization of firewood collected from the forest as it may result in unsustainable extraction of wood products, some residents (3% of total households that sale NTFPs) still collect firewood for sale with average earnings of Sh. 9,257 per annum (about 93 head-loads of firewood). But majority (71%) of the respondents uses firewood worth an average of Sh. 13,995 per annum (140 head-loads of firewood) for domestic purposes. Firewood and medicinal plants are extracted mostly for domestic consumption while fish harvesting and beekeeping are mainly invested for financial gain. While fuelwood, which is one of the main extractive activity in the forest, consumption may decrease with increases in its price (real or shadow), the household expenditures on fuelwood and other forest related resources tend to increase (Cooke et al., 2008). The increased household expenditures on fuelwood in the rural areas are in the form of increased labour allocation to wood collection among women and children depriving them quality and quantity time for education and other economic activities. This exacerbates poverty cycle within the household.

Most (53%) of the households extract medicinal plants from the forest. An average household consume medicinal plants worth Sh. 15,771 per annum for human and livestock health treatments. This represents approximately 65% of the households that extract medicinal plants in the forest. The other 35% of households who extracted herbs commercialized them with average earnings of Sh. 26,441 per annum. About 2% of the households' harvested fish in the forest and on average Sh. 98,320 is earned per annum for sales of this product while Sh. 15,120 worth of fish are consumed. The average money value of honey the respondents (16%) sold is Sh. 11,577 and that consumed within the household is worth Sh. 1,300 (6%). Vegetables sold in the market have the residents interviewed average Sh. 25,400 (5%) and those consumed Sh. 6,522 (17%) respectively per year. Hence, NTFPs play a more important role in domestic consumption in improving livelihoods than income sales. Delang (2006) had the same conclusion. Table 4.9 shows the NTFPs money worth sold and consumed with the range of cattle owned per household.

Table 4.9: Consumption and Sales of Non-Timber Forest Products

NTFP	Domestic Consumption	Sales
	Yearly Amounts (KSh.)	
1. Medicinal Plants	15,771 (40)	26,441 (13)
2. Fish	15,120 (2)	98,320 (2)
3. Honey Sells	1,300 (6)	11,577 (16)
4. Firewood	13,995 (71)	9,257 (3)
5. Vegetables	6,522 (17)	25,400 (5)
Number of Household Cattle	Household Frequency	
Range	Percent	
1-4	70	
5-8	25	
9-15	5	

Source: Field survey

Note: 1. The figures in parentheses indicate the percentage respondents (of the total households) that consume or sale the non-timber forest product.

2. Each range group shows the range of cattle owned per household.

Table 4.9 shows livestock range and distribution of cattle owned. Households that consume forest pasture are 58% of the respondents. The average number of cattle grazing in the forest is 2 per household. The households (70%) who own between 1 and 4 cows grazing in the forest use the resource for subsistence purposes whose livelihoods could be threatened by the few commercial grazers. Many of the cattle are kept in the forest for future sale by the local elite in competition for pasture with subsistence milk producers. This is posing a great challenge for sustainable management of this resource. Hence, the local population that depends more on the forest resources for livelihood subsistence are more susceptible to development policy shifts that impact on forestry industry. The commercialization of non-timber forest products is a growing trend among rural households and the trading of these products was a recent phenomenon (Shackleton et al., 2005). As NTFPs are important source of income to forest-fringe communities, unchecked commercialization of these products could cause their depletion (Quang et al., 2006). Generally, poorer rural households tend to consume more of NTFPs in proportion to their incomes than the wealthy (Shackleton et al., 2006) and it is livelihoods of the poor who are threatened with unsustainable commercialization of forest goods. Therefore there is need of balance between commercialization for improved livelihoods and conservation of biodiversity.

The forest resources were ranked to analyze their benefits rating among the households. Collecting firewood and grazing of livestock in the forests are ranked the most beneficial NFTP by 80% and 64% of the households respectively. Livestock pasture had a positive and significant correlation with gathering wild-fruits (0.55, $p<0.05$), meaning that people collect wild-fruits as they take livestock to the forest for grazing. Firewood had significant spearman's rank correlation with wild-fruits (0.54, $p<0.05$), mushroom (0.54, $p<0.05$) and medicinal plants (0.51, $p<0.05$), suggesting that as people collect firewood they would pick wild-fruits, harvest mushroom and get herbal medicines in the forest to supplement their incomes. Hence, firewood is more essential product for households compared to livestock pasture due to the fact that some of the participants do not rear livestock. This demonstrates that financial benefits of forest resources can motivate its consumers to properly manage them for continued supply.

Medicinal plants and beekeeping is considered most beneficial by 62% and 28% respondents respectively. Mushroom collection (12%) had a positive correlation with medicinal plants (0.58), indicating that medicinal plants are extracted with mushrooms for income supplements. Picking of wild-fruits and mushroom collection are positively and highly correlated, meaning both are related in offering financial benefits to households. This is because the seasons of use of the products are the same. The bar graph below better illustrates (Figure 4.8)

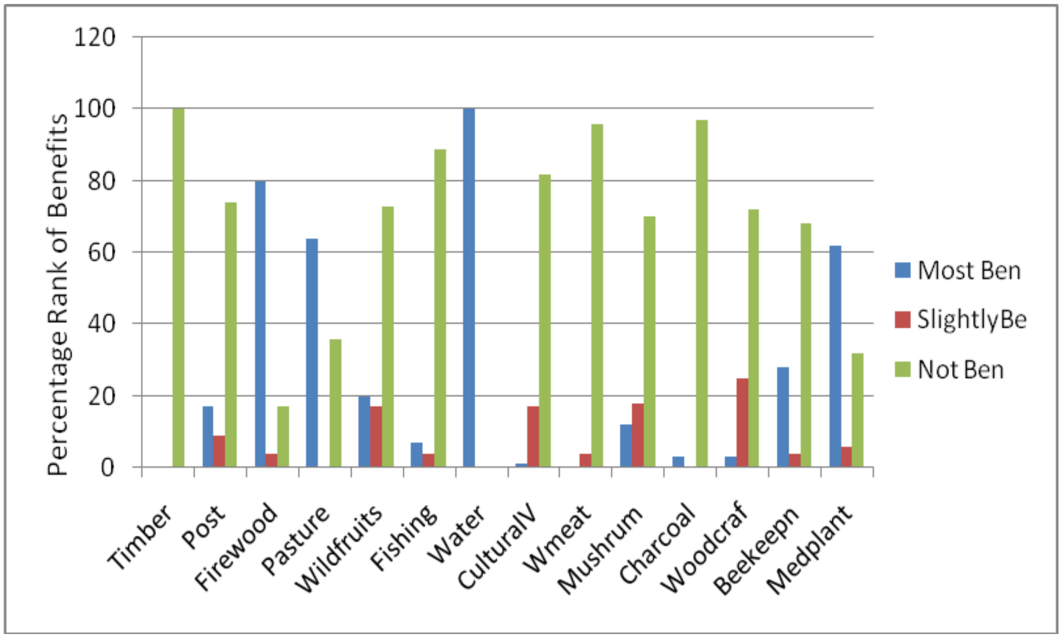

Figure 4.8: The benefits of the NTFPs to the households

Source: Survey Data

Notes: Most Ben means financially Most beneficial; SlightlyBe is financially Slightly beneficial; Not Ben is Not beneficial; Pasture is Livestock pasture; CulturalV is cultural and religious value; Wmeat is wild meat; Mushrum means mushroom collection; Charcoal is charcoal burning; Woodcraf is Woodcraft; Beekeepn denotes Beekeeping; Medplant stands for Medical plants.

4.3.5 Pricing and Payments for NTFPs

Except for forest fodder and firewood collection the other non-timber forest products like wild foods and fruits, medicinal plants, fishing, vegetables and mushroom collection are not charged for consumption. Although livestock pasture user fees is Sh. 50 per cow per month 43% of forest grazers did not pay for the services, yet the local market price of pasture per cow is about Sh. 3,500 per month. The low prices encourage the wealthy households to use the forests to benefit more, increasing inequality problems (Dhaka et al., 2009) and unsustainable resource extraction. Most (61%) of the households who use the forest to meet domestic firewood needs did not pay at all and those who paid (39%) did not do so regularly. Kenya Forest Service charges Sh. 100 per head-load per month for firewood collection. The firewood user fees reflect the real market price (Community Forest Association chairman in interview, 2011) and hence, it is only inefficient payment mechanism that has lead to non-payment of this service. Inappropriate payment systems like perception of unfairness and open corruption (Gebremariam, 2009) lead to non-payment of NTFPs even where there is proper resource pricing.

The challenges in financing forest products in South Nandi include poor payment mechanism. The respondents interviewed said that KFS officers are rarely available to receive payments as the place of payment, Kobujoi, which was far and hence inconvenient. There is also lack of a system of excluding those who do not pay. The other problem is that forest officers most often demand bribes for access to the forest. Also, People often mask their activities in the forest. None of the households using the forest for beekeeping paid (at Sh. 1,500 per year) for the service. The reasons were that KFS may not identify the ownership of hives, and hence easy to evade payment, and that there is lack of incentive to pay since the hives are not secure from thieves. Hence, the beneficiaries of the natural resource commodities do not bear the cost of their consumption in the private market environment. The effects are unsustainable extraction of the natural resource commodities. For efficient and sustainable use of NTFPs the commodities must be priced and effective payments mechanism instituted. Table 4.10 explains the total yearly household payment amounts for each forest product.

Table 4.10: Household Current Fees Paid for Forest Resource Use

Forest Product	Percentage Households		Fees Paid (KSh.)
	Paid	Did not Pay	(Average)
Livestock Pasture	57	43	3181
Beekeeping	0	100	0
Firewood	39	61	1171

Source: Field survey

The average household fees paid per annum are Sh. 3,181 for livestock pasture and Sh. 1,171 for firewood collection. If fees was to be increased by 50% respondents would stop consumption of the products are 12%, but if the fees is increased by 100% only 28% of the respondents would stop. Increase in fees charged on livestock pasture and firewood consumption did not have major effect on consumption. This is due to unavailability of alternative grazing places and firewood sources. The fact that over 99% of the respondents would still take cattle to the forest when payment is compulsory for forest access shows that there is little effect of payment on the number of cattle taken to the forest. Table 4.11 shows the effects of fees increases on household consumption of livestock pasture and firewood collection, the products currently paid for.

Table 4.11: Effect of Product Fees Charges Increase on Household Consumption of livestock fodder and firewood collection

Price Changes (%age)	Household (%age) response to changes in NTFP fees		
	No effect	Reduce	Stop
		Livestock Pasture	
i) 20	(99)	(1)	(0)
ii) 30	(96)	(1)	(2)
iii) 50	(81)	(14)	(5)
iv) 100	(71)	(14)	(15)
		Firewood Collection	
v) 20	(96)	(1)	(3)
vi) 30	(88)	(7)	(4)
i) 50	(78)	(10)	(12)
ii) 100	(67)	(6)	(28)

Source: Field survey

Note: 1.The count is the percentage changes (increase) in the product fees charged.

2. Figures in parentheses show the percentage of the households consuming that product.
3. The increase is from the amount indicated by the respondent as current fees paid

A chi-square test was done to test the relationship between fees increase and consumption of pasture and firewood by the households. In all cases the calculated value of χ^2 was greater than the table value, indicating that the two variables are associated with each other. In other words, the changes in fee prices of NFTPs are not expected to affect consumption of these products. In contrast to the findings of Cooke et al. (2008) fuelwood consumption is not likely to decrease with increase in its price. The main reasons may be lack of alternative sources of fuel and perceived ineffective payment systems. An effective pricing system allows for the efficient production and consumption of NTFP and helps conserve the forest products. The prevailing value of the products is reflected in access and consumption of the forest goods and services (Borner et al., 2009).

Hence, a good forest product pricing mechanism ensures equitable sharing of benefits and sustainable utilization of NTFPs (Dhakal et al., 2009). The forest fees charged for extraction of forest resources, if properly priced in an efficient financial system, can ensure improved household livelihoods and be an instrument of better environmental conservation. This is because consumption of forest products is influenced by their market prices (Illukpitiya et al., 2010).

4.4 Economic Valuations of Non-Timber Forest Products

In analyzing the economic value of NTFPs, as natural resource commodity in the South Nandi forest ecosystem, this study combines and compares revealed and stated preference methods – random utility model and contingent valuation method respectively.

4.4.1 Using the Random Utility Model in Valuation of NTFPs

The random utility model estimates of NTFPs were obtained through revealed household willingness to pay values of the products as reflected by the actual prices paid for the products in the normal market place. The prices of honey, vegetables, firewood and fish were obtained from the available markets while the value of livestock pasture, medicinal plants and wild-fruits were obtained from their shadow prices (market prices of close substitutes) or that of the best alternatives. Table 4.12 shows the household random utility valuation estimates of the non-timber forest products.

Table 4.12: Random Utility Valuation of Non-Timber Forest Products

Forest product	Yearly Market Price (Sh.)	Labour Costs	Forest User Charge	Resource Rent
Livestock Pasture	9,141,600	478,150	347,160	8,316,290
Wild fruits	35,100	-	0	35,100
Mushrooms	66,000	0	0	66,000
Medicinal Plants	2,278,200	0	0	2,278,200
Fishing	567,200	0	0	567,200
Honey	427,300	1448	1,500	424,325
Firewood	2,436,000	0	85,600	2,350,400
Water	147,360	30,000	0	117,360
Vegetables	569,600	0	0	569,600
Total	**15,668,360**	**509,598**	**434,260**	**14,724,502**

Source: Field Survey

Note: Figures in Kenya Shillings.

Forest pasture contributes Sh. 5,080/ha per annum to the South Nandi residents. Firewood and medicinal plants contributes Sh. 1,350/ha and Sh. 1,270/ha in a year, respectively, to the households. The other combined NTFPs contribute on average Sh. 1,010/ha per annum. Households use about 10% of the 18,000 hectare forest for NTFPs (Forest official, 2011). Hence, income from forest grazing was more than half of total NTFPs benefits. Croitoru (2007) also found that livestock grazing had the most notable benefits to the Mediterranean countries than other NTFPs.

The labour costs are yearly man-hours spent on extracting the NTFP activity multiplied by an hour worth of local labour costs. Medicinal plants, mushrooms, fishing and wild-fruits have zero labour costs because of very low opportunity costs of family labour. Due to abundant labour within the household or high unemployment rates many respondents did not consider labour as a cost in resource extraction. Forest products like firewood are generally collected by women and girls after work or school in the afternoon or over the weekend.

4.4.2 Contingent Valuation of NTFPs

In presenting the contingent market, in this study, respondents were informed that in order to increase the flow of environmental services from the forest some experts have argued for the establishment of an independently managed trust fund to finance regulation and management of Nandi forest. They were also informed that all the community stakeholders were expected to influence the management of the fund, and that the new project would only succeed if he/she contributed in monetary terms for the forest product management and that the project was to start soon. Nandi forest Trust Fund was presented as the payment vehicle and the way to contribute was through payment for accessing the forest products.

4.4.2.1 Willingness to Pay Responses

The survey asked the respondents how much they were WTP to continue receiving non-timber forest product benefits from South Nandi forest. Most (84%) of the respondents were willing to pay some amount of money in the contingent market representing a significant number of respondents who valued the benefits of the forest ecosystem for improved household welfare (Table 4.13). Then, a validation question was asked to investigate validity of household's WTP bids (Shaikh et al., 2007) and results showed that 55% of the households were not ready to contribute above what they bided. This indicates that over half of the respondents were certain on their bids, while 45% of them expressed WTP response uncertainty (that is, they were WTP more than their maximum bids when prodded further and hence expressing uncertainty on their initial maximum WTP amounts).

A single factor ANOVA test was done to examine whether there is any significant difference in maximum WTP amounts due to responses certainty and the results show that calculated F-value (21.6) is less than the F-critical of 243.3 ($p<0.05$). This means that the differences among household WTP bids were not affected by the responses uncertainty and hence, the bids are valid. Table 4.13 shows the willingness to pay response for continued flow of forest environmental benefits.

Table 4.13: Willingness To Pay Responses and Reasons for Not WTP

WTP Response	**Households**
	Count (%age)
Willing to Pay:	188 (84)
Not Willing to Pay:	36 (16)
Reason:	
1. Not able to pay	9 (26)
2. Not willing to place a Shilling value	2 (6)
3. Not well informed	0 (0)
4. Don't want to participate	6 (18)
5. NTFPs is of no value	17 (50)
Total	**34**
Protest bids	**2** (6)

Source: Field survey

Those who were not WTP (16%) anything were probed to investigate the reason for their responses. Of these households 26% indicated that the reason for not WTP was because of lack of ability to pay for improved environmental service. A Pearson correlation shows that there is a significant relationship (0.964, $p<0.01$) between WTP response and normal household income (excluding forest income). The interviewees not willing to place a shilling value on the exercise were 6%. The respondents (18%) who did not want to participate in the survey desired that the project takes off first before participating, may be because of the belief that they can still free-ride on the forest benefits. Half of the households that were not WTP anything indicated that non-timber forest products are of no direct economic benefit to them due to; the distance to the forest, lack of enough household income, past frustrations by individuals especially theft of livestock and lack of adequate information on NTFP enterprises.

4.4.2.2 The Maximum WTP Amounts

The average maximum WTP in the contingent valuation is Sh. 2,886 per annum (excluding the option values). This expresses the stated price of improved NTFPs management commodity among the South Nandi forest adjacent communities. Regular household income and maximum WTP were positively and significantly related in a paired 2 tailed t-test (+12.7, 1.96), $p<0.05$, showing that high income households bid higher WTP amounts than poorer households. Income from non-timber forest products, in RUM valuation, was positively and significantly (+14.6, 1.96) related with contingent WTP, indicating that people are WTP more in the contingent market if the revealed NTFPs benefits are higher. As expected NTFPs dependency had a positive and significant (+0.137, $p<0.05$) effect on maximum willingness to pay amounts. This shows that the households who depended more on the forest resources are likely to pay more than those less dependent. Table 4.14 shows the frequency distribution of payment bids.

Table 4.14: Maximum Willingness to Pay and Frequency Distribution

Maximum Willingness to Pay Amounts	Bid (Sh.)	Number of respondents	Total Amount (Sh.)
Maximum WTP (Sh.):			
	100	3	300
	150	1	150
	200	3	600
	300	2	600
	400	1	400
	500	20	10,000
	600	2	1,200
	700	1	700
	1,000	38	38,000
	1,200	4	4,800
	1,500	2	3,000
	1,800	3	5,400
	2,000	29	58,000
	2,400	2	4,800
	2,500	4	10,000
	3,000	19	57,000
	3,600	1	3,600
	4,000	10	40,000
	5,000	21	105,000
	6,000	3	18,000
	7,000	2	14,000
	8,000	9	72,000
	10,000	6	60,000
	15,000	1	15,000
	20,000	1	20,000
Total		**188**	**542,550**

Source: Field survey

The lowest WTP bid amount was Sh. 100 and the highest bid was Sh. 20,000. The bids with the highest frequencies were Sh. 1,000 (20%) and Sh. 2,000 (15%) respectively. Those who bid Sh. 5,000 are 11% of households. The average WTP amount is Sh. 2,886. An analysis of variance test was done to test whether the difference in WTP bids affected the WTP mean and results (F-value of 36.6, F-critical of 243.3) demonstrated that the difference in WTP bids is insignificant in determining the mean WTP. Further, a non-parametric chi-square test of the association between the bids offered and total amounts of each bid was done. The calculated χ^2 was 367.27 and table value was 11.52 ($p<0.01$)

indicating that the bid values and the total amounts of each bid are related, meaning that each bid offered affected the total amounts. Hence, even though most (61%) of the households' WTP bid amounts are below average, all bids are important for pricing policy of forest goods.

4.4.2.3 Option Value for Non-Timber Forest Products

The survey study shows that 45% of the respondents are willing to contribute extra money, above the normal maximum WTP amounts for improved forest products management, as guarantee for future availability of NTFPs. Of these 27% gave bid amounts higher than maximum WTP amounts indicating that they valued more the future availability of the forest products than their current flows. In other words, unexpected future income shortfalls or cash needs cause households to value more the future benefits of the resource. This means that their social discount rate for forest resources is lower compared with the interest rates. On average the option value of NTFPs is Sh. 2,538 per annum indicating that the residents' option demand (Kula, 1994), which is an insurance premium to guarantee continued supply of NTFPs. Table 4.15 illustrates the findings.

Table 4.15: Option Values Amounts

Maximum Monetary Contribution	Bid (Sh.)	Number of Respondents	Total Value to the society (Sh.)
Extra Amount (KSh.):			
	100	2	200
	200	3	600
	500	18	9,000
	1,000	21	21,000
	1,200	1	1,200
	1,500	1	1,500
	2,000	14	28,000
	3,000	4	12,000
	3,200	1	3,200
	4,000	3	12,000
	5,000	8	40,000
	6,000	2	12,000
	7,000	1	7,000
	8,000	2	16,000
	10,000	1	10,000
	12,000	1	12,000
	15,000	2	30,000
Total		**85**	**215,700**

Source: Field survey

The lowest extra contribution was Sh. 200 and the highest was Sh. 15,000. The total extra contribution is 40% above the maximum WTP amount. The findings are in agreement with that of Cavendish (2000) which reported a 40% of total environmental income was utilized to fill gaps in times of income shortages. Takasaki et al. (2004) found that Peruvian farmers reported 22% of households as utilizing the forest resources as an insurance mechanism. Hence, the forest resources provide informal and self-enforcing consumption insurance for the rural economy and people are WTP above the normal willingness to pay amounts to secure the NTFPs for future consumption.

4.5 Estimating Parameter Predictors

4.5.1 Validity Tests of Contingent Valuation and Random Utility Model Regressions

Criterion validity, theoretical validity and convergence validity tests were performed for the RUM and CVM empirical models to assess their fitness to underlying economic theory. In the contingent market the protests bids (simply do not want to participate in the survey and not valuing improved provision of forest resources) market among the households were inserted as zeros and included in the analysis. This was done after checking for the presence of sampling selection bias that may affect validity of estimates obtained (see Sumukwo et al., 2012 for details).

4.5.1.1 Criterion Validity Tests between CVM and RUM Estimates Predictors

Farmland size influences the extent of agricultural production (Fisher, 2004; Heubach et al., 2011) and hence was chosen as the main indicator for farm incomes. It was expected that with increased farmland size, and thus agricultural productivity, household WTP for improved provision of NTFPs would decrease because of the anticipated reduction in forest dependency. Results indicates that size of farmland had the expected negative and significant (-2.37) relationship with WTP in the contingent market. But in the RUM analysis farmland size had a positive, but insignificant, relationship with the NTFPs income revealed preference. This suggests that the revealed positive effect was not significantly important to influence NTFPs consumption in the actual market and hence, the CVM predictor better fits its theoretical construct. We would say there is low criterion-related validity between household land size in stated preference and revealed preference of NTFPs (see Table 4.16).

Results also indicates that in both revealed and stated valuations the proximity of the forest to the household homestead had negative and highly significant effect (-3.770, -2.399 respectively), as expected, on the provision of NTFPs. This indicates that increased distance from the forest lead to decreased demand for forest products. Indeed, just like Getachew et al. (2007), Falco et al. (2010) and Mitra et al. (2011) noted, the households near the forest bid higher willingness to pay amounts in contingent market and consume more in the actual market, as they were likely to extract the forest resources, than those far away. This is because people are likely to pay for what they depend on most.

Table 4.16: Results of CVM and RUM Regression Analyses of NTFP Estimates

Contingent Valuation Regression Model					
Variable	Expected Sign.	Coefficient	Std. Error	t-value	Significance
Constant		614.937	515.578	1.193	0.243
Land size	-	-130.620	55.039	-2.373	0.019*
Household Cattle	+	338.607	58.782	5.760	0.000*
Forest Proximity	-	459.214	191.420	-2.399	0.017*
Information	+	514.542	136.331	3.774	0.000*
Off-farm Income	-	567.689	0.001	-0.120	0.905
Years in Village	+	6.054	10.568	0.573	0.567
Random Utility Model Regression					
Variable	Expected Sign.	Coefficient	Std. Error	t-value	Significance
Constant	-	77906.880	19838.19	3.927	0.000
Proximity	+/-	-18024.530	4780.485	-3.770	0.000*
Sex	+	-16691.006	9442.955	-1.768	0.079
Age	-	-2181.459	5568.477	-0.392	0.696
Education	-	-11222.712	5609.933	-2.001	0.047*
Land-size	-	1403.809	1116.773	1.257	0.210
Normal Income	+	0.013	0.019	0.692	0.490
Information	+	7926.916	3481.577	2.277	0.024*
Pay to Use		50732.190	9002.415	5.635	0.000*

Source: Field survey

Notes: 1. Dependent Variable: Maximum WTP

2. Proximity indicates the distance, in km, of forest edge from household homestead.
3. Information means knowledge of acceptance to use NTFPs
4. Pay to Use means pay to use forest resources
5. Std. Error is the standard error.
6. * Significant at $p<0.05$, R^2 =0.259, Adjusted R^2 =0.238

Household education level was positive and significantly (3.774) related with willingness to pay in CVM analysis while RUM estimates was negative and significantly (-2.001) related to the NTFPs income provision. These relationships are consistent with economic theory. The inverse relationship in the RUM estimates showed that more educated households are likely to have access to broader income sources and hence depended less on forest incomes. Instead of measuring the formal education levels in the CVM survey, the level of information on the legal acceptance of extracting NTFPs was used. After all formal education levels normally is related with information access, yet household information about environmental resources tended to affect more extraction of natural resource goods irrespective of formal education levels (where most of the residents have secondary education and below). Hence, there is a high criterion-related validity between the level of information on NTFPs in CVM valuation (intermediate variables) and formal education of households' RUM preferences (ultimate variable). While Hammitt et al. (2001) found that education levels of respondents had a positive and significantly related with willingness to pay, Shultz et al. (1998) and Whittington et al. (1993) showed that education were not significantly related with willingness to pay.

Unlike in the CVM, where there was positive and high significant relationship with formal income sources, the effect of regular income was positive though not significantly related to RUM estimates meaning that it did not influence household consumption in real market situation. But off-farm income in the contingent market had negative and insignificant influence on the WTP showing that off-farm activities decreased demand for environmental improvement. The insignificance means that the relationship is not a good economic predictor. Studies of Munisinghe et al. (1993), Choe et al. (1994), McConnel, (1997) and Wasike (1996) income had positive and significant effect on WTP.

The number of household cattle was also used as the main determinant of forest income since forest pasture contributed significantly to RUM income and also because NTFP income should be positively related to number of cattle (Heubach et al., 2011). As expected (and in Heubach et al., 2011) the number of household cattle had positive and significant (+5.76) relationship with on WTP for stated preference valuation. The respondents who paid for the forest resources (Yes =1, No = 0 for Pay to Use) had a positive and significant relationship with RUM estimates, hence would reveal more their WTP for forest products even though 60% (as earlier noted) of them were not paying for accessing the NTFPs that had user fees.

4.5.1.2 Testing Theoretical Validity of the CVM

Multivariate regression analyses of the determinants of WTP have been used in testing theoretical validity of CVM bids (Mitchel et al., 1989). The accepted rule is that WTP bids are theoretically valid and reliable if; first, a group of theoretical determinants of the explanatory variables in the commodity demand function being valued are statistically significant with the expected signs (Urama et al., 2006). Second, the model has a R^2

value that is above 0.15, as adjusted for degree of freedom (Mitchel et al., 1989; OECD, 1994; Urama et al., 2006).

The four significant ($p<0.05$) predictors for the WTP bids were farmland size, forest proximity, number of household cattle and information about forest-based products. The R^2 of the CVM regression model was 0.259 and the signs of all explanatory variables were expected (Table 4.16 above). Further, the WTP response uncertainty test described earlier in section 4.4.2.1 reinforces the findings. As in Urama et al. (2006) the results of this analysis showed no significant correlation among the independent variables. Hence, the statistical tests showed that the WTP values were not from some chance factor but were associated in reality to the variables postulated in economic theory. Since the econometric analysis reveals systematic relationship between the explanatory variables and the households' stated WTP, it can be concluded that the CVM was within the theoretical framework. In other words, the stated preference valuation of households' demand for improved provision of NTFPs in South Nandi is consistent with economic theory.

4.5.1.3 Tests for the Convergence between RUM and CVM bids

When the results of the distribution of random utility model and contingent valuation bids are tested for convergence, 80% of the respondents revealed their preference while 84% of the households stated willingness to pay some amount of money on a yearly basis to continue receiving the non-timber forest product benefits from the Nandi forest. This indicates that there was no marked difference in the number of households who valued the environmental service provision in the two WTP estimates. The other observation is that all households who actually spent money on NTFPs stated their preference in the contingent market, unlike the findings of Urama et al. (2006) where more respondents revealed their preference than those who stated. Therefore, since about 4% of residents were WTP in the hypothetical market yet did not purchase the forest goods in the real market system means that the “not able to pay”, “NTFPs of no value”, “refuse to participate in survey” and “not willing to place a shilling value” responses to the contingent bids represent actual preferences of the households in the actual and hypothetical markets. The other explanation may mean that these respondents were valuing the option or/and existence value of the non-timber forest goods. The households revealed (RUM) and stated (CVM) preferences were significantly correlated (Pearson correlation of 0.611, $p<0.01$), suggesting that the RUM and CVM estimates were from the same theoretical construct.

The willingness to pay to continue receiving NTFPs as a forest good is lower when estimated using the CVM relative to estimates from the RUM. The average total annual CVM (maximum WTP and option values) willingness to pay estimate was Sh. 4,033 and the mean RUM estimate was Sh. 68,261 per household. The CVM estimates ranged from Sh. 100 to Sh. 20,000 while the RUM values were between Sh. 61,400 for mushroom collection to Sh. 9,141,600 for livestock pasture per annum. The explanation for the wide ranges is that the CVM estimates were for the whole valuation commodity while the RUM estimates each of the NTFPs products. Wholesome estimation is generally lower than aggregated estimation. Since the presented market scenarios were incomplete, due to distorted pricing system, therefore stated WTP choices are lower than the revealed choices. Many studies have found that CVM estimates were biased downward and RUM estimates were biased upwards (e.g. Boyle et al., 1996; Carson et al., 1999; Whitehead, 2000).

To investigate whether there is any difference among the RUM and CVM estimate means, independent paired t-test was done between RUM and CVM estimates, and the two values were statistically different (t-value, 14.514, $p<0.05$). Therefore, at 5% level of confidence, the null hypothesis that there is no significant difference between average willingness to pay values across RUM and CVM estimates for improved provision of forest-based products is rejected. Therefore, there was divergence of willingness to pay values in the revealed and stated preference estimates. The divergences of the RUM and CVM values can be interpreted that the contingent WTP valued improved provision of products of the forest ecosystem as a commodity while the RUM estimates the value of forest products benefits generated by ecosystems. Other RUM and CVM comparison studies (Boyle et al., 1996; Carson et al., 1999; Whitehead, 2000; Urama et al., 2006) corroborate these findings.

Although the open-ended CVM willingness to pay question underbid the values but the main reason for the difference was the distorted pricing system of NTFPs. Since CVM values from the costs-side many households, as rational consumers, would tend to reduce costs. The RUM approaches resource use through maximization of benefits. The other reason is that most of the forest resources were not priced, for example medicinal plants, forest foods and fibres, vegetables and mushrooms. But fees charged for priced products were very low. For example, livestock fodder was extremely under priced that the RUM estimates using its shadow price (average of Sh. 3,500 compared with Sh. 50 per cow per month user fee) was high yet CVM estimates were related to user charges. Worse still only 40% of the households in the study paid for the forest products enjoyed. Weak enforcement of the current user charges, like beekeeping and firewood collection fees, made many households believe they could consume the resources for free. The other underlying cause was that with many people accessing the products without paying, problem of non-excludability, affects contingent valuation estimates. This shows that beneficiaries of NTFPs normally do not bear the real cost of their consumption in the private market environment.

4.5.2 Effects of Forest User Charges on Contingent Valuation Estimates

When user fees were increased by 100% for forest pasture 71% of the respondents indicated that they would still use the forest for livestock grazing. 67 percent of them indicated that they would still collect firewood even with 100% increase in user charges. In Pearson correlation, maximum WTP was highly and positively correlated (0.602, $p<0.01$) with the NTFPs user fees charges. This means that the user fees charged on NTFPs affected the household valuation of forest commodity in a contingent market. Low user fees charged on the forest goods lead to lower bids. To further confirm the results an ANOVA single factor test was undertaken which gave an F-value of 8.95, which is just above the F critical of 7.72 indicating that the two variables, NTFPs user charges and maximum WTP, are significantly different. Hence, CVM estimates were as low or high as the user fees charged. This means that the current user fees were sub-optimal and therefore do negatively affect the CVM estimates.

4.5.3 Factors influencing Option Demand for NTFPs using CVM

A logit regression procedure was used to analyze the probability of household option demand as expressed in WTP to guarantee availability of NTFPs for future consumption (Willis, 1989; Chambers et al., 1994; Perman et al., 2003) in the contingent market. In the analysis the household socioeconomic and demographic factors were regressed on the WTP for an option to consume the forest goods in the future (Table 4.17). Results demonstrated that the more the children and the better the education, the higher is the households' option values. This means that forest products, especially livestock grazing and beekeeping are invested to cushion in times of adversity, particularly expected high fees payments among households with many children. Like in Völker et al. (2010) and Fisher et al. (2010), the results indicated that the educated used the forest resources to spread investments and reduce consumption risks in the future.

Household farmland size (a measure of income) had a negative effect on option values, indicating that increased land size reduces the probability of option demand. Households with bigger land size would invest more in farming but small-holder farmers would opt to invest in forest products as an income diversification strategy. Age was negatively related with extra WTP and the probable reason is that the elderly are not likely to contribute extra amounts as guarantee for future NFTPs use because of their low income elasticity and increased dependency on own children for upkeep. Willis (1989) found that age and income had negative effect on WTP for option value of wildlife conservation in Britain. Fisher et al. (2005) also had age negatively affecting option value of NTFPs. But Fisher et al. (2010) found that increase in age of the household head more likely increased reliance on forests for shock coping. MCsweeney (2005) and Völker et al. (2010) showed that land wealth strongly determine the use of forest resources as safety nets for the rural economy. Baland et al. (2005) demonstrated that low income dwellers generally depend on forest products to provide informal and self-enforcing consumption insurance for the very poor.

Table 4:17 Logistic Regression Results of the Option Demand

Variable	Coefficient	Standard Error	Significant
Age	-0.282	0.201	0.160
Education	0.903	0.224	0.000
Own Children	0.236	0.078	0.002
Use forest Income	1.620	0.694	0.020
Land Size	-0.003	0.041	0.941
Forest Information	0.166	0.139	0.233
Cattle in Forest	-0.094	0.08	0.253
Direct Social benefits	0.588	0.295	0.046
Indirect Social benefits	0.041	0.222	0.853
Constant	-6.930	1.610	0. 00

Source: Field survey

The more the cattle grazing in the forest a household has the less likely the option demand for NTFPs. Although this relationship was not significant, it however shows that the households would rather diversify investments in other areas than depend on the forest ecosystem. Those who use the forest as means of improving income were more likely to pay an insurance premium for NTFPs, indicating their need for continued supply of these resources. Direct social benefits (good rainfall, employment opportunities from

Nyayo Tea Zone Company, recreation services, eco-tourism, cultural and religious benefits and aesthetic value society enjoy) of the Nandi forest was positively and significantly related to extra WTP. These direct social benefits provide for the supply of the NTFPs. Although indirect social benefits (rainfall, climate regulation, genetic resources capacity, bio-diversity, soil erosion arrest and carbon fixing) of the forest was positive, it did not significantly affect option demand may be because these benefits are not directly related to the non-timber goods. Hence, the Nandi forest resources function as natural insurance scheme and stress-coping strategy for vulnerable households.

4.5.4 Determinants of NTFPs Income Dependency

Relative forest income was used to measure household dependence on forest resources. In an OLS regression to assess the determinants of forest dependency, formal education had an expected negative and statistically significant effect on NTFPs dependency. More education increases access to wider income opportunities. Apart from having diverse income sources, the more educated households are better aware of the effects of forest degradation. As expected off-farm income had an inverse and significant effect on forest dependency, indicating that increased off-farm income among the households reduced forest dependency (see Table 4.18). The reason for this is that other sources of income enhances household wealth opportunity and increases opportunity costs of NTFPs extraction, leading to reduced extraction of forest products (Table 4.22). Adhikari et al. (2004), Fu et al. (2009), Illukpitiya et al. (2010), Mitra et al. (2011) and Heubach et al. (2011) registered similar results for both the household education levels and off-farm incomes.

The distance of the forest from the household homestead displayed a negative and significant relationship with forest resource dependency, meaning that the likelihood of depending on NTFPs significantly reduces with increased distance from the forest edge. Similarly, studies by Mamo et al. (2007), Kamanga et al. (2009) and Mitra et al. (2011) demonstrated that the distance of the household homestead to the forest, is as expected, negatively and significantly associated with forest dependence.

Land size had an inverse and statically significant effect on NTFPs dependency. The size of the household farmland directly influences agricultural production. With increased farm income people are likely to decrease extraction of non-timber forest products. This is confirmed by the negative effect of farm income on index of diversification (see section 4.3.2) and results of Godoy et al. (1997), Mamo et al. (2007), Fu et al. (2009) and Heubach et al. (2011).

Table 4.18: NTFPs Dependency Regression Model

Explanatory Variable	Coefficient	Standard Error	t-value	Significance
Constant	-	0.068	3.851	0.000
Off-Farm	-0.290	0.000	-5.109	0.000
Education	-0.205	0.015	-3.579	0.000
Index of Income Diversity	0.278	0.025	4.870	0.000
Number of Cattle	0.207	0.004	2.749	0.006
Land-size	-0.272	0.004	-3.421	0.001
Proximity to forest	-0.192	0.014	-3.545	0.000
Years in Village	-0.103	0.001	-1.836	0.068

Source: Field survey

Notes: N = 224; R^2 = 0.400; R^2 Adjusted = 0.381; F = $20.6_{calculated}$, $3.23_{critical}$

Index of income diversification had a positive and significant influence on NTFP dependency. The positive relationship indicates that households with more diverse income sources are likely to depend on the NTFPs. Since forest fodder, firewood and herbal incomes had significant ($p<0.01$) correlation with diversification index, these forest activities constitute major household diversification strategies. Hence, NTFP income represents an extra source of income. These findings are concomitant with that of Vedeld et al. (2007) where increasing reliance on forest incomes raised the index to near equality with agriculture and off-farm incomes. But results of Coulibaly-Lingani et al. (2009), Illukpitiya et al. (2010) and Heubach et al. (2011) demonstrated an inverse relationship, meaning that greater diversity lessens forest dependency.

As expected the number of household cattle had a positively and significant effect on NTFPs dependency. In the RUM estimates livestock pasture contributed the highest (58%) NTFPs income, which means that increased number of cattle is likely to cause greater dependency on the forest resources. Heubach et al. (2011) also reported a positive and significant relationship between the number of cattle and NTFP dependency.

4.5.5 Assessing Benefits Sharing of NTFPs

Policy makers may be interested in analyzing the welfare changes to forest peripheral households resulting from imposition of specific limits on household socioeconomic characteristics. The measure of welfare loss or gain was estimated using compensating variation. Following Parsons et al. (1992), Feather (1994) and Herriges et al. (1999), compensating variation in the RUM values were estimated in order to assess the sharing of NTFPs income benefits among the forest-fringe dwellers by estimating changes in utility due to changes in the significant variables in the RUM regression model, that is proximity of the resident's homestead from the forest, education level of household, off-farm income, number of cattle and farmland size. For easy computation of RUM's compensating variation aggregated scenario (Perman et al., 2003; Bateman et al., 2006) alternatives were used to model households' benefits sharing of NTFPs income due to changes in FOREST PROXIMITY, EDUCATION, OFF-FARM INCOME, NUMBER OF CATTLE, and LAND SIZE characteristics. These factors are considered because they influence the calculation of aggregate RUM willingness to pay values. The estimation results for aggregation are illustrated in Tables 4.19 and 4.20.

4.5.5.1 Improvement and Loss Policy Scenarios

In the compensating variation (CV) measure a positive change scenario would leave the individual household indifferent between gaining the improvement and remaining at the current reference point (Knetsch, 2007), and a loss scenario occurs where the household moves to an inferior position from the reference position. The reference point in the benefits loss scenario is where the individual is indifferent between avoiding the loss and accepting it.

Two sets of policy scenarios are considered in the welfare analysis, which are; improvement and loss of benefits associated with extracting NTFPs. In forest proximity scenario the benefits improvement among the households was ensured so that the associated benefits of NTFPs from the decreased distance of all the respondents of more than 1km were made to be within 1 km radius from the forest edge. Reduced distance is a benefit because in the forest dependency regression model more proximity to forest increases the dependency on NTFPs. Since about 41% of households are already within this distance the 59% are adjusted to be affected by this scenario. Secondly, a benefits loss is considered where households 1km and below from the forest are considered for a distance above 1km as the NTFP values decay with proximity to forest (see Bateman et al., 2006 for details on effects of distance decay characteristics on welfare measures). For educational policy change the first scenario was to improve income benefits of NTFPs by limiting all the people accessing the forest resources to primary education and below, and residents with secondary education and above were set as loss scenario. In the third policy scenario benefits improvement was where all respondents had an off-farm annual income above the average of Sh. 65,686 yearly while in the loss scenario all respondents were made to have an annual income of less than the average. The percentage of households affected by the changes in the scenarios is given in Table 4.19.

Table 4.19: Various Policy NTFPs Scenarios

Policy Scenario	Percentage of Households affected by NTFP predictor
Forest Proximity 0	40.6
Forest Proximity 1	59.4
Education 0	68.3
Education 1	31.7
Off-farm Income 0	76.3
Off-farm Income 1	23.7
Number of Cattle 0	67.8
Number of Cattle 1	32.2
Land Size 0	45.5
Land Size 1	54.5

Source: Field survey

Proximity 0 represents households located a distance of 1km and less from forest; Proximity 1 is distance above 1km, Education 0 shows the percentage households with primary education and below while Education 1 denotes those with secondary education and above. Off-farm Income 0 is Annual income equivalent or less than the average (Sh. 65,686); Off-farm Income 1 indicates income above the average, the Number of Cattle 0 shows households with four cattle (the average) and below; Number of Cattle 1 shows the households with more than four cattle. Land Size 0 indicates households with 2.5 acres (1 hectare) and above while Land Size 1 is those with 2.5 acres and below.

To assess the effect of number of cattle on NTFPs benefit sharing, improved policy scenario was set such that all households who have cattle each had more than the average of 4 and a loss scenario was adjusted so that all households had less than 4 cattle. Finally, a scenario that increased farmland size was considered where all the respondents are made to have 2.5 acres and above, while in a loss scenario the all households are limited to less than 2.5 acres. Again see Table 4.19 for the percent of NTFPs predictors under each scenario.

4.5.5.2 Benefits RUM Regression Analysis

RUM coefficients are used to provide welfare estimates for changes in attribute levels in which the ratio represents WTP for a unit increase in the quantity of the socioeconomic attributes (Colombo et al., 2009) such as education levels, off-farm income, forest proximity and farmland size. In Table 4.20, for each RUM model the ratio of the NTFP marginal utility of income improvement to the corresponding loss is presented. A value close to 1 shows good performance of the RUM predictor (Parsons et al., 1992). In this study we consider ratios greater than or equal to half (½) as evidence of models that fare well in approximating forest product benefits distribution because averages were used for most of the predictor variables as reference points (Knetsch, 2007). When the income elasticity is greater than one it means that the spread of forest resource benefits to the household communities rises with increased income. This positive income elasticity of WTP agrees with Environmental Kuznets curve (Parry et al., 2006).

The coefficients ratio for proximity of the household homestead to the forest is 0.60 which indicates that people are WTP, on average, 60% of their NTFP income for improved access to the forest goods, either by better infrastructure or provision of substitutes, since it may be impractical to relocate people nearer to the forest. Hence, forest proximity changes influences the household utility in NTFP benefits. In other words, the closer households may be extracting more forest goods (as they are likely to be poorer) than the far away residents, but the utility the two groups get from the forest resources are not extremely disproportionate. Table 4.20 presents the RUM regression analysis of the aggregated model estimates.

Table 4.20: Ratios of Individual Measures of NTFP Benefits

Benefits Scenario	**Coefficients (**Marginal Utility of Incomes**)**	**Ratios**
Proximity 1*	-30010.57	
Proximity 0**	-50388.81	0.60
Education 1*	-5314.87	
Education 0**	-35750.18	0.15
Land Size 1*	-7902.31	
Land Size 0**	-450.93	17.52
Off-farm Income 1*	-0.051	
Off-farm Income 0**	-0.062	0.82
Number of Cattle 1*	+16298.91	
Number of Cattle 0**	+15084.18	1.08

Source: Field survey

Note: Ratios can also be interpreted as the income elasticity of demands of the products;
* Denotes Benefits improvement; ** Indicates Benefits loss.

The land size coefficient ratio shows that increased farmland for households drastically reduce the ratio of benefits received from NTFPs' income. When land size improvement was assessed, farm income opportunities available to those with small lands increase and hence less dependency on forest resources due to reduced propensity to use forest goods for improving domestic income. But a change in policy scenario where those with more than 2.5 acres were restrained from accessing the forest resources the NTFPs benefits drastically changed and shifted to those with small parcels of land. Now, more households have reduced farm incomes and with decreased opportunity costs to extract NTFPs results leading to greater dependency on forest goods. Farm incomes' high elasticity of demand means that the less endowed households with farmland are more likely to be reliant on the local environmental resources than those with bigger land sizes when disposable income reduces marginally. Households with bigger farmlands can diversify income sources within agricultural production unlike those with smaller lands (Illukpitiya et al., 2010; Heubach et al., 2011).

The low (0.15) education coefficient ratio indicates high utility loss for NTFPs would occur if the education levels of the households are improved beyond primary school. Also households with primary education and below are likely to have increased marginal income benefits with increase in access of NTFPs than the better educated. When educational improvement was assessed, fewer households depended on forest goods for improving income as the increased education levels of households drastically reduced the ratio of benefits received from NTFPs' income. But when policy scenario was changed where those with secondary and above education were restrained from accessing the forest resources the NTFPs benefits reduced. The less educated households are more likely to be reliant on the local environmental resources than the more educated when disposable income reduces marginally. These findings are consistent with other studies (Paumgarten et al., 2009 and Cavendish, 2002.) that found poorer and less educated households to have a high propensity to use more of NTFPs resources on a per capita basis than the wealthier and more educated households.

The marginal utility of incomes ratio for number of household cattle (1.08) showed that utility changes as a result of gain and loss scenarios did not affect the benefits the households get from investing livestock in the forest. This indicates equivalence in revealed willingness to pay and willingness to accept compensation (Knetsch, 2007) if the goods were not available to the households or the mean WTP for benefits improvement is approximately equal to marginal WTP for pasture income. In other words, benefit and loss welfare scenarios are the same beyond the reference position (which is the average household cattle). The findings also mean that limiting the number of cattle accessing the forest affects the utility of households in South Nandi in an almost equal measure, irrespective of other socioeconomic parameters. Hence, cattle are an important commodity that assists households share benefits of the forest ecosystem.

Off-farm income ratio of income marginal utilities (0.82) reveals that this income sources performs very well in approximating NTFP benefits. This means that a marginal off-farm income gain or loss causes a less, but an almost similar, effect on income utility from NTFPs. Since majority (76%) of the residents has a less than average off-farm income an improvement scenario encourages reduced dependency on non-timber forest products. If there is lack of opportunities to participate in agricultural production due to small land sizes and limited off-farm activities, reduction in income to those without access to forest products may increase poverty and inequality. The average marginal income utility of off-farm sources (Sh. 0.06) is negligible, meaning that residents are not willing to use off-farm income to compensate for any income reduction in NTFPs. The negative sign rather shows that increased NTFP income would be used to diversify portfolio of income activities away for agricultural production. That is, increase off-farm income.

4.5.6 Implications of the Results to Policy and Management

Rural households in Kenya, like in other developing countries, diversify their income portfolio activities to improve household livelihoods and reduce income risks (Ellis, 1998; Tesfaye et al., 2011). Research findings reveal that index of income diversification had a positive and significant influence on NTFP dependency, indicating that households with more diverse income sources are likely to depend on the NTFPs. Non-timber forest products in South Nandi contribute 24% of total household income, farm income (54%) and other sources of income (22%). Hence, although not appreciated in conventional national income statistics, NTFPs is an important contributor to household income. The positive effect of off-farm and NFTP incomes on diversification index means that these income activities are important in household portfolio diversification strategies. Since farm income had inverse effect on level of diversification policies that target improved farm incomes help reduce reliance on NTFPs. Thus, it is important for policy makers to appreciate the economic benefits of NTFPs to forest-fringe dwellers and incorporate NTFP income in county's and national's GDP in order to be considered in national development plans. Pro-poor approaches, like enhancement of entrepreneurial skills that focus on increased product values of forest resources, can be developed for better off-farm incomes. Improved rural incomes, and hence reduced poverty, hinges on how forest-based activities and off-farm businesses are maintained coevally with efficient agricultural productivity interventions.

In the forest dependency model the explanatory variables, namely; off-farm income, formal education, index of income diversity, number of household cattle, farmland size and forest proximity all had statistically significant effects on NTFPs dependency. The negative influence of off-farm income on NTFPs dependency implies that contributions of this income portfolio to household income need to be encouraged to reduce the dependency while allowing the extreme poor and vulnerable to extract forest resources. Policy makers need to design policies that encourage creation of employment opportunities that increases opportunity costs of NTFPs extraction. Formal education had negative effect on forest dependency, indicating that the less educated are more likely to be reliant on the local forest goods. Hence, there is need of improving rural education standards by encouraging more children to attend schools. Good education not only enhances income opportunities but also improve agricultural efficiency which ultimately will reduce dependency on forest products.

A Gini coefficient analysis indicated that the NTFP income has a significant (Gini reduced by almost 1 point) equalization effect on rural household incomes. This shows that NTFP income can be an economic instrument for bridging income disparities and alleviate poverty among surrounding communities. Implications of this are that public undertakings that intend to reduce income disparities in study area should include the forest sector development. It is therefore concluded that any policy that may limit access of NTFPs to the rural poor will have an adverse effect of increasing income inequalities and exacerbate poverty in the rural areas. Policy makers, hence, need to design policies that balance forest conservation and rural households' demand for NTFPs as a vehicle for improving domestic livelihoods.

In the RUM compensating variation analysis of NTFP welfare measures indicated a marginal utility of incomes ratio near unity which depict indifference among households for willingness to pay and willingness to accept compensation policy scenarios for the number of household cattle. Hence, cattle are an important commodity that assists households share benefits of the forest ecosystem. The compensating variation analysis also show that less educated households are more likely to rely on the local environmental resources than the more educated when disposable income reduces marginally. The South Nandi people are not willing to use income from off-farm activities to compensate for any income reduction in NTFPs. Equitable distribution of forest benefits among the communities adjacent near the forest encourages public participation in sustainable management of the forest. Therefore NTFPs welfare evaluation can be used to guide policy makers in determining compensation measures in situations where forest dependent households are deprived of this source of income for example, cattle owners are required to destock from the forest or a massive forest project that alters peoples' consumption patterns.

Forest resources provide coping, and risk insurance to the poor, and the educated respectively (see Ellis, 1998 for the difference between household coping and risk strategies). Study results show that the main factors that positively influence option demand for NTFPs are education and number of children of household head. Findings show that there is a high probability of households to use forest products if there was an expected future financial obligation like fees payment (sort of ‘education policy insurance plan’) and real or perceived threat to livelihoods. Due to poor enforcement of user fees payments and no maximum limit to the cattle allowed in forest, the local elite have capitalized on this to use the forest as a capital accumulation investment. Therefore it is important that planners and decision makers incorporate natural insurance policies in forest management. Most importantly, the local elite should be discriminated against by introducing a private endowment system where the poor alone are allocated transferable pasture rights so that those who cannot or not able to use the forest resource can sell to others within the group. Since the product is a function of private endowments, the transferable property rights ensure equity distribution. This policy serves to; one, reduce forest induced wealth competition with its resultant consequences for forest biodiversity destruction. Two, stop spiraling income inequalities and encourage bridging of the gaps by motivating the poor to participate. Three, improves productivity and availability of pasture for future use. This is because intensive grazing in the forest not only leads to decreased fodder productivity but in the long-term cause soil erosion (Croitoru, 2007). Four, provide means of subsistence and fall-back in times of distress especially climatic variability to the poor (Fisher et al., 2010). Hence, forest protective policies that are too restrictive may compromise the natural insurance provision of these resources and inhibit economic stress-coping capacity of vulnerable households.

Most of the NTFPs in South Nandi are not priced and the priced have ineffective payment mechanism which can result in overexploitation of the forest resources. The prices of NTFPs should reflect local values of these resources and forest goods like medicinal plants, wild fruits, vegetables and mushroom collection should be priced. When all forest products are priced, even at low levels at the beginning so as not to hurt the poor, consumers will factor these costs in their forest use decision making. Also the adjacent residents should be involved in the determination of user fees. For efficient allocation of forest resources institutional failures like corruption, misinformation about forest products and unfair treatment of people accessing forest goods should be adequately corrected. The forest managers need to plough back the monetary income from the forest into the local community and forest conservation.

The analysis finds that there is statistically significant divergence of willingness to pay values between the RUM and CVM estimates. It also showed that the households' stated and revealed demand for NTFPs is statistically correlated indicating that the economic estimates are from the same theoretical construct. The results proved that the people are aware about the importance of forest resources and that the high willingness to pay responses (84% and 80% for stated and revealed preferences respectively) demonstrates the availability of capital and support resources in South Nandi for improved management of non-timber forest products. Comparing stated and revealed valuation estimates in NTFPs are important for convergent validity of estimates and hence results of analysis could provide basis for policy makers to be confident on which method to use. From the findings RUM appears to be more effective valuation method for NTFPs, but the bid function in CVM estimates give qualitative information that can be used to support design and planning of forestry programs that incorporate improved rural incomes in sustainable management of forest products in developing countries.

4.6 Modelling Demand for Non-Timber Forest Products Using a Random Utility Framework

4.6.1 Random Utility Function

Economists have used random utility models (RUM) to estimate (or measure) values of environmental goods or services. Travel Cost Method (TCM) has been used in valuing recreational distinct sites affecting the demand for each site in Tampa Bay, Florida (Greene et al., 1997), the value of viewing wildlife in Nakuru, Kenya (Navrud et al., 1994), and the economic value of elephants also in Nakuru, Kenya (Brown et al., 1989). Cropper et al. (1993) compared hedonic pricing model with random utility model estimates of welfare measures for given known household preferences in the Baltimore housing market in the U.S.A. The study concluded that for non-marginal changes in housing attributes, the RUM provided more accurate estimates of the welfare measure than the hedonic price model.

The RUM estimates in the present study examine the revealed prices of the NTFPs in the conventional market system, and in instance where the goods are not traded a surrogate market was constructed and the prices of substitutes of the product were used in the valuation exercise. The random utility model presumes that the utility u_{ij} to $_{i}$th household obtained from forest product *g* is composed of a deterministic component y_{ij}, which can be calculated based on revealed market prices or the substitutes in the market.

Households (h) are assumed to maximize utility, a function of the consumption of regular income sources (farm and off-farm incomes) denoted by X_1, and extraction of forest-based goods (Livestock pasture support, honey harvesting, medicinal plants, hunting, fishing) denoted by g. The household resources (money, labour, time) used for extracting forest products are denoted by r. These resources are used as factor inputs in the household production and consumption so as to maximize improved income levels.

Each of the r resources is available in fixed quantities Q_r, $r, = 1, \ldots, R$ for all resources such that i = 1, 2, …, R.

These are resource inputs such as time, money, labour etc for extraction of forest resources. Hence, the production function of good g is

$$F_g(Q_{r_1 g_1}, Q_{r_2 g_2}, Q_{r_3 g_3} \ldots Q_{r_R g_G}) \quad \text{Equation 4.1}$$

$g = 1, \ldots, G$; Which are forest goods for improving household income (directly or indirectly).

The utility function of household $h, h = 1, \ldots, H$ is represented by the function;

$$U^h(X_1^h, \ldots X_g^h, \ldots, X_G^h) \quad \text{Equation 4.2}$$

such that X_1 is household income portfolio sources excluding NTFPs, and X_g is consumption of forest goods as income diversification strategy. The arguments represent the amount of forest-goods extracted (consumed) by the households. Equation (4.2) denotes the utility a household gets from extracting several forest products, $g = 1, \ldots, G$, for improving income levels.

Total consumption of each forest product is required to equal its extraction from forest ecosystem (assuming we do not have wastes and losses in the process)

$$\sum_{h=1}^{H} x_g^h = F_g, g = 1, \ldots G \qquad \text{Equation 4.3}$$

Where;

$\sum_{h=1}^{H} x_g^h$ = total forest products consumed by households

$F_g =$ is NTFPs extracted from forest ecosystem

The income improvement (Y^*) function to be maximized has as arguments the utility of households, that is:

$$Y^*(U1, \ldots, U^h, \ldots, U^H) \qquad \text{Equation 4.4}$$

Where $h = 1, h, \ldots, H$ denotes the households 1 to H.

To simplify,

Production function for good g is $F_g(Q_{rg})$ Equation 4.5

Utility function of households h is $U^h(X_g^h)$ Equation 4.6

Where $r =$ resource inputs for extraction of the forest resources

$g =$ forest products (goods)

$h =$ the number of households

Let us now find utility functions of households' (X_g^h) and product outputs of forest-goods to the household consumers' (q_{rg}) functions that maximize,

$$Y^*(U^h(X_g^h)) \quad \text{Equation 4.7}$$

Subject to

$$\sum_{h=1}^{H} X_g^h = F_g(Q_{rg}), q = 1, \ldots, G \quad \text{Equation 4.8}$$

and

$$\sum_{g=1}^{G} Q_{rg} = Q_r, r = 1, \ldots, R \quad \text{Equation 4.9}$$

The constraint (4.9) above shows that the total amount of each resource (e.g. household money, time, labour) for extracting the forest-products used by all the households equals to the amount of available resources. This is because households' resources are substitutes for each other.

To maximize household income due to inclusion of forest incomes and using β_g as multiplier for constraint (4.8), and λ_r multiplier for the (4.9) constraint, the Lagrangean becomes

$$\lambda(\beta, \lambda, X, q = Y^*(U^h(X_g^h)) + \sum_{g=1}^{G} \beta_g \left[F_g(Q_{rg}) - \sum_{h=1}^{H} X_g^h \right] + \sum_{r=1}^{R} \lambda_r \left[Q_r - \sum_{g=1}^{G} Q_{rq} \right]$$

Equation 4.10

In order to derive the conditions of the variables; $\beta_g, \lambda_r, X_g^h$ and q_{rg}, we assume that all the functions are increasing, concave and the four variables positively valued guarantees Pareto optimality. The derivatives of these conditions are:

$$F_g(Q_{rg}) - \sum_{h=1}^{H} X_g^h = 0, \quad g = 1, \cdots, G$$

Equation 4.11

$$Q_r - \sum_{g=1}^{G} Q_{rg} = 0, \quad r = 1, \cdots, R$$

Equation 4.12

$$Y_h^* x U_g^h - \beta_g = 0 \qquad h = 1, \cdots, H, g = 1, \cdots, G$$

Equation 4.13

$$\beta_g x F_{rg} - \lambda_r = 0 \qquad g = 1, \cdots, G, r = 1, \cdots, R$$

Equation 4.14

Where $Y_h^* = \dfrac{\delta Y_h^*}{\delta U^h}$,

$$U_g^h = \frac{\delta U^h}{\delta X_g^h}$$

$$F_{rg} = \frac{\delta F_g}{\delta q_{rq}}$$

The multipliers β_g, λ_r are the shadow prices of the forest good g and resource r, respectively. We can interpret equation (4.11) above that when the sum of households' utility for consuming forest goods is subtracted from households' fixed resources of time, money and labour for producing the same goods is equal to zero. That is, people invest in extracting forest products to the level that maximizes their improved income. Equation (4.12) is similar to equation (4.9) in interpretation because both are the same.

How do we interpret derivative (4.13)? For this to be clear let us make the household h to use two forest-based goods (e.g. livestock pasture support and honey harvesting), g^1 and g^2:

$Y_h^* x U_g^h - \beta_g = 0$ From equation (4.13)

$Y_h^* . U_{g1}^h = \beta_{g1}$ for good one

$Y_h^* . U_{g2}^h = \beta_{g2}$ for good two

These equations means that the shadow prices (β_g) of forest goods g is a function of household utility got from forest income that improves total incomes.

Hence, taking the ratio of the two goods representing their marginal utilities, then we obtain

$$\frac{U_{g1}^{h}}{U_{g2}^{h}} = \frac{\beta_{g1}}{\beta_{g2}} \qquad \text{Equation 4.15}$$

This means that the ratio of the marginal utilities of two forest goods is equal to the ratio of shadow prices of the goods. Now, keeping the forest-based good to be one and having two households access the same good in the forest ecosystem:

$Y_{h1}^{*}.U_{g}^{h1} = \beta_{g}$ and $Y_{h2}^{*}.U_{g}^{h2} = \beta_{g}$

We get

$$Y_{h1}^{*}.U_{g1}^{h} = Y_{h2}^{*}.U_{g2}^{h} \qquad \text{Equation 4.16}$$

The explanation of Equation (4.16) is that the marginal contribution of a unit of forest-based product to achieve improved income through consumption of the forest resource by one household is equivalent to the income increase achieved through consumption of the same product by another household.

From equation (4.14) $\lambda_{r} = \beta_{g} x F_{rg}$ and it suggests that the opportunity costs (shadow prices) of factor inputs (λ_{r}) are influenced by the shadow prices of forest goods and extraction of the forest resources.

4.6.2 Benefits Sharing Using Compensating Variation in RUM

Compensating variation in the random utility model (Equations 4.1-4.16 above) was used to measure the changes in NTFPs utility due to changes in household characteristics. The compensating variation is given as:

$$CV = 1/\beta_f \left[\sum_{i=1} (V_1 - V_1^*) \right]$$ Equation 4.17

Where;

V_1 is utility of good with improvement

V_1^* is utility of good without improvement

$1/\beta_f$ is the RUM coefficient in the OLS regression model

(Which is the marginal utility income)

We could say that the ratio of RUM income estimates of the households is the same as the ratio of the marginal utilities, represented by the equation below (derived from equation 4.16):

$$\frac{Y_{h1}^*}{Y_{h2}^*} = \frac{U_g^{h1}}{U_g^{h2}}$$ Equation 4.18

Households extract forest-based products to achieve their expected income improvements levels. In other words, households increase extraction of these resources to realize particular income point where consumption of these products is adjusted to their optimality levels, which are their values as revealed in RUM estimates. In conclusion, the assessment of benefits sharing of NTFPs could be achieved directly by utility maximization derivatives from Equations 4.1 to 4.18 $(CV = \frac{Y_{h1}^*}{Y_{h2}^*} - \frac{U_g^{h1}}{U_q^{h2}})$, or from the compensating variation in Equation 4.17.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes and concludes the analysis in the previous chapters. It also provides the areas of further research.

5.2 Conclusions

The main objective of this study was to analyze the economic value of non-timber forest products, in a combined random utility model and contingent valuation preferences, and their contribution to the income of rural households in South Nandi of Kenya. The study found that non-timber forest products, concomitantly with off-farm income sources, are used by forest-margin households to construct income diversification strategies for improved domestic income, and to meet other livelihood needs including consumption risk reduction and response to economic crisis. Farm income, on the other hand, had an inverse effect on index of diversification indicating that this source of income reduced level of income diversification strategies.

On average 24% of annual household income is generated from various NTFPs, while farm income and off-farm income contributed 54% and 22 % respectively of total income. Interestingly the difference between the percentage (70%) of those earning below a 1 dollar (a dollar to Sh.84) a day from regular incomes and the poverty rates (46%) in the National Well-Being Statistics of 2009 (Republic of Kenya, 2010) is equivalent to the contribution of NTFP income to total household incomes (i.e. 24%).

Hence, NTFP income is an important contributor to better incomes and poverty reduction in the rural economy. This computation, further, demonstrates the essential gain of NTFP extraction to people whose income opportunities are limited and insecure. Also, a Gini coefficient analysis indicates that the NTFP income had a significant (Gini reduced by 0.9 points) equalization effect on rural household incomes. In other words, forest income reduced inequality between households by an index of about 9%.

Forest dependency regression was modeled to evaluate the determinants of household dependency on NTFPs. Results show that better educated households, increased off-farm incomes, bigger farmland size, closer proximity to forest and greater income diversity had inverse and significant effect on dependency of non-timber forest income. These findings have important policy implications for development planners and conservation managers. There is need for macroeconomic policies designed to encourage creation of employment opportunities that increase opportunity costs of extracting forest goods. Conversely, since the NTFPs assist households to cope in times of economic adversity, forest protective policies should not be too restrictive so as to compromise the natural insurance provision of these resources to economically vulnerable households.

The study examined the convergence between stated and revealed preference for non-timber forest products in South Nandi. The analysis reveals that the households' CVM values are lower than the RUM estimates. The differences in willingness to pay values are in the expected direction. A convergence test indicated a positive and significant difference between average willingness to pay values for NTFPs across RUM (Sh. 4,033) and CVM (Sh. 68,261) estimates at 5% level. Also the households' revealed (RUM) and stated (CVM) preferences were significantly correlated (Pearson correlation of 0.611, $p<0.01$), suggesting that the RUM and CVM estimates are from the same theoretical construct. Therefore, there is divergence of willingness to pay values in the revealed and stated preference estimates.

While theoretical validity tests in CVM valuation reveals a systematic relationship between the explanatory variables and the households' stated WTP, lending credence that the CVM was within its theoretical framework and hence consistent with economic theory, qualitative analysis of the estimates reveals a huge disparity between the stated and revealed preferences. For example, criterion validity analyses show that age and sex of the household heads had the same effects on both CVM and RUM valuation estimates. On the other hand, there is low criterion-related validity between farmland size in stated preference and revealed preference of NTFPs. Although regular household income is positively related to both RUM and CVM estimates, but significant only to the contingent values. Hence, the households' farm and off-farm incomes do not influence respondents' revealed investments in forest resources. Residents' proximity to the forest reserve had negative effect to both revealed and stated valuation estimates. In conclusion, when the distribution of results for random utility model and contingent valuation estimates are compared, own utility maximization can be said to be the dominant incentive in both revealed and stated preferences for most of the households (80%).

The fact there is no marked difference in the number of households who valued the environmental service provision in the two approaches (84% for RUM and 80% for CVM) indicates that all households who actually spent money on NTFPs stated their preference in the contingent market. Therefore, since 4% of residents were WTP in the hypothetical market yet did not purchase the forest goods in the real market system means that the "not able to pay", "NTFPs have no value", "refuse to participate in survey" and "not willing to place a shilling value" responses to the contingent bids represent real preferences of the households in the actual and hypothetical markets. Since the differences among households' WTP bids in contingent market were not affected by the responses uncertainty demonstrates that these bids are valid.

The respondents who stated their preferences for NTFPs, but did not reveal in actual market, may have been valuing the option or/and existence value of the non-timber forest goods. The survey results show that 45% of households were willing to contribute extra money as guarantee for future availability of NTFPs in addition to the normal maximum WTP amounts for improved forest products management, and approximately 27% of these households gave bids higher than their maximum WTP amounts. This means that these people value more the future availability of the forest products than their current flows, and hence their social discount rate for forest resources is lower compared with its interest rates.

It can, thus, be asserted that the RUM and CVM preferences converge in the predictors for the WTP bids but diverge in the valuation estimates. Analyses, therefore, reveal that the differences in the households' stated and revealed preferences amounts cannot be adequately explained on the basis of economic theory. The study suggests that the main reasons could be the CVM bids were capped by the low forest permit fees as demonstrated by the strong correlation between Maximum WTP values and NTFPs user fees charges (0.602, $p<0.01$). Lack of pricing of most forest products and, hence unavailability of environmental markets also caused undervaluation in the contingent market. The other reason is weak enforcement of institutional arrangements governing use of forest resources.

In welfare assessment of forest products' benefits distribution among the households, compensating variation in the RUM estimates indicates that the sharing of the NTFPs income benefits among the residents is very good irrespective of the distance of the household homestead from the forest. The marginal utility of incomes ratio for household cattle was near unity, depicting indifference among households for willingness to pay and willingness to accept compensation in demand for forest products. Better education levels of household head drastically reduce the ratio of benefits received from NTFPs' income. The high elasticity of demand for education means that the less educated households are more likely to rely on the local environmental resources than the more educated when disposable income reduces marginally. Furthermore, the results show that the residents of South Nandi are not willing to use income from off-farm activities to compensate for any income reduction in NTFPs. The NTFPs benefits assessment analyses assists in prioritizing and directing development policy and plans for improved rural household livelihoods.

5.3 Recommendations

The fact that NTFP income contributes 24% to total household income and reduces income disparities, it is paramount that policymakers appreciate the economic benefits of NTFPs to forest-peripheral dwellers in South Nandi by incorporating NTFP income in county and national development plans. Improved rural incomes, and hence reduced poverty, hinges on how forest-based portfolio activities and off-farm businesses (because they are positively related to income diversification index) such as developing pro-poor approaches that focus on increased product values of forest resources, for example enhanced entrepreneurship development, for better off-farm incomes. Since farm income has an inverse effect on level of diversification, policies that target improved farm incomes like efficient agricultural productivity interventions help reduce over reliance on NTFPs.

The current use of non-timber forest products in South Nandi exhibit non-competing consumption and lack of market driven excludability leading to unsustainable extraction of these resources. Most of the NTFPs are not priced and the few that are priced like livestock pasture is charged extremely below its actual market price. For example, forest pasture user fees are Sh.50 per month per cow yet its price outside the forest is on average Sh.3500. The fees charged on livestock pasture are at suboptimal levels (70 times below the real price) leading to supernormal profits. The low prices encourage the wealthy households to use the forests to benefit more resulting in increased inequality problems. Therefore, as these forest resource services are supplied to the households for free or at the point where the marginal costs of provision of the environmental services are less than the marginal benefits, incentives are given by the current distorted pricing mechanism for unsustainable use of these natural resource commodities. Hence, for optimal provision of NTFPs the true market value should be incorporated in forest resource policy formulation and for better development plans that improve rural incomes and encourage sustainable use of forest resources.

Since livestock contributed the highest (58%) of NTFP income and the number of household cattle had positive and significant effect on forest dependency the poor can be allocated tradable pasture permits to cushion them in periods of uncertainty and economic stress, and also as means of supplementing primary income when livelihoods are threatened. This can be done by discriminating against the local elite by introducing a private endowment system where the poor are allocated transferable pasture rights so that those who are unable to use the forest resource can sell to others (i.e. transfer user rights) within the group. Since the forest product is a function of private endowments, the transferable property rights ensure equity distribution. The assigned property rights not only ensure optimal NTFPs extraction but also create efficient environmental market for the forest goods. Forest resources also provide coping and risk insurance to the vulnerable households. Therefore, policy planners and decision makers should incorporate natural insurance policies in forest management.

The non-timber forest users need to be encouraged to form strong and effective user associations in line with the 2005 Forest Act. This creates opportunity for efficient and rational utilization of resources. Local institutions such as community forest association and forest user groups working with KFS could be empowered to regulate the use of, and access to, forest resources. Households should be involved in determining the NTFPs user fees charges that reflect their market value by rationalizing and converging RUM and CVM valuations. But the involvement of the local community should not become means of devaluing high value NTFP resources rather than improving them for better livelihoods of the poor, equitable distribution of forest benefits and sustainable extraction of the forest goods. Since respondents have unanimous support for forest trust fund (FTF) as payment vehicle in CVM survey, the study recommends the establishment of an independently managed FTF to finance regulation and management of Nandi forest.

The compensating variation analysis shows that less educated households are more likely to be reliant on the local environmental resources than the more educated when disposable income reduces marginally, and that South Nandi people are not willing to use income from off-farm activities to compensate for any income reduction in NTFPs. Hence, forest managers need be careful not to put in place programs that inhibit the poor sectors of society from accessing forest commodities as this might exacerbate poverty and by extension increase household income disparities. Equitable distribution of forest benefits among the communities adjacent to the forest encourages public participation in sustainable management of the forest. Policy makers, therefore, need to design policies that balance forest conservation and rural households' demand for NTFPs as a vehicle for improving domestic livelihoods. Furthermore, the NTFPs welfare evaluation can be used to guide policy makers in determining compensation measures in situations where forest dependent households are deprived of this source of income for example, where cattle owners are required to destock from the forest or a massive forest project that alters peoples' consumption patterns.

Comparative consumer willingness to pay estimates for non-timber forest goods from random utility model and contingent valuation method provides market values that can be used for convergent validity of the economic estimates. The convergent validity tests was performed not to dispute the validity of either valuation method but to seek to improve the precision of parameter estimates obtained and assist policy makers to be confident when using the results from either method. The comparison of stated and revealed preference valuations assists to understand the effects of current pricing, or lack of it, methods in the consumer's valuation dynamics of fees charged on natural resource commodities. Random utility model is an important instrument in solving the problem associated with effects of substitution between non-forest products income and income from forest products. The other advantage is that the model can be used to value changes in income due to specific characteristics of the forest products. Further, it is able to value the benefits of introducing a new forest product use. This is especially important due to the 2007 operationalisation of the 2005 Forest Act, allowing for consumption of products that before were considered illegal. Finally, the value losses from limiting certain products (for example, when there is over consumption and resource replenishment is required) are incorporated within the RUM framework. The main challenge in RUM valuations of non-timber resources is identifying the opportunity costs of labour and time.

This is due to very low elasticity of demand for labour among rural communities from high unemployment and abundant supply of domestic workers.

CVM, although flexible and relatively straightforward in estimating willingness to pay, had values extremely lower than the RUM estimates. The open-ended willingness to pay bid question and forest resource user fees charged became the benchmark for CVM valuation. Since the forest resource user charges undervalues and provides the households with an inefficient market scenario in which to underbid, the contingent market estimates were biased downwards. If a dichotomous choice question, where respondents are offered a price and they are to choose either 'yes' or 'no' is used instead of the open-ended willingness to pay question estimates that are convergent with RUM values could be obtained. From this study we recommend that for better understanding of the impact of respondent uncertainty on valuation of forest-based products, a comparative analysis between the revealed (RUM) and stated (CVM) valuation method estimates is necessary. In order to determine optimal price value of the NTFPs a convergence study of willingness to pay estimates of the stated (CVM) and revealed preference (RUM) is important. Comparing RUM and CVM preferences diminishes individual weakness of each of the methods while enhancing their strengths and hence, improving quality of analysis results. Finally, it assists incorporate conditions beyond the current resource managerial experience with expected impacts on household utilization of forest goods, for example RUM includes random variables in its analysis while CVM considers non-use values.

5.4 Areas of Further Research

Rural households living in forest peripheries in Kenya, like in other developing countries, have in the course of diversifying their income portfolio activities, use forest goods in constructing income diversification programs. This study demonstrated that households' reliance on NTFP income increases the diversification index to the point where forest income is approximately equal to income from farm activities. What then is the level of agricultural efficiency improvement that is necessary to compensate the income currently generated by non-timber forest products? Hence, to understand the effect of agricultural technical efficiency on NTFPs extraction, further research is necessary.

Policy makers and forest managers face the challenge of designing cost-effective incentive schemes that balances the local demand for non-timber forest products against conservation efforts. In other words, how much does Nandi South forest conservation costs to the forest-adjacent households? One of the ways of increasing the cost-effectiveness of forest management is to properly price NTFPs in a way that adequately reflects local environmental and economic values in order to discourage excessive exploitation of forest goods. Hence, an important research direction is recommended to find the effects of NTFP prices on equitable benefits sharing and livelihood improvement. In other words, what kind of pricing strategy would be suitable to achieve equity and livelihood objectives of forestry industry while lowering opportunity costs of forest conservation?

Though the application of economic instruments are not well developed in Kenya country research can be done on the effects of some financial and market based incentives such permit auctions, transferable fodder rights, marketable permits as alternative to the current *ad hoc* permit price determination in order to come up with efficient management of forest products. This is especially as a policy instrument to incorporate natural insurance in forest management. An analysis of the role of property rights allocation in determining the value of forest resources may be an important path for future research.

In the economic valuations of NTFPs both the revealed and stated preferences converge in the predictors for the WTP bids respondents' but diverge in the valuation estimates. Therefore, drivers of forest products preferences may not be adequately explained by the standard socioeconomic variables hitherto included in the NTFP demand models. To determine reasons for the huge disparities between actual and stated WTP values requires further research which includes relationship between economic valuation of NTFPs and social psychological models in determination of willingness pay values to estimates variables which are not explained by socioeconomic parameters.

REFERENCES

Abdullah, S., and Jeanty, P.W. (2011). Willingness to pay for renewable energy: Evidence from a contingent valuation survey in Kenya. *Renewable and Sustainable Energy Reviews* 15, 2974-2983.

Adamowicz, W., Swait, J., Boxall, P., Louviere, J., and Williams, M. (1997). Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of environmental valuation. *Journal of Environmental Economics and Management* 32, 65-84.

Adhikari, B., Falco, S.D., and Lovett, J.C. (2004). Household characteristics and forestry dependency: evidence from common property forest management in Nepal. *Ecological Economics* 48, 245-257.

Amirnejad, H., Khalilian, S., Assareh, M.H., and Ahmadian, M. (2006). Estimating the existence value north forests of Iran by using a contingent valuation method. *Ecological Economics* 58, 665 – 675.

Arnold, J.E., and , M.R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics* 39, 437-447.

Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., and Mathijs, E. (2009). The economic contribution of forest use to rural livelihoods in Tigray, Northern Ethiopia. *Forest policy and Economics* 11, 109-117.

Baland, J., and Francois, P. (2005). Commons as Insurance and the Welfare Impact of privatization. *Journal of Public Economics* 89, 211-231.

Barret, C.B., Reardon, T., Webb, P. (2001). Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications. *Food Policy* 26, 315 – 331.

Bateman, I.J., Day, B.H., Georgiou, S., and Lake, I. (2006). The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecological Economics* 60, 450-460.

Beaumais, O., and Appéré, G. (2010). Recreational shellfish harvesting and health risk: A pseudo-panel approach combining revealed and stated preference data with correction for on-site sampling. *Ecological Economics* 69, 2315-2322.

Bett, R.C., and Bett, H.K, Kahi, A.K., and Peters, K.J. (2009). Evaluation and Effectiveness of Breeding and Production Services for Dairy Goat Farmers in Kenya. *Ecological Economics* 68, 2451-2460.

Bishop, J.T. (1999). Valuing forests: a review of method and application in developing countries. *International Institute for Environment and Development* (IIED), London: WCI ODD, U.K.

Bluffstone, R., Boscolo, M., Molina, R. (2001). How does community forestry affect rural households? A labor allocation model of the Bolivian Andes. Working Paper, University of Redlands, USA.

Börner, J., Mburu, J., Guthiga, P., and Wambua, S. (2009). Assessing Opportunity Costs of Conservation: Ingredients for Protected area Management in the Kakamega, Western Kenya. *Forest Policy and Economics* 11, 459-467.

Boxall, P.C., Englin, J., and Adamowicz, W.L. (2003). Valuing aboriginal artifacts: a combined revealed-stated preference approach. *Journal of Environmental Economics and Management* 45, 213-230.

Brookshire, D.S., Eubanks, L.S. and Randall, A. (1983). Estimating option prices and existence values for wildlife resources. *Land Economics* 59 (1), 1-15.

Brown, G., and Henry, W. (1989). The Economic Value of Elephants. London, LEEC Paper 89-12, *London Environmental Economics Centre*.

Brown, B.W., and Walker, M.B. (1989). The Random Utility Hypothesis and Inference in Demand Systems. *Econometrica*, Vol. 57, No. 4 (July), pp. 815-829.

Campbell, B.M., and Luckert, M.K. (2002). Towards understanding the role of forests in rural livelihoods. In: Campbell, B.M., and Luckert, M.K (eds.), Uncovering the Hidden Harvest: *Valuation Methods for Methods for Woodland and Forest Resources.* CIFOR, Bogor, pp. 1-16.

Carson, R.T., Flores, N.E., Kerry, M.M., Wright, J.L. (1996). Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for quasi-public Goods. *Land Economics* 72 (1), 80-89.

Cavendish, W. (2000). Empirical irregularities in the poverty-environment relationship of rural households: evidence from Zimbabwe. *World Dev*. 28, 1979-2003.

Cavendish, W. (2002). Quantitative methods for estimating the economic value of resource use to rural households. In: Campbell, M.B., Lucket, K.M. (Eds.), Uncovering the Hidden Harvest: *Valuation Methods for Woodland and Forest Resources.* Earthscan Publications Ltd., London.

Chambers, C.M., Chambers, P.E., and Whitehead, J.C. (1994). Conservation organizations and the option value to preserve: an application to debt-for-nature swaps. *Ecological Economics* 9, 135-143.

Chambers, C.M., Chambers, P.E., and Whitehead, J.C. (1996). Contingent valuation of quasi-public goods: Validity, reliability, and application to valuing a historic site. Central Missouri University. Department of Economics and Finance. Warrensburg, MO, 64093.

Choe, K.A., Whittington, D., and Lauria, D.T. (1994). Household demand for surface water quality improvements in the Philippines; A case study of Davao City. In, United Nations Environment Programme: Economic values and the environment in the developing world. *Environmental Economics series* 14, 56-57. UNEP. Nairobi.

Chopra, K., and Gulati, S.C. (1998). Environmental degradation, property rights and population movements: hypotheses and evidence from Rajasthan (India). *Environment and Development Economics*. Vol. 3 (1), 44-56.

Chune, N.C. (2003). Highlights of Current Labour Market conditions in Kenya. Global Policy Network. Downloaded from htt://www.globalpolicynetwork.org, on 30th July, 2011.

CIFOR. (2011). Forests and non-timber forest products. CIFOR fact sheets. http://www.cifor.cgiar.org/publications/corporate/factsheet/NTFP.htm2011 Accessed in July, 2011.

Coulibaby-Lingani, P., Tigabu, M., Savadogo, P., Oden, P.C., and Ouadba, J.M. (2009). Determinants of access to forest products in Southern Burkina Faso. *Forest Policy and Economics* 11, 516-524.

Colombo, S., Calatrava-Requena, J., Hanley, N. (2006). Analyzing the social benefits of soil conservation measures using stated preference methods. *Ecological Economics* 58, 850-861.

Colombo, S., Hanley, N., and Louviere, J. (2009). Modeling preference heterogeneity in stated choice data: an analysis for public goods generated by agriculture. *Agricultural Economics* 40, 307-322.

Common, M.S. (1988). Environmental and resource economics. Longman Group UK Limited. pp. 98.

Cooke, P.A. (1998). Intra household labor allocation responses to environmental good scarcity. A case study from the hills of Nepal. *Economic Development and Cultural Change* 48(4), 807-830.

Creel, M. (1998). A note on consistent estimation of mean WTP using a misspecified logit contingent valuation model. *Journal of Environmental Economics and Management.* Vol. 35 (3).

Croitoru, L. (2007). Valuing the non-timber forest products in the Mediterranean region. *Ecological Economics* 63, 768-775.

Das, N. (2010). Incidence of forest income on reduction of inequality: Evidence from dependent household in Milieu of joint forest management. *Ecological Economics* 69, 1617-1625.

Darling, A.H., Gomez, C., and Niklitschek, M.E. (1993). The question of a public sewerage system in a Caribbean country; A case study. In Munasinghe, M.(ed.); *Environmental Economics and Natural Resource Management in Developing Countries*. The World Bank. Washington. pp. 106.

Deaton, A. (1997). The analysis of household surveys: a micro-econometric approach to development policy/Angus Deaton. Published for the World Bank [by] Johns Hopkins University Press, Baltimore, MD, pp. 139.

Delang, C.O. (2006). Not just minor forest products: The economic rationale for the consumption of wild food plants by subsistence farmers. *Ecological Economics* 59, 64-73.

Dhakal, M., and Masuda, M. (2009). Local pricing system of forest products and its relations to equitable benefit sharing and livelihood improvement in the lowland community forestry program in Nepal. *Forest Policy and Economics* 11, 221-229.

Dixon, J., and Hufschmidt, M.M. (eds.). (1990). Economic valuation techniques for the environment: A case study workbook. John Hopkins University Press. Baltimore and London.

Dolisca, F., McDaniel, J.M., and Teeter, L.D. (2007). Farmers' perceptions towards forests: A case study from Haiti. *Forest Policy and Economics* 9, 704-712.

Ellis, F. (1998). Household Strategies and Rural Livelihood Diversification. *Journal of Development Studies* 35, 1-38.

Emerton, L. (1997). Valuing Household Use of Non-Timber Forest Products. In, Crafter, S.A., Awimbo, J., and Broekhoven, A.J. (ed.) 1997: Non-Timber Forest Products. Value, Use and Management Issues in Africa, Including example from Latin America. *International Union for Conservation of Nature and Natural Resources*.

Emerton, L., and Tessema, Y. (2001). Economic constraints to the management of marine protected areas: the case of Kisite Marine National Park and Mpunguti Marine Reserve, Kenya. IUCN Eastern Africa, Nairobi, Kenya.

Eom, Y.S., and Larson. (2006). Improving environmental valuation estimates through consistent use of revealed and stated preference information. *Journal of Environmental and Management* 52, 501-516.

Falco, S.D., Bezabih, M., and Yesuf, M. (2010). Seeds for livelihood: Crop biodiversity and food production in Ethiopia. *Ecological Economics* 69, 1695-1702.

FAO (1997). http://www.fao.org/docrep/W4345/W4345E00.htm In state of the World's forests. Ed. Accessed in July 2011.

Fisher, M. (2004). Household welfare and forest dependence in Southern Malawi. *Environment and Development Economics*, 9, 16.

Fisher, M., and Shively, G. (2005). Can Income Programs Reduce Tropical Forest Pressure? Income Shocks and Forest Use in Malawi. *World Development* Vol.33, No.7, pp.1115-1128.

Fisher, M., Chaudhury, M., and MCCusker, B. (2010). Do Forests Help Rural Households Adapt to Climate variability? Evidence from Southern Malawi. *World Development* Vol. 38, No.9, pp. 1241-1250, 2010.

Freeman, A.M., III. (1993). The measurement of environmental and resource values: theory and methods. *Resources for the future*. Washington.

Fu, Y., Chen, J., Guo, H., Chen, A., Cui, J., and Hu, H. (2009). The role of non-timber forest products during agroecosystem shift in Xishuangbanna, Southern China. *Forest Policy and Economics* 11, 18-25.

Gavin, M.C, and Anderson, G.J. (2007). Socioeconomic Predictors of forest use values in the Peruvian Amazon: A potential tool for biodiversity conservation. *Ecological Economics* 60, 752-762.

Getachew, M., Sjaastad, E., and Vedeld, P. (2007). Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics* 9, 916-927.

Githinji, M. (2000). Income Distribution and Dualism: The Case of Kenya. *Review of Development Economics*, 4(3), 326-339.

Godoy, R., Lubowski, R., Markandya, A. (1993). A method for the economic valuation of non-timber tropical forest products. *Economic Botany* 47 (3), 220-233.

Godoy, R., O'neill, K., Groff, S., Kostishack, P., Cubas, A., Demmer, J., MCSweeney, K., Overman, J., Wilkie, D., Brokaw, N., and Martinez, M. (1997). Household Determinants of Deforestation by Amerindians in Honduras. *World Development*, Vol. 25. No.6, pp. 977-987.

Godoy, R., Wilkie, D., Overman, H., Cubas, A., Cubas, G., Demmer, J., McSweeny, K., Brokaw, N. (2000). Valuation of consumption and sale of forest goods from a Central American rain forest. *Nature* 406, 62-63.

Godoy, R., Overman, H., Demmer, J., Apaza, L., Byron, E., Huanca, T., Leonard, W., P′erez, E., Reyes-Garcia, V., Vadez, V., Wilkie, D., Cubas, A., McSweeney, K., and Brokaw, N. (2002). Local financial benefits of rain forests: Comparative evidence from Amerindian societies in Bolivia and Honduras. *Ecological Economics* 40, 397-409.

Gram, S. (2001). Economic Valuation of Special Forest Products: An Assessment of Methodological Shortcomings. *Ecological Economics* 36, 109-117.

Grimes, A., Loomis, S., Jahnige, P., Burnham, M., Onthank, K., Alarcon, R., Cuenca, W., Martinez, C., Neill, D., Balick, M., Bennett, B., Mendelsohn, R. (1994). Valuing the rain forest: the economic value of non-timber forest products in Ecuador. *Ambio* 23 (7), 405-410.

Gunatilake, H.M., Senaratne, D.M.A.H., Abeygunawardena, P. (1993). Role of non-timber forest products in the economy of peripheral communities of knuckles national wilderness area of Sri Lanka: a farming systems approach. *Economic Botany* 47 (3), 275-281.

Hammitt, J.K., Liu, J.T., and Liu, J.L. (2001). Contingent valuation of a Taiwanese wetland. *Environment and Development Economics* 6(2), 264-267.

Hanley, N., Bell, D., and Alvarez-Farizo, B. (2003). Valuing the benefits of coastal water quality improvements using contingent and real behaviour. *Environmental and Resource Economics* 24, 273-285.

Hecht, J.E. (1999). The Economic Value of the Environment: Cases from South Asia. IUCN-The World Conservation Union, Nepal Country Office, Kathmandu.

Herriges, J.A., and Kling, C.L. (1999). Nonlinear Income Effects in Random Utility Models. *The Review of Economics and Statistics*, Feb. 81 (1): 62-72.

Heubach, K., Wittig, R., Nuppenau, E.A., and Hahn, K. (2011). The Economic Importance of Non-Timber Products (NTFPs) for Livelihood Maintenance of Rural West African Communities: A Case Study from Northern Benin. *Ecological Economics* 70, 1991-2001.

Hill, M., (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology* 54, 427-432.

Illukpitiya, P., and Yanagida, J.F. (2010). Farming Vs Forests: Trade-off between Agriculture and the Extraction of Non-Timber Forest Products. *Ecological Economics* 69, 1952-1963.

Illukpitiya, P., and Yanadida, J.F. (2008). Role of Income diversification in protecting natural forests: evidence from rural households in forest margins of Sri Lanka. *Agroforestry Systems* 74, 51-62.

Janse, G., and Ottitsch, A. (2005). Factors influencing the role of Non-Wood Forest Products and Services. *Forest Policy and Economics* 7, 309-319.

Kamanga, P., Vedeld, P., and Sjaastad, E. (2009). Forest Incomes and Rural Livelihoods in Chiradzulu District, Malawi. *Ecological Economics* 69, 613 – 624.

Kilchling, P., Hansmann, R., and Seeland, K. (2009). Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland. *Forest Policy Economics* 11, 294 – 300.

Kijazi, M.H., and Kant, S. (2011). Social acceptability of alternative forest regimes in Mount Kilimanjaro, Tanzania, using stakeholder attitudes as metrics of uncertainty. *Forest Policy and Economics* 13, 242-254.

Knetsch, J.K. (2007). Biased valuations, damage assessments, and policy choices: The choice of measure matters. *Ecological Economics* (63), 684-689.

Kohlin, G. (2001). Contingent Valuation in Project Planning and Evaluation: The Case of Social Forestry in Orissa, India. *Environment and Development Economics* 6 (2), 255-256.

Kumari, K. (1995). An Environmental and Economic Assessment of Forest Management Options: A Case Study in Malaysia. Environment Department Papers, *Environmental Economics Series*, Paper, vol. 26. World Bank, Washington DC, p. 49.

Kula, E. (1994). Economics of Natural Resources, the Environment and Policies. Chapman & Hall, London.

Lienhood, N., MacMillan, D. (2007). Valuing Wilderness in Iceland: Estimation of WTA and WTP Using the Market Stall Approach to Contingent Valuation. *Land Use Policy* 24, 289-295.

Mahapatra, A.k., Albers, H.J., Robinson, E.J.Z. (2005). The impact of NTFP sales on rural households' cash income in India's dry deciduous forest. *Environmental Management* 35 (3), 258-265.

Mamo, G., Sjaastad, E., and Vedeld, P. (2007). Economic Dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics* 9, 916-927.

McConnel, K.E. (1997). Income and the demand for environmental quality. *Environment and Development Economics* 2(4), 394-397.

McSweeney, K. (2005). Natural Insurance, Forest Access, and Compounded Misfortune: Forest Resources in Smallholder Coping Strategies Before and After Hurricane Mitch, Northeastern Honduras. *World Development* Vol. 33, No. 9, pp. 1453-1471.

Mitchel, R.C., and Carson, R.T. (1989). Using Surveys to Value Public Goods: The Contingent Valuation Method. *Resources for the Future*, Washington, D.C. pp. 463.

Mitra, A., and Mishra, D. (2011). Environmental Resource and Consumption Patterns in Rural Arunachal Pradesh. *Forest Policy and Economics* 13, 166-170.

Mogaka, H., Simons, G., Turpie, J., Emerton, L., and Karanja, F. (2001). Economic Aspects of Community Involvement in Sustainable Forest Management in Eastern and Southern Africa. *IUCN – The World Conservation Union*, East Africa Regional Office, Nairobi.

Morgan, O.A., and Huth, W. (2011). Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving. *Resource and Energy Economics* 33, 107-118.

Munasinghe, M., and Lutz, E. (1993). Environmental Economics and Valuation in Development Decision-Making. In, Munasinghe, M. (eds.) 1993: Environmental Economics and Natural Resource Management in Developing Countries. The World Bank. Washington. pp. 65-66.

Navrud, S., and Mungatana, E.D. (1994). Environmental Valuation in Developing Countries: The Recreational Value of Wildlife Viewing. *Ecological Economics* 11, 135-151.

Nijkamp, P., Vindigni, G., and Nunes, P.A.L.D. (2008). Economic valuation of biodiversity: A comparative study. *Ecological Economics* 67, 217-231.

OECD. (1994). Project and Policy Appraisal: Integrating Economics and Environment. OECD, Paris.

Parry, I.W.H., Sigman, H., Walls, M., and Williams III, R.C. (2006). The Incidence of Pollution Control Policies. In, Tietenberg .T and Folmer .H (eds.): *The International Yearbook of Environmental and Resource Economics 2006/2007*. A Survey of Current Issues. Edward Elgar. Cheltenham, U.K. Pg. 23.

Pearce, D., and Moran, D. (1994). The Economic Value of Biodiversity. *IUCN-The World Conservation Union.* Earthscan Publications Limited. pp. 59-60.

Pendleton, L., and Mendelsohn, R. (2000). Estimating Recreation Preferences Using Hedonic Travel Cost and Random Utility Models. *Environmental and Resource Economics* Vol. 17 (89-108). Kluwer Academic Publishers.

Perman, R., Ma, Y., McGilvray, J., and Common, M – 3rd ed. (2003). Natural Resource and Environmental Economics. Pearson Education Limited. Harlow, England. Pp. 448.

Pouta (2005). Sensitivity to scope of environmental regulation in contingent valuation of forest cutting practices in Finland. *Forest Policy and Economics* 7, 539-550.

Quang, D.V., and Anh, T.N. (2006). Commercial collection of NTFPs and households living in or near the forests: Case study in Que, Concuong and Ma, Tuong Duong, Nghe An, Vietnam. *Ecological Economics* 60, 65-74.

Republic of Kenya (2009). Nandi South District Development Plan 2008-2012.

Republic of Kenya (2010). Basic Report on Well-Being in Kenya. Based on Kenya Integrated Household Budget Survey- 2008/2009. Kenya National Bureau of Statistics.

Ruiz-P′erez, M., and Arnold, J.E.M. (2001). Can non-timber forest products match tropical forests conservation and development objectives? *Ecological Economics* 39, 437-447.

Ruto, E., Garrod, G., and Scarpa, P. (2008). Valuing animal genetic resources: a choice modeling application to indigenous cattle in Kenya. *Agricultural Economics* 38, 89-98.

Scarpa, R., Hutchinson, W.G., Chilton, S.M., and Buongiorno, J. (2000). Importance of forest attributes in the willingness to pay for recreation: a contingent valuation study of Irish forests. *Forest Policy and Economics* 1, 315-329.

Schläpfer, F. (2008). Contingent valuation: A new perspective. *Ecological Economics* 64, 729-740.

Scott, P. (1997). Utilisation of Non-Timber Forest Products from Mount Elgon National Park, Uganda. In, Crafter, S.A., Awimbo, J., and Broekhoven, A.J., (eds.) 1997: *Non-Timber Forest Products: Value, Use and Management Issues in Africa, Including examples from Latin America*. International Union for Conservation of Nature and Natural Resources. Pg. 45-49.

Shackleton, C.M., Shackleton, S.E., Buiten, E., and Bird, N. (2007). The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics* 9, 558-577.

Shackleton, C.M., Shackleton, S.E. (2006). Household wealth status and natural resources in the Kat River Valley, South Africa. *Ecological Economics* 57, 306-317.

Shaikh, S.L., Sun, L., and Kooten, G.C. (2007). Treating Respondent Uncertainty in Contingent Valuation: A Comparison of Empirical Treatments. *Ecological Economics* 62, 115-124.

Shone, B and Caviglia-Harris, J.L. (2006). Quantifying and comparing the value of non-timber forest products in the Amazon. *Ecological Economics* 58, 249-267.

Sjaastad, E., Angelsen, A., Vedeld, P., Bojo, J. (2005). What is environmental income? *Ecological Economics* 55 (1), 37-46.

Smith, V.K., and Kaoru, Y. (1986). Modelling Recreation Demand within a Random Utility Framework. *Economic Letters*. Elsevier Science Publishers B.V. Pg.395 – 399.

Soutukorva, A. (2004). The Value of Improved Water Quality – A Random Utility Model of Recreation in the Stockholm Archipelago. *The Beijer International Institute of*

Ecological Economics. The Royal Swedish Academy of Sciences, Stockholm. Pages 1-11.

Stevens, T.H., Echeverria, J., Glass, R.J., Hager, T. and More, T.A. (1991). Measuring the existence value of wildlife: What do CVM estimates really show? *Land Economics* 64(4), 390-400.

Stevens, T.H., Belkner, R., Dennis, D., Kittredge, D., and Willis, C. (2000). Comparison of contingent valuation and conjoint analysis in ecosystem management. *Ecological Economics* 32, 63-74.

Sultz, S., Pinazzo, J., and Cifuentes, M. (1998). Opportunities and limitations of contingent valuation survey to determine national park entrance fees: Evidence from Costa Rica. *Environment and Development Economics*. Vol. 3(1), 138-147.

Sumukwo, J., Mark, K., and Cheserek, G. (2012). Economic Valuation of Improved valuation of solid waste management in Eldoret municipality. Journal of Emerging Trends in Economics and Management Sciences (JETEMS) 3(6), 962-970.

Sunderlin, W.D., Angelsel, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L., and Wunder, S. (2005). Livelihoods, Forests, and Conservation in Developing Countries: An Overview. *World Development* Vol. 33, No. 9, pp. 1383-1402, 2005.

Sunderlin, W.D. (2006). Poverty alleviation through community forestry in Cambodia, Laos, and Vietnam: An assessment of the potential. *Forest Policy and Economics* 8, 386-396.

Takasaki, Y., Barham, B.L., and Coomes, O.T. (2004). Risk coping strategies in tropical forests: Floods, illnesses, and resource extraction. *Environment and Development Economics* 9(2), 203-224.

Takasaki, Y. (2011). Do the Commons Help Augment Mutual Insurance Among the Poor? *World Development* Vol. 39, No. 3. pp. 429-438, 2011.

Tejam, C. and Ross, A. (1997). Manual of practices: Contingent valuation survey for integrated coastal management applications. Quezon City, GEF/UNDP/IMO Regional Program for the prevention and management of marine pollution in the East Asian seas.

Tesfaye, Y., Roos, A., Campbell, B.M., and Bohlin, F. (2011). Livelihood Strategies and the Role of Forest Income in Participatory-Managed Forests of Dodola area in the Bale Highlands, Southern Ethiopia. *Forest Policy and Economics* 13, 258 – 265.

Thomas, M., and Stratis, N. (2002). The Cost of Manatee Protection: A Compensating Variation Approach to Lost Boating Opportunity in Florida, USA. *Marine Resource Economics* 17(1), March, 2002.

Tisdell, A.C. (2005). Economics of Environmental Conservation. Edward Elgar. Cheltenham. U K. pp. 163.

Turpie, J.K., Heydenrych, B.J., and Lamberth, S.J. (2003). Economic value of terrestrial and marine biodiversity in the Cape Floristic Region: implications for defining effective and socially optimal strategies. *Biological Conservation* 112, 233-251.

Urama, K.C., and Hodge, I.D. (2006). Are stated preferences convergent with revealed preferences? Empirical evidence from Nigeria. *Ecological Economics* 59, 24-37.

Valdivia, C., Duhn, E., and Jette, C. (1996). Diversification as a risk management strategy in an Andean Agro Pastoral Community. *American Journal of Agricultural Economics* 78, 1329-1334.

Varian, H. (1990). International Microeconomics: A Modern Approach. W.W. Norton and Company, New York.

Vedeld, P., Angelsen, A., Sjaastad, E., Berg, G. (2004). Counting on the environment: forest environmental incomes and the rural incomes. *Environmental Department Papers*. World Bank. No. 98.

Vedeld, P., Angelsen, A., Bojo, J., Sjaastad, E., and Berg, G.K. (2007). Forest environmental incomes and the rural poor. *Forest Policy and Economics* 9, 869-879.

Venn, T.J., and Quiggin, J. (2007). Accommodating indigenous cultural heritage values in resource assessment: Cape York Peninsula and the Murray – Darling Basin, Australia. *Ecological Economics* 61, 334-344.

Vodouhe, F., Coulibaly, O., Adegbidi, A., and Sinsin, B. (2010). Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy and Economics* 12, 505-512.

Vö lker, M., and Waibel, H. (2010). Do rural households extract more forest products in times of crisis? Evidence from the mountainous uplands of Vietnam. *Forest Policy and Economics* 12, 407-414.

Von Haefen, R.H., and Phaneuf, D.J. (2008). Identifying demand parameters in the presence of unobservables: A combined revealed and stated preference approach. *Journal of Environmental Economics and Management* 56, 19-32.

Wasike, W.S.K (1996). Contingent Valuation of River Pollution Control and Domestic Water Supply in Kenya. PhD Dissertation. University of Sterling.

White, P.C.L and Lovet, J.C (1999). Public Preferences and Willingness to Pay for Nature Conservation in the North York Moors National Park, U.K. *Journal of Environmental Management.* Vol.55 (1), 2.

Whitehead, J.C., Haab, T.C., and Huang, J-C. (2000). Measuring recreation benefits of quality improvements with revealed and stated behavior data. *Resource and Energy Economics* 22, 339-354.

Whitehead, J.C. (2000). A Comparison of Contingent Valuation Method and Random Utility Model Estimates of the Value of Avoiding Reductions in King Mackerel Bag Limits. Department of Economics. Appalachian State University. North Carolina. U.S.A.

Whitehead, J.C., Dumas, C.F., Herstine, J., Hill, J., and Buerger, B. (2008). Valuing beach access and width with revealed and stated preference data. *Marine Resource Economics* 23, 119-135.

Whitehead, J.C., Phaneuf, D.J., Dumas, C.F., Herstine, J., Hill, J., and Buerger, B. (2010). Convergent validity of revealed and stated recreation behavior with quality change: A comparison multiple and single site demands. *Environmental and Resource Economics* 45, 91-112.

Whittington, D., Lauria, T., Wright, A., Choe, K., Hughes, J., and Swarna, V. (1993): Household demand for improved sanitation services in Kumasi, Ghana; A contingent valuation study. *Water Resources,* Vol. 29 (6), 1539-1560.

Willis, K.G. (1989). Option Value and Non User Benefits of Wildlife Conservation. *Journal of Rural Studies*, Vol. 5, No. 3, pp. 245-256.

World Bank (2004). Response Growth for the New Millenium, Integrating Society, Ecology, and the Economy. The World Bank. Washington D.C. pp. 141-146.

World Bank (2008). Forests Sourcebook. Practical Guidance for Sustainable Forests in Developing Cooperation. The World Bank. Washington, D.C. pp. 85-90.

Zander, K.K., and Drucker, A.G. (2008). Conserving what's important: Using choice model scenarios to value local cattle breeds in East Africa. *Ecological Economics* 68, 34-45.