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FOREST DEPENDENCE AND HOUSEHOLD WELFARE: EMPIRICAL EVIDENCE FROM KENYA*

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TABLE OF CONTENTS

LIST OF TABLES

Abstract

This paper explores the role of forest in household welfare in Kenya. The paper uses primary household level data collected from Nakuru district in November and December 2006. The household level data is supplemented by a community survey to gather community level information on market access among other factors. Both descriptive and econometric methods are used to explore the correlates of participation in forest activities and also in forest collective action. The paper also analyses the contribution of forests to income distribution in the study sample using the Lorenz curve approach. The paper further explores resource extraction and the economic reliance of households on forests. The results suggest that forests play an important role as safety nets that cushion households during periods of hardship. The results also suggest that forests play an important role as a gap-filler and as a source of regular subsistence use and also an important role in poverty reduction. The econometric results point at the role of household heterogeneity in terms of willingness to participate in forest collective action and private resource endowments in influencing economic reliance on forests. The results further suggest that both the poor and the less poor derive a substantive share of incomes from forest activities and that forests are not necessarily poverty traps for rural households. Forest policies need to take into account tradeoffs between forest extraction and forest degradation and also consider targeting of households in forest use and management depending on household heterogeneities in both current and permanent incomes.

Key words: *Forest dependence; Non-resident cultivators; Poverty; Household heterogeneity; Kenya.*

JEL: D31 O13 Q23 Q24 Q28 Q56

Acronyms

ANOVA	Analysis of Variance
CPR	Common Pool Resources
DDC	District Development Committee
FD	Forest Department
FUG	Forest User Group
KEFRI	Kenya Forestry Research Institute
KWS	Kenya Wildlife Service
NRC	Non-Resident Cultivators
NTFP	Non-Timber Forest Products
MEA	Millennium Ecosystem Assessment

1. Introduction

1.1 Background

Role of forests: Forests are very valuable in terms of biodiversity and as economic resources for the state (Millennium Ecosystem Assessment (MEA), 2005). According to the MEA report, forest ecosystems play at least five important roles. First they are extremely important refuges for terrestrial biodiversity; a central component of earth's biogeochemical systems; and a source of ecosystem services essential for human well-being. Second, forests and woodlands play a significant role in the global carbon cycle and, consequently, in conditioning global climate change. Third, more than three quarters of the world's accessible freshwater comes from forested catchments. Fourth, forests play important cultural, spiritual, and recreational roles in many societies. Fifth, the rural poor are dependent on forest resources for sustaining their livelihoods. As many as 300 million people, most of them very poor, depend substantially on forest ecosystems for their subsistence and survival. Although use of forest resources on its own is often insufficient to promote poverty alleviation, forest loss and degradation has significant negative consequences on human well-being (MEA 2005).

Forest-Poverty Linkage: Forest environmental income is relatively more important for the poor than the non-poor. Forest degradation and overuse will therefore hurt the poor more than the non-poor (Vedeld et al. 2004). There are three distinct roles of forests: safety nets, support of current consumption (coping strategy) and a pathway out of poverty through household income sustainability (Cavendish, 2003; Vedeld et al. 2004; Angelsen and Wunder 2003; Fisher, 2004). The safety net role refers to the role that forests can play during periods of hardship (such as to cushion against unexpected income shortfalls due to say family illness, natural disasters etc.). The second role sees forests not only as a gap-filler (complementing other incomes especially when there are seasonal food shortfalls) but also as a source of regular subsistence use. The poverty reduction role is through diversification and specialized forest strategies adopted by households, and also provision of important environmental services which benefit local, regional, national and even global stakeholders (Vedeld et al. 2004; Angelsen and Wunder 2003).

Available literature argue that the potential benefits that the poor can derive from forests are not always forthcoming because the poor are sometimes agents of forest degradation; sometimes in a struggle to subsist, sometimes in an effort to prosper, and sometimes in response to temporary misfortune (Shively, 2004). The literature debates on the possibility of a two way causal relationship between forest and poverty. The causality however runs mainly from the poor to forest dependence whereby low return activities become an employment of last resort because the poor lack alternative lucrative income opportunities. For this reason, the prime role of forests

has been viewed as providing a safety nets and means to maintain current levels of consumption rather than poverty reduction (Vedeld et al. 2004).

Angelsen and Wunder (2003) however say that though forests may be safety nets for poverty, they may also be poverty traps. As poverty traps, the main problem of forests is the low returns from most Non-Timber Forest Products (NTFP) activities, due to high costs of harvesting and low net returns to extractive labour. In addition, remoteness and low population density often mean that physical infrastructure is poorly developed, complicating market access. The poor do not necessarily benefit from forest activities due to exclusion by the more powerful, economic inequalities and differentiation resulting from resource forest use. While high economic rents may lead to overexploitation and collapse of the resource base of a common property resource, higher prices can make it profitable to domesticate the resource. It is well documented that the NTFPs provide a wide range of subsistence and cash income to a large number of households in many countries (Narain et al. 2005)

Other studies have however found mixed results on the potential role of forests in the livelihoods of the very poor and marginalized sections of communities (Campbell et al. 2001; Beck and Neshmith, 2001; Adhikari, 2005). The common pool resources (CPR) literature argues that the poor people extract more resources from the commons due to greater reliance on natural resources and also due to their high individual rates of time preference. Angelsen and Wunder (2003) argue that risk aversion impedes a greater degree of specialization in the most rewarding activities and is therefore a main causal factor of poverty. According to Dasgupta (1993), the poor may depend more on common property resources than the non-poor, but in absolute terms, their dependency is lower. While the poor may attempt to minimize risk by using forest resources to mitigate shortfalls in consumption levels, the less poor may be interested in enhancing their earnings by selling these resources, particularly when there are good market opportunities (Adhikari, 2005).

1.2 Statement of the problem

The importance of forests in the livelihoods of the poor is retaliated in the literature (see for instance, the Millennium Ecosystem Assessment 2005). The literature further shows that the use of forest resources can contribute significantly to poverty reduction by providing additional benefits and income for the rural people (Fisher 2004). This is the case if access rules are defined in a way which ensures that the poor households benefit from forests use and an effective management system ensuring sustainable resource use and preventing further environmental degradation is put in place.

Though rigorous studies on forest-poverty links are emerging for developing countries (Cavendish, 2000; 2003; Fisher, 2004; Campbell, et al. 2001; Adhikari et al. 2004 (see also

Angelsen and Wunder, 2003; Vedeld et al. 2004), no systematic study has been carried out for Kenya. In addition, though the management of CPRs and the implications for environment and poverty has been well studied in developing countries, no such study has been carried out for Kenya. Studies on Kenya have focused on impact of land (agricultural) degradation and household welfare (Kabubo-Mariara et al. 2006). No specific study has been undertaken to document the differential nature of returns to different interest groups within the forest resource using communities in Kenya. This paper seeks to address this research gap. The paper explores the nature and extent to which resource poor households depend on forests for a livelihood.

The study analyses the forest-poverty links of two categories of communities. The first category is non-resident cultivators (NRC), who depend directly on forests for a livelihood through crop cultivation. The second category is other households neighbouring forests (commonly referred to as forest adjacent communities- FAC), who do not cultivate in forests but are likely to depend on forests for timber and non-timber products.

The study addresses the following research questions: What is the level of household dependence on forest environmental incomes? What is the distribution of forest environmental income between the different forest user groups (FUGs) in the sample? Are there different levels of access to and control over forests by households with different socio-economic status? What role do local communities play in forest management? How does heterogeneity and inequalities of communities created by private resource endowments of households affect the ability to use forest products? How does heterogeneity springing from land ownership and forest use rights impact on poverty and livelihoods?

1.3 Objectives of the study

The general objective of the proposed study is to analyse the linkage between forests and household welfare in Kenya. The specific objectives include:

i. To investigate the level of dependence on forest resources by different forest user groups.
ii. To analyse the determinants of the share of earnings derived from forest-based activities.
iii. To analyze the impact of forest user group heterogeneity and other household heterogeneities on forest environmental incomes.
iv. Based on research findings, draw policy recommendations for poverty reduction and forest conservation.

The rest of the paper is structured as follows. Section two presents the study setting and the data. Section three presents the methodology, section four presents the results and section five concludes.

2. The study setting and data

2.1 Forests and forest management in Kenya

Forest types and cover

Forests of Kenya can be divided into four major regions based on climate. (I) The coastal forests consist of closed canopy and cover approximately 82,000 hectares of exotic forests with an additional 3,200 hectares of forest plantation. The remaining area is under other types of vegetation including woodland, thicket, grassland and bush. (ii) Dry land zone forest region covers about 211,000 hectares of closed canopy and an addition of 8,200 hectares of forest plantation. For much of this region, closed canopy forest is limited to small islands at high altitude on isolated hills and mountains, surrounded by lower attitude arid to semi arid bush land. (iii) Montana forest region consists of closed canopy and occupies about 748,500 hectares with 102,800 hectares on plantation.(iv) Western rain forest region also consist of closed canopy and covers about 49,000 hectares and plantation of 18,600 hectares. Although the western forest area has a high potential for closed canopy forest growth similar to montane region it has very little of its original forest cover intact because of high population pressure on forest resources (Wass, 1995).

The government is committed to ensuring that the country maintains an adequate forest cover for environmental control. However, due to increased burning and clearing of forest cover for cultivation, the average area under forests has seen a declining rather than an increasing trend. For instance, the forest plantation area remained almost constant between 1992 and 1996 at 160,000 hectares. Thereafter, the area fell to about 120,000 hectares in 2001, but increased to 132, 000 in 2004 (Economic Survey, 2005).

Forest management

Forest areas in Kenya fall under different management regimes and have different legal status. The majority of closed canopy forestland is gazetted forest reserve. Forest reserves are owned by government and managed directly by the forest department (FD) and/or Kenya Wildlife Service (KWS) on behalf of the state. There are also closed canopy forests gazetted as national parks and national reserves managed by KWS and national monuments managed by the national museums. The role of the forest department in management of forest reserves include law enforcement, licensing of permitted extraction of forest produce, fire protection, control of problem animals in both adjacent plantations and farms and maintenance of infrastructure.

The s*hamba* system, first introduced in Kenya in 1910, is a method of forest plantation establishment in which farmers tend young plantation trees as they produce food crops (Kagombe and Gitonga 2005). Resident forest workers are allocated deforested areas to plant food crops for 2-3 years within which period the canopy closes up and the seedlings become

established. It is therefore almost similar to the traditional slash and burn agriculture but under control of forest management. The *shamba* system practices in Kenya have changed over time. From 1910 to 1975; forest cultivators were integrated into the forest department as resident workers. They were allocated forest plots (*shambas)* and guaranteed work for 9 months per year. The produce from the *shamba* was considered part of workers emolument as they tended the young trees. The system was revised in 1975 when resident workers were permanently employed by the forest department (FD), and were required to rent *shambas*. The system was banned by a presidential decree in 1987.

In response to the increasing backlog and inadequate resource capacities within FD to re-establish plantations, the *shamba* system was reorganized and re-introduced in few districts as non-resident cultivation (NRC) in 1994. Cultivators were not allowed to reside in forest areas and the forest management authority was vested to district development committees (DDC). By 1997 NRC had started in all major forest plantation districts in the country. Strong influence of politicians and administrators in the DDC overshadowed management by technical departments, leading to large areas being cleared for cultivation with little meaningful replanting of trees. In 2000, the FD headquarters reissued NRC management guidelines and established an inter-institutional task force with representation from the FD, Kenya Forestry Research Institute (KEFRI) and Kenya Wildlife Society (KWS) to review the implementation of the NRC.

Following the recommendation of the task force, the NRC was banned in October 2004 but the environment minister gave authority for NRC to be piloted in Dundori and Bahati forest stations. But by then, the two forests were almost bare and were in urgent need for re-afforestation. Due to the ban of NRC, most of the plantations areas are under young plantations, are not planted or hold over-mature trees. This scenario is not conducive for sustainable forest management as all age classes are not represented. The forest department estimates that about 14,400 hectares should be under NRC at any one time but this is currently not the case.

The forest bill (Republic of Kenya, 2005) provides for community participation and says that forest associations will be given user rights to collect both timber and non timber forest products so long as these activities are not in conflict with conservation of biodiversity. Community participation has however been seriously contested by conservationists on the premise that it will have adverse environmental consequences on forests by encouraging return of the *shamba* system. The bill also provides for joint management of forests between the forest service, local authorities, forest communities, government agencies and the private sector, but it is yet to be seen how these stakeholders will work together to reduce poverty and also forest degradation.

2.2 The study site

This study is based on data gathered from forest communities in the context of the *shamba* system in Dundori and Bahati forests located in Nakuru district of the Rift Valley province of Kenya. Dundori forest covers approximately 3845 hectares, of which 51% is categorized as productive area, where trees can be planted. Another 33% is classified as protected area and 10% as bush land area with indigenous vegetation but limited trees. The rest of the area *(*6%*)* has been excised for private development and 33% of this 6% has already been de-gazetted as forest land. The NRC have participated in re-afforestation in three different episodes of forest cultivation since the gazettement of the forest for non-resident cultivation. The first episode started in 2001, with 150 hectares being planted with cyprus trees, the second episode commenced in 2003, with another 150 hectares planted with cyprus and pine trees and the current episode started in mid-2006, with 215 hectares planted with cyprus and pine trees.

Bahati forest covers about 6,957 hectares of land and was only gazetted for NRC in 2004. 47% of the land is plantation productive area, while 49% is protected area. The rest of the land covers bush land (3%) and bamboo (1%). There have been three episodes of exotic tree (cyprus and pine) planting in Bahati forests, covering 229, 181, and 195 hectares in 2004, 2005 and 2006 respectively. Though there is non-resident cultivation, this forest relies more on a private company (Comply) that is licensed to plant trees rather than non-resident cultivators. This is because the government is concerned about possible forest degradation through destruction of trees and competition of nutrients from food crops. Plantation by the private company is therefore taken as a control group to assess the impact of NRC on forest regeneration.

2.3 Sampling and data collection procedures

The data used in this paper was collected from a sample of 290 households. The survey was carried out in November and December 2006. Purposive sampling methods were used to select the district (Nakuru) and division (Bahati) of study, taking into account presence of the characteristics of interest and the scope of the study. All four locations of Bahati division were included in the sample. Multistage sampling was then employed to select lower level sampling clusters: sub-locations and villages. First, a total of 7 sub locations were selected randomly and subsequently a village randomly selected from each sub-location. The villages were then stratified according to prior information on participation in forest activities and proximity to forests[†].

Effort was also made to ensure representation of at least two heterogeneous groups: members and non-members of non-resident cultivator (NRC) groups. To facilitate selection of the sample,

[†] The categorization from district to village follows the hierarchy of administrative units in Kenya. Kenya is divided into 8 main provinces, which is the largest administrative unit. Provinces are then sub divided into districts, divisions, locations, sub-locations and finally villages.

a list of all registered non-resident cultivators was obtained from the local forest department office, while a list of non-members was compiled with the help of local administrators. It further emerged that the registered groups comprised of two different categories- those that were allocated plots after successful balloting and those that were unsuccessful and so did not have forest plots at the time of the survey. The group without plots will be allocated forest plots when a new area will be opened for cultivation.

A detailed questionnaire was used to collect the requisite data and probed the socio-economic characteristics of households, economic activities, forest collection activities and involvement in forest care and management. The household level data was augmented by a community survey for each of the sampled villages. The community survey sought information on local market prices for crops, farm inputs, livestock and forest products. The questionnaire also sought information on local wages, market access and local forest management.

The actual sample survey yielded 122 registered non-resident cultivators, but only 71 of these were cultivating forest plots at the time of the survey. The rest (178 households) were from forest adjacent Communities who are not registered as forest user group members and do not cultivate in forests. They however interact with forests for NTFPs and grazing at modest user charges.

3. A survey of selected literature

There is growing literature on poverty and natural resource management in developing countries. Most previous studies concentrate on poverty and environmental conservation through investment in soil and water conservation technologies. More recent studies have however focused on the poverty-forest link, moreso on the contribution of forests and other common pool resources (see Vedeld et al. 2004). These studies point at a two way link between poverty and forests. On one hand, the literature argues that the poor depend on forests as a safety net to counter the impact of income shortfalls. On the other hand, the literature says that forest communities are poor because of reliance on forest activities which are not only low return but are also labour intensive. The Millennium Ecosystem Assessment (2005) says that many developing countries have not effectively used forest resources in support of development efforts. Widespread corruption in the forestry sector has resulted in valuable forest resources frequently being seized and controlled by political and economic elites. The poor have therefore often seen access to forest resources diminish and have not widely shared in the benefits of forest resource exploitation. Some studies however find that both the poor and the non-poor are forest dependent, only that the level of dependence is determined by differential socio-economic characteristics of the two groups (Vedeld et al. 2004; Cavendish, 2000; Fisher, 2004; Narain et al. 2005).

A synthesis of literature on poverty and forest dependence is presented in a recent World Bank study that sought to investigate the extent to which rural communities depend on income from forest environmental resources and how this dependence is conditioned by different political, economic, ecological, and socio-cultural factors (Vedeld et al. 2004). The authors carry out a meta-study that synthesized results from 54 case studies on forest environment income in developing countries. They argue that other than being a safety net and gap-filler, forest income is part of household livelihood diversification strategies. The authors find that forest environmental income represents a significant income source with an average contribution of about 22%. The authors further find that forest environmental income has a strong and significant equalizing effect on local income distribution and that cash income constitutes about half of total forest environment income for the poor. The authors concur with studies that find heterogeneity and social differentiation to play an important role in determining forest-poverty links. The authors also concur with studies which find that the poor are more dependent on forest environmental income. The authors call for more in-depth studies to understand the role of environmental income in individual households and broader development strategies, more so the extent to which forest environmental income can provide a way out of poverty. In addition, the authors call for studies that address local heterogeneity and social differentiation, as well as studies that address how legal, ecological, economic, political and socio-cultural factors affect the ability and willingness to become involved in forest activities.

A set of studies on poverty and forest degradation appear in a special issue of the Environment and Development Economic journal (volume 9, 2004). The studies disentangle cause and effect, control for unobserved heterogeneity and examine how economic and environmental shocks influence forest-impacting behaviours. The studies not only represent the current state of the art but also contribute to the ongoing debate on the existence and shape of household-level environmental Kuznet's curves (Shively, 2004). For instance, Rodríguiez-Meza et al. (2004) in a study of El Salvador found a precautionary demand for land that diminishes as incomes rise and a positive correlation between income and farming capacity. These results imply that the relationship between forest clearing and per capita income exhibits an inverted-U relationship. The authors also traced the beneficial shifts in a derived empirical environmental Kuznets curve relationship to other factors such as household level heterogeneities. Three other studies in this special issue that are of particular relevance to the issue at hand are Fisher (2004), Pattanayak et al. (2004) and Takasaki et al. (2004). Fisher (2004) examines the economic reliance on forests and its effects on the welfare of low-income households in rural Malawi. She used Tobit models for earning shares from low return and high return forest activities and the Gini coefficient to measure inequalities in earnings from forest resources. The author found that on average households earned about 30% of their incomes from forests and that forest income reduced measured income inequality by 12%. Her findings suggest that households that are poor in human capital and animal holdings are more reliant on low return forest activities than high return forest activities. The author also found that reliance on forest products is also determined by availability of adult male labour and location. Based on research findings, the author concludes that forests have a role to play in poverty alleviation.

Pattanayak et al. (2004) investigate how forests contribute to household welfare and how that contribution varies across households among the socio-economic spectrum. The authors combine the travel cost method and household production theory applied to household survey data to estimate a derived demand for collection trips to forest, with a truncated negative binomial model. The results indicate that local people derive significant economic benefit from forests and that wealthier households are less dependent on forests products than the less wealthy. The authors also find that public infrastructure, wage opportunities and trees on own farms are likely to reduce dependence on forests. Lower costs of fuel alternatives would be expected to reduce dependence on forests for fuel wood. These findings support Reddy and Chakravarty (1999) who found that poor households were much more dependent on forest income than the average rural household in a forested area in the Indian state of Uttar Pradesh.

Takasaki et al. (2004) argue that the link between asset poverty and resource extraction as insurance may be very significant in tropical forests where the livelihoods of the poor often depend on the extraction of biological resources in a biodiverse yet fragile environment. The

author's examine resource extraction as a coping strategy among riverine peasant households in the Peruvian Amazon, where species degradation and biodiversity loss are the primary environmental concerns. The authors find that in environments with alternative means of livelihood, forest dependence is almost non-existent. For households without alternative means, forest dependence is most common among young and poor households and those households with large labor endowments. The authors therefore conclude that there are strong links between asset poverty and non-timber forest product gathering in certain areas of Peru. They recommend that well targeted interventions and programs for the poor to promote sustainable forest resource use are needed not only for environmental conservation but also for poverty alleviation.

Other recent studies that link poverty and forests include Angelsen and Wunder (2003) and Cavendish (2000). Angelsen and Wunder (2003) explore the linkages between forests and poverty. They analyse the potential contribution of forests to poverty reduction in three different ways: NTFPs, timber, and environmental/ecological services[‡]. They find that NTFPs serve subsistence needs and may have important gap filling or safety net functions and sometimes provide regular cash income (see also Vedeld et al. 2004). NTFPs however mostly benefit hunters and gatherers but also supplement incomes for other groups of forest users. Features of NTFPs which include low or medium returns to labour, low capital and skill requirements and open/semi-open resource access favour the poor who have less access to markets for skilled labour and thus have a low opportunity cost of labour (Angelsen and Wunder, 2003). Timber has not been traditionally pro-poor but the picture is changing due to increased local ownership of natural forests, increasing tree commercialization and small scale wood processing. Timber is most important for commercial users (artisans and employees in forest industries) but supplement income for other users. Characteristics of timber extraction make it anti-poor in that it requires capital, skills, land tenure, technology, production systems and time horizons that do not favour poor people. Last they argue that though environmental service payments are emerging rapidly, it is uncertain how much the poor will benefit. The highest poverty-reduction potential of environmental services is through payments of off-site benefits enjoyed at the regional, national and global levels.

Cavendish shows that the dependence of households on environmental income decreased as their average income rose. Although the poor tended to get more of their total income from the environment, the rich still made heavy use of natural products for income (Cavendish, 2000). Cavendish's findings are supported by emerging literature. Narain et al. (2005) find that agriculture provided 58% of total income of the poorest families. But families in the study region

[‡] Environmental services include services for on-site forest dwellers (such as clean drinking water) and off-site benefits such as regional use (downstream water benefits), national benefits (e.g. to urban tourists) or global stakeholders.

(Jhabua) also supplemented their incomes with livestock rearing and collection of various products such as fuel wood, fodder, tendu leaves and mahua flowers.

A number of other related studies have analyzed the role of heterogeneity in forest dependence. The term heterogeneity is used to describe asymmetric distributions of wealth and power, different preferences, opportunity costs, unequal claims to natural resources and socio-cultural differences within a community. Heterogeneity may encompass economic and social inequalities, i.e. inequalities in incomes, inequalities in sacrifices made by community members in cooperating with forest management, inequalities in benefits derived from forest resources and common property resource (CPR) management, inequalities in outside earning opportunities, cultural heterogeneity and locational differences. Heterogeneity may also be through references over diversified forest products which often leads to different preferences for resource management regimes (Adhikari, 2005; Bardhan and Dayton-Johnson, 2000; Kant, 2000). The literature shows that economic heterogeneity really matters in terms of CPR use i.e. poorer households are more dependent on CPRs and consequently derive higher income from these resources (Adhikari, 2005; Bardhan and Dayton-Johnson, 2000; Kant, 2000). Kuik (2005) argues that environmental goods are a heterogeneous bundle in that demands for environmental resources are differentially affected by income changes, while use is also affected by socio-economic variables such as sex, age and household composition.

The general conclusions that we can draw from the reviewed studies are varied. In the first place, the literature suggests that forests and other common pool resources contribute significantly to rural incomes (Vedeld et al. 2004) Another finding is that the poor are more natural resource dependent than the rich, though some studies show that the absolute benefits for the poor are lower (Dasgupta, 1993; Cavendish, 2000; Fisher, 2004; Adhikari, 2005). Narain et al. (2005) however find that the quality of natural resources matters to a larger share of rural population (both the rich and the poor) than estimated by earlier studies.

4. Methods of Analysis

4.1 Exploring forest dependence

This study analyses dependence on forests of two distinct groups of forest communities: non-resident cultivators (NRC), and forest adjacent communities (FAC). The NRC can further be categorized into two groups: those with forest plots at the time of the survey and those without forest plots. Three working hypotheses are addressed: One, the poor are more dependent, than the non/less poor on forest resources; two, forest user group heterogeneity is an important determinant of the poverty-forest link; and three, forest dependence is conditioned by other household level heterogeneities (such as private resource endowments). The study employed both descriptive and econometric methods to test these hypotheses. In the econometric analysis, we proceed as follows: First we investigate the socio-economic correlates of participation in forest activities and in membership in forest user groups; second, we analyse the correlates of resource extraction (value of forest products); and third, we investigate the determinants of economic reliance/dependence on forests (share of household income from forests). It has been observed that unsustainable rates of forest use as well as forest dependence by small holder farmers arise as a result of a complex interplay of incentives, constraints, and institutional forces (Fisher, 2004, Vedeld et al. 2004). Against this background, this study hypothesizes that participation in forest activities and household-level benefits from forests can be associated with household and community attributes. The benefits from forests accruing to household i (Y_i) can therefore be defined as:

$$Y_i = \beta_o + \beta_1 X_1 + \beta_2 Z_j + \varepsilon_i \quad \text{.....(1)}$$

where Xi is a vector of household (i) characteristics and Z_j is a vector of attributes of community j, with j=1-7. Yi is defined as the proportion of forest income out of total income. The betas are parameters to be estimated. ε_i is a random disturbance term. An alternative specification defines Yi as the gross income from resource extraction from forests. Households participate in forest activities because of the benefits (Y_i) they expect to derive from participating. The probability that a household participates in any forest activity can therefore be expressed as:

$$Y_i^* = \beta_o^* + \beta_1^* X_1 + \beta_2^* Z_j + \mu_i \quad \text{.....(2)}$$

Where Y_i^* takes a value of 1 if a household participates in a given forest activity (collection of forest products, forest grazing and membership in forest user groups) and zero otherwise. X_i and Z_i are as defined earlier, μ_i is a random disturbance term.

Definition and measurement of variables

In this paper we explore the impact of several household characteristics that may be expected to influence dependence on forests. These include: age of household head; education level of household head; gender of household head; household size; and household wealth.

Age of the household head (in years) is expected to capture the extent to which household labour allocation changes over the life-cycle of the head of the household (Adhikari, 2005). Young households may be clearing more forest to build up a sufficient amount of cropping or pasture land (Vedeld et al. 2004). Age may also be expected to reduce forest dependence as older people may have less time and physical strength to engage in forest activities (Vedeld et al. 2004, Kohlin and Parks, 2001) and also because the age of the household head is related to the household's experience in managing common resources as well as accumulation of social capital.

Education of the household head is expected to lead to extraction of fewer forest resources since education opens up alternative employment opportunities and diverts people from subsistence agriculture and gathering activities (Vedeld et al. 2004; Shively and Pagiola, 2004; Gunatilake, 1998). Vedeld et al. (2004) further argue that the impact of education, like age may be a cultural factor where going to the forest is considered backward and not for the elderly or the well educated. Angelsen and Wunder (2003) and World Resource Institute (2005), also say that the poor often use forest products due to permanent or temporary lack of better alternatives. In addition, technology, knowledge and skills are expected to enhance the efficiency of harvesting forest products (Adhikari, 2005). However, Angelsen and Wunder (2003) note that forest activities have low entry costs and have few requirements in terms of skills and capital, making it quite easy for the poor to participate. In this paper, education is defined as the highest level attained and classified into three categories: none, primary or post primary education. Primary education is used as the reference category in the econometric estimation.

Gender of the head is included to test whether access to and income from forests is significantly different between male-headed and female-headed households. It is expected that women participate more in common property resources than men and may be more involved in gathering activities than men (Folbre, 1994; Grossman, 1996; Narain et al. 2005).

Household size (number of household members) is expected to have a direct link with forest dependence because gathering activities are labour intensive. A larger household therefore has more labour to spread across various collection activities and such households may derive more resources from the commons. Indeed, some studies look at dependence on forests as a labour/time allocation issue (Gunatilake, 1998; Shively, 2004).

Household wealth endowment is expected to affect benefits from forests directly as productive wealth creates more opportunities for better-off households to use biomass resources, while social reputation of wealthy individuals has indirect effects (Adhikari, 2005). The wealth related factors explored include land (in hectares) and livestock holdings (total livestock units). Households better endowed with land and livestock holdings are expected to benefit more from forests because forests are an important source of intermediate products that serve as inputs in the farming system (Adhikari, 2005; Fisher, 2004). In addition, wealthier households with larger herds and more land have greater need for animal fodder and agriculture compost (Varughese and Ostrom, 2001; Narain et al. 2005).

Land tenure and rights are also expected to have an impact on forest dependence. In addition, administrative, policy and legal frameworks also affect access to resources. Concession rights, the degree of local participation and the amount of land under different types of protection all have implications for levels and dependence on environmental income (Vedeld et al. 2004; Narain et al. 2005). Due to data limitations, this paper only tests for the impact of tenure arrangements (mode of acquisition) and participation in community and forest collective activities.

Community variables include distance to and availability of forest, market access and participation/membership in village institutions (Angelsen and Wunder, 2003; Vedeld et al. 2004). Households that live closer to the forest have a more secure and accessible supply of produce regardless of whether or not there are allocation rules in place (Varughese and Ostrom, 2001; Gunatilake 1998). Access to markets may also be expected to reduce the dependency of households on the local commons since community members may have some exit options in terms of outside earning opportunities. In contrast, villages far from the market are more likely to be dependent on CPRs due to lack of alternative livelihood opportunities. The impact of market access on forest dependence is therefore ambiguous because access is correlated with other factors such as forest availability and population density (Vedeld et al. 2004).

Participation in village institutions is also expected to affect the extent of forest use and thus economic benefit from the commons. Participation enhances awareness of the potential gains from forests as institutions are an important source of relevant information, including information on policy changes that directly affect forest communities (Gaspert et al. 1999, Adhikari, 2005). Other important institutional characteristics include customary rules governing forest/product use, government regulations affecting resource use and changes in rights governing resource use (Vedeld et al. 2004). Many previous studies concur that efforts to promote sustainable livelihoods among the poor are more successful when they simultaneously promote ecosystem stewardship and democratic governance World Resource Institute (2005).

Due to data limitations, this study only investigates the impact of membership in village institutions and in forest user groups.

4.2 Contribution of forests to distribution of income

In addition to exploring forest dependence, this study also investigates the contribution of forests to the distribution of income (Fisher, 2004; Vedeld et al. 2004). The study employs the Lorenz curve and the Gini index to measure inequality and also to test for inequality dominance (Duclos and Araar, 2006). The Lorenz curve, for a given percentile p, indicates simply the share of total income detained by the group that represents the bottom P proportion of the population. Following Duclos and Araar (2006), the Lorenz curve can be defined as follows:

$$L(P)=\frac{\int_0^p Q(q)dq}{\int_0^1 Q(q)dq} \quad = \quad \frac{1}{\mu}\int_0^p Q(q)dq \quad \ldots\ldots (3)$$

Where the numerator sums the incomes of the bottom P: proportion (the poorest 100P%) of the population. The denominator sums the incomes of all and since population size is normalized to 1, gives the average income. L(P) ranges from L(0) =0 to L(1) =1 and indicates the cumulative percentage of total income held by a cumulative proportion P of the population when individuals are ordered in increasing values of their income. For instance, if L(0:1) = 0:3, then the 10% poorest individuals hold 30% of the total income in the population 1- L(0:1) measures the share of incomes of the rest of the population.

The Lorenz curve is also useful for testing for inequality dominance. To check for inequality dominance, we can simply test for welfare dominance once incomes have been normalized by their mean If the Lorenz curve LB(P) of a distribution B is everywhere above the Lorenz curve LA(P), distribution A is more unequal than distribution B. All the inequality indices that obey the Pigou-Dalton principle should indicate that inequality in A is higher than inequality in B.

The Gini index is a synthetic index of inequality that compresses all information about inequality into one value. This value lies between zero (perfect equality) and one (perfect inequality). If all had the same income, the cumulative % of total income held by any bottom proportion P of the population would also be P. The Lorenz curve would then be L(P) = P: population shares and shares of total income would be identical. A useful informational content of a Lorenz curve is thus its distance, P-L(P), from the line of perfect equality in income. Compared to perfect equality, inequality removes a proportion P -L(P) of total income from the bottom 100.P% of the population. The larger the deficit, the larger the income inequality. The Gini index equals twice the expected deficit shares:

$$\text{Gini index} = 2\int_0^1 (P-L(P))dP \quad \ldots\ldots (4)$$

The index assumes that all share deficits across P are equally important and thus computes the average distance between cumulated population shares and cumulated shares in income.

Finally, we use the difference in Lorenz curves approach to test for the inequality dominance (Araar and Duclos, 2007).

5. Research findings

5.0 Introduction

This section presents the research findings. To achieve the first study objective, detailed descriptive analysis of data is carried out (section 5.1). The section explores the nature of household heterogeneities of sampled households, the contribution of forests to household welfare and distribution of incomes. Section 5.2 presents the econometric results. Three models results are presented: determinants of participation in forest activities, resource extraction and economic reliance on forests.

5.1 Descriptive analysis

5.1.1 Sample statistics

The socio-economic characteristics of all sampled households are presented in Table 1. The data displays a rather high ratio of female headed households, at 33% of all household in the sample. The data also indicates that 7% of all female heads were widowed. These statistics are important given that female household headship and widowhood have been shown to be positively correlated with poverty in Kenya. The statistics also indicate low average levels of education: an average of primary education (7 years) for most household heads. This is also supported by the education attainment dummies which indicate that only 30% of all household heads had completed secondary education compared to 61% who had completed primary education. The demographic characteristics are consistent with current country wide statistics based on 1999 population census. We do not uncover any significant differences in household characteristics by forest user groups and so the results are not presented.

Table 1: Descriptive statistics of all sampled households

Variable	Mean	Std. Dev.	Min	Max
Male head	0.67	0.47	0	1
Widow	0.07	0.26	0	1
Age of head	45.36	13.13	20	87
Main occupation of farming	0.81	0.40	0	1
Head years of schooling	7.42	3.81	0	18
No education	0.09	0.28	0	1
Primary education	0.61	0.49	0	1
Post primary education	0.30	0.46	0	1
Household size	5.39	1.89	1	10
No. of children =< 5 years old	0.59	0.84	0	3
No. of children >5 years old	1.91	1.53	0	6
Number of adult women in a household	1.44	0.80	0	6
Number of adult men in a household	1.56	0.98	0	6

5.1.2 Heterogeneity of forest user groups

To take a closer look at household welfare indicators, we categorize the sample into heterogeneous groups and then describe the characteristics by group heterogeneity. The study initially sought to interview three groups of farmers: non-resident cultivators, directly depending on forests, forest neighbours cultivating their own land and not directly depending on forests, and forest neighbours who do not own land but depend on rented land. Discussion with forest user group leaders however led to a different categorization: registered forest users without forest plots; registered forest users with forest plots; and non-registered forest adjacent households (FAC). The distribution of the sampled households across these groups is presented in Table 2. The data indicates that 39% (112) of the sample comprised of non-resident cultivators of whom 37% (41) did not have any forest plots. Of the 178 non-registered households, 14 (8%) were tenants with no land of their own. This sample however represented a rather insignificant proportion of the whole sample (only about 5%) to allow any meaningful analysis with this group as a distinct category.

Table 2: Category of households by level of participation in forest user groups.

Group	Not registered	Registered without plot	Registered with plot	Total
Non-resident cultivator	0 (0)	41 (100)	71(100)	112 (39)
Forest neighbour (own land)	164 (92)	0 (0)	0 (0)	164 (56)
Forest neighbour (tenant)	14 (8)	0 (0)	0 (0)	14 (5)
Total	178 (100)	41 (100)	71 (100)	290 (100)

* Percentages in parenthesis.

5.1.3 Land tenure issues

To investigate the role of household and group heterogeneity in participation in forest activities and also forest dependence, this paper focused on the three registration criterion of user groups: non-registered households, registered without forest plot and registered with forest plots. Table 3 presents land ownership indicators by forest user group. The table details the category of land ownership (acquisition), land size and distance to the plot. The data suggests that there are significant differences in the mean land ownership by forest user groups. For instance, the average land owned by non-forest user groups is about 3 hectares compared to <1 for forest user groups without forest plots and 1.5 for forest user groups with forest plots. The mean land size for the households with allocated plots is only 1 hectare. On average, all households hold about 2 hectares of land, with a minimum of zero landholding (two households) and a maximum of 18.25 hectares. 5% of all households were reported to be tenants with no land of their own. One way analysis of variance suggests that there are significant differences in land ownership by the three distinct groups, which is another indicator of group heterogeneity.

Table 3: Land ownership by forest user groups

Variable\Group	Not registered		Registered without plot		Registered with plot		Full sample	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Own plot	2.71	2.54	0.76	0.35	1.47	0.76	2.31	2.3
Allocated plot	0	0	0	0	1.13	0.74	1.13	0.74
Rented plot	2.84	3.17	0.58	0.3	1.59	0.79	2.13	2.68
Gifted plot	2.26	1.71	0.71	0.39	1.35	0.85	1.51	1.37
Plot area (hectares)	2.56	2.49	0.59	0.33	1.13	0.74	1.93	2.14
Distance to plot (km)	2.86	9.27	6.15	28.23	15.73	54.73	6.52	30.46

For the econometric analysis, we employ factor analysis (iterated principal components analysis) to derive measures of land tenure security based on questions probing methods of acquisition of

the land and period of time that the household has used this land. The data suggests that on average, households who are not members of forest user groups farm plots which are relatively near to their households (3 kilometers) compared to all other households. Forest user groups with forest plots travel the longest distance (16 kms) probably reflecting the distance between their homesteads and their forest plots.

5.1.4 Household incomes by sources

It has been argued that forests play an important role in poverty reduction through diversification of household income sources (Vedeld et al. 2004). In this section, we investigate the average household incomes and also the share of incomes from different activities by forest user groups for the 12 months prior to the survey. Table 4 shows the relative contribution of different activities to the total household incomes. Forest crop income is the gross value of crops cultivated in forest plots. Income from forest collection is the total value of fuel, fodder, construction material and all other products (fruits, vegetables, herbs and honey) collected from forests. Self employment includes all forms of small business. Transfers include cash, and kind transfers as well as net proceeds from self-help groups. The data seems to suggest that a few households (only 4) that are not registered as non-resident cultivators still cultivate in the forest. However the mean incomes from forest crop cultivation for these households is negligible. The data further suggests that forest activities on average make a relatively small contribution to total household incomes. For example, collection from forests contribute only 3%, 11% and 12% respectively of the total incomes of the "non-registered", 'registered without plots" and "registered with plots" households respectively, and only 7% to all households. However, forest crop farming contributes a substantial share of incomes to "registered with plots" groups at 39%, though the contribution to the other groups is negligible. Forest crop incomes contribute 10% of the total incomes of all households.

Except for the non-resident cultivators, agriculture in general, followed by wages makes the largest contribution to total incomes, their sum amounting to about 68% for "non-registered" and 'registered without plots" groups respectively; and 58% for all households. The respective total incomes, including value of livestock and farm capital as well as shares of income seem to suggest that the 'registered without plots" category has the lowest level of welfare by all indicators, followed by their counterparts with forest plots. This points at the potential role of forest cultivation in household welfare. One way analysis of variance of the mean incomes by source for the three groups suggest significant differences for forest crop, forest collection, own crop farming, wages and value of livestock, but not for other categories.

Table 4: Incomes (Kenya Shillings) and income shares by source and by forest user groups

Source of income	Not registered	Registered without plot	Registered with plot	All groups	ANOVA test (F)
Forest crop farming	78	116	12925	3273	135.3*
	(0.002)	(0.004)	(0.39)	(0.10)	
Forest collection	1969	4399	12608	4954	4.26*
	(0.03)	(0.11)	(0.12)	(0.07)	
Crop farming	40954	13495	9299	29213	17.08*
	(0.58)	(0.45)	(0.15)	(0.46)	
Wages	4182	3158	2610	3647	2.53***
	(0.10)	(0.22)	(0.09)	(0.12)	
Self employment	2490	961	1253	1967	1.02
	(0.03)	(0.04)	(0.04)	(0.03)	
Transfers	2808	2647	1824	2541	0.93
	(0.05)	(0.09)	(0.06)	(0.06)	
Livestock products	22331	3238	11505	16944	1.49
	(0.20)	(0.08)	(0.15)	(0.17)	
Total income	74814	28012	52024	62539	4.26*
	(1.00)	(1.00)	(1.00)	(1.00)	
Other categories					
Value of Livestock	34296	8511	23575	27989	8.90*
Value of Farm capital	11282	2718	3829	8221	1.87
Sample size	178	41	71	290	

*,*** significant at 1%, 10%; Income shares in parenthesis

5.1.5 Dependence of households on forests

In this sub-section, we analyze the key sources of environmental incomes and the relative dependence of the three user groups on forest products. From the data, we categorize the main resources into four main groups: fuel, fodder, construction material and other products (wild fruits, vegetables, honey and herbs). This categorization points at the potential role of forests in poverty reduction through diversified and specialized forest strategies adopted by households (Vedeld et al. 2004; Angelsen and Wunder 2003). The results (Table 5) suggest that collection of construction materials constitutes the highest proportion to forest collection incomes, followed by fuel. As expected, registered users who hold forest plots are the major beneficiaries from all categories of forest products. Analysis of variance test for differences in the values of the products by user groups indicate that all differences are statistically significant from zero.

Table 5: Household dependence on forest products by forest user group

	Not registered	Registered without plot	Registered with plot	All groups	ANOVA test (F)
Value of Forest products collected (Kenya Shillings)					
Forest product: Value of fuel	492	300	1068	608	5.26*
	(2613)	(168)	(5268)	(3325)	
Value of fodder	115	44	1108	351	2.24***
	(296)	(103)	(7112)	(3560)	
Value of construction material[§]	1317	4038	10332	3940	4.05*
	(6066)	(15216)	(43284)	(23003)	
Value of other forest products	45	17	100	55	2.07*
	(272)	(63)	(379)	(286)	
Total value of forest products	1969	4399	12608	4954	4.26*
	(7762)	(15269)	(50075)	(26553)	
Participation of households in forest activities (proportion)					
Forest grazing	0.16	0.32	0.53	0.28	17.79*
	(0.37)	(0.47)	(0.50)	(0.45)	
Forest collection	0.56	0.98	0.96	0.72	33.55*
	(0.50)	(0.16)	(0.20)	(0.41)	
Sample size	178	41	71	290	

*,*** significant at 1%, 10%; Standard deviations in parenthesis

The bottom rows of Table 5 presents a tabulation of participation of households in forest two activities: forest grazing and collection of forest products by forest user group. The tabulation suggests that registered forest users on average rely more on forests than non-registered users. For grazing, the difference in means is quite pronounced between the three groups at a ratio of almost 1:2:3. The differences in collection of forest products are much less pronounced, particularly for registered groups. ANOVA tests support the existence of significant difference in forest dependence by different forest user groups. Grazing is perhaps one of the most common and intensive form of dependence on forest resources. Out of the 80 households that grazed in the forest, 46% grazed cattle throughout the year, while 28% grazed sheep and goats throughout the year. The payment for use of forest resources for grazing were very modest (at about Kenya shillings 40 and 20 per head of cattle and goat/sheep respectively per month) compared to any other possible means of raising livestock. Furthermore, this is labour and time saving because: livestock could be tethered to the forest throughout the day as the owner attended to other activities; or large herds could be attended to by a single worker resulting in economies of scale in grazing.

[§] As with most surveys of forest dependence, we would expect gross underreporting of key categories such as construction material, especially due to government controls on illegal logging.

5.1.6 Contribution of forests to household welfare

In this sub-section, we seek to answer the question whether poor households depend more on forests than the less poor. To answer this question, we divide the households into three different wealth groups on the basis on total household incomes. Since this does not take into account value of livestock and other household assets, it is more of a transitory measure of household poverty because it does not take into account previous incomes or potential for future income. A more permanent measure is one that takes into account the more permanent measures of wealth such as land holding, livestock and other fixed assets. To take these into account, we construct a second measure of wealth taking into account household head's education, land holding, total livestock units, farm capital inputs, household assets (ownership of radio, television, motor transports etc.) and the quality of dwelling (quality of floor, roof, toilet etc.). We use factor analysis to derive a single measure of household wealth (see Filmer and Pritchett, 2000; Sahn and Stifel, 2003)[**] and use the index obtained to divide the households into three wealth categories: poor, middle and rich.

First we investigate the distribution of the different user groups by wealth quintiles (Table 6). A question that arises is whether poor households are more likely to participate in forest activities or even more willing to cooperate with others in forest management. Looking at the table, one can infer that by considering current income groups, only 24% of farmers not registered as forest users were poor, compared to 63% of registered users without forest plots and 39% of registered users with plots. For the upper income group, 40% were the unregistered cultivators, compared to only 12% and 28% of the "without" and "with plot" registered users groups. This analysis suggests that poorer households are more likely to participate in forest activities than the less poor. ANOVA tests indicate that the distribution of the wealth groups across the three forest user groups is statistically different from zero.

Table 6: Membership in forest user groups by wealth category

Group	Income groups			asset groups		
	Poor	Middle	Rich	Poor	Middle	Rich
Not registered	24	36	40	34	31	35
Registered without plot	63	24	12	22	51	27
Registered with plot	39	32	28	38	30	32

[**] This approach uses the standardized first principal component of the variance covariance matrix of the observed household assets as weights, allowing the data to determine the relative importance of each asset, based on its correlation with the other assets. The scoring coefficients from the factor analysis are applied to each household to estimate its wealth index.

Turning to the more permanent measure of income, the disparities in the distribution is less pronounced, with the unregistered users being almost equally distributed across the three wealth groups. However, for registered users "without plots", it is surprising to note that 51% are in the middle wealth group, while a low 22% is in the low wealth group. The registered groups "with plots" are on average poorer than the other two categories of user groups. The ANOVA test for this distribution yield insignificant results. The results suggests that the decision to participate in forest user groups may be based on a households current rather than permanent income, such that households that are transitorily poor may engage in forest activities to cater for temporary shortfalls in income rather than to cater for a long term fall in permanent income. This supports studies that argue that forests play an important role in support of current consumption (as a gap filler) and also as a source of regular subsistence use.

We further investigate the dependence of poor households on forests by tabulating the income shares by source and wealth groups (Table 7). First, looking at income groups, as already illustrated in table 4, the largest share of incomes from all groups is from crop farming. The poor however also derive a substantial share of income from wages (20%) and forest crop farming (15%), but only a marginal 6% from collection of forest products. The middle income group also obtains a substantial share from crop farming, wages and forest crops, but also a much larger share (16%) from livestock products. The upper income group has only two main sources of incomes: own crop farming and livestock products. Though this group derives little income from forest crop farming, it is important to note that it obtains a relatively larger share from forest collection (8%) than the lower income groups. This supports literature that has shown that the rich may also depend more on common property resources than the poor, moreso in the extraction of fodder (see Narain et al. 2005).

Table 7: Income shares by source and wealth groups for all sampled households

Share of income from	*Income groups*			*Asset groups*		
	Poor	Middle	Rich	Poor	Middle	Rich
Forest crop farming	0.15	0.10	0.04	0.11	0.07	0.11
Collection of forest products	0.06	0.06	0.08	0.09	0.06	0.04
Crop farming	0.39	0.48	0.50	0.42	0.51	0.44
Wages	0.20	0.11	0.05	0.11	0.14	0.11
Self employment	0.05	0.02	0.03	0.03	0.03	0.04
Transfers	0.06	0.08	0.04	0.05	0.05	0.07
Livestock products	0.09	0.16	0.26	0.19	0.13	0.19

The last panel of table 7 shows income shares by asset groups. The results support the income group tabulation with some minor variations. The poorest asset group relies much more on livestock products than the poorest by income group, and also reports the largest share of income from forest collection (9%). The middle asset group relies more on own crop farming and wages, but less on livestock. Finally, the richest asset group relies as much as the poor asset group on forest cropping but much less on forest collection. The group also relies more on wages and less on livestock than the richest income group. In summary, combining shares of incomes from both forest crop farming and collection of forest products indicates that the poorest groups (by both incomes and asset categories) derive a much larger share of income from forests (20%) compared to other groups. In this particular respect, since both the transitorily and the chronically poor households are involved, we can infer that households depend on forests for the three distinct functions: safety nets, support of current consumption and as a pathway out of poverty.

Grazing in the forest is a form of forest dependence though this cannot be quantified into a percentage share. A tabulation of grazing by income groups (results not presented) suggest that the highest income group is more likely to graze in the forest (32%) than the middle income (23%) and the poorest group (28%). Analysis of variance however suggests that the differences are not statistically significant. Turning to asset groups, there is a clear relationship between household wealth and dependence on forest pasture with 34%, 27% and 22% of the poor, middle and high income groups respectively grazing in the forest. One way analysis of variance indicates that the differences are statistically significant, implying that the poor are more likely to depend on forests for grazing than their richer counterparts.

The next issue that we investigate is the relative contribution of different forest products to incomes of the various wealth groups. The tabulation by income groups (Table 8), suggests that the rich on average draw larger gross value of all forest products than the poorer groups. The only exception is other products (honey, herbs, wild fruits and vegetables), but these make a negligible contribution for all households. This scenario is however reversed for asset groups with the poorest asset group drawing much more than the middle and rich groups. This suggests that the chronically poor are more likely to depend on low return forest activities than the transitorily poor.

Table 8: Collection of products by wealth groups

Variable	*Income groups*			*Asset groups*		
	Poor	Middle	Rich	Poor	Middle	Rich
Fuel	281	488	1060	803	307	716
Fodder	31	151	877	757	79	216
Construction material	334	1618	9929	7564	3077	1151
Other forest products	59	61	45	2	92	71
All forest products	705	2318	11911	9126	3554	2154

5.1.7 Forest management and household labour allocation

Forest management

Households in the sample participate in forest management in several respects. The forest user groups are run by a management committee comprising a chairman, a treasury, a secretary and members. The functions of the registered members depend on their positions in the groups. The functions include attending FUG meetings (which are mandatory for all members); participating in scheduled forest patrols (only committee members) to ensure that there are no illegal activities or violation of forest use rules; and participation in forest group labour activities which include working on seedling nurseries, planting and thinning of trees. The forest user groups however operate independently of each other, though the committees of different groups must work closely together and with forest officers in planning and coordination of forest activities. Some groups charge membership fee, while others do not. 69% of the registered members reported that they pay between 50 and 350 Kenya shillings to be members of FUGs, while the rest did not pay anything, except a one time entry fee. This fee does not include a stipulated fee for registration as an NRC.

The rules governing participation and use of forest resources are issued by the forest officer through a written memorandum. Each registered forest cultivator must sign the memorandum and attach a copy of their national identity card before being allowed to cultivate. The rules stipulate that each member must: (i) be a member of a FUG, (ii) pay a nominal registration fee as an NRC through the FUG, (iii) can only plant specific crops allowed by the forest department, (iv) not cultivate near river beds, (v) never burn crop residuals in forests, (vi) not allow livestock into the *shambas*, (vii) never use tractors for land preparation (viii) participate in all scheduled forest activities (ix) report any cases of poaching or other unlawful activities, and, (x) not construct any structures in the forest. Penalties for non-compliance depend on the nature of violation and may include a modest fine for petty offences, expulsion from FUGs, discontinuation of cultivation and even prosecution in a court of law for gross violations.

At the initiative of the forest officers, FUGs were established in 2001 as a requirement for participation in forest activities. Some of the groups were pre-existing social welfare groups, and still serve social welfare functions (merry go round and benevolent funds). The main goals of the forest user groups are: to organize farmers to cultivate in the forest; to ease supervision of the use of forest resources; and to monitor forest destruction. Before the establishment of the FUG, there was little coordination of forest activities, which made it very difficult to monitor and ensure compliance in the use of forest resources. The forest department lacked enough personnel to patrol forests and also to keep track of cultivators, grazers and collectors. This contributed greatly to the destruction of forest in the 1980s and 1990s. The respondents reported that the changes that have followed the establishment of the FUGs include: regeneration of the forest (71%), building cooperation among villagers (78%), decreased logging (38%) and controlled forest grazing (32%). The respondents also reported that changes in official management of the forests over the previous 10 years had resulted in both positive and negative effects on the forests and local communities. These included: enhanced participatory management (reported by 43%), more trees planted (95%), strict rules and regulations (15%) and decreased logging (13%). The survey results indicate that FUG members were generally happy with their groups and the management, with 58% ranking the functioning of the groups as good, 38% as moderate and only 3% indicating their dissatisfaction.

Participatory forest management was reported to have contributed to forest conservation though plantation of more trees (64%), improvement in water catchment areas and beautification (6%) and decreased illegal logging (14%). The respondents further reported that the main contribution of the forests to the welfare of local communities included food products (96%), wood fuel (100%), grazing and fodder (92%), increased rainfall (61%), environmental protection (56%) and construction material (7%).

Labour allocation to forest activities

We investigate the allocation of labour time to forest product gathering and also to forest care activities. Though households spent substantial amount of time gathering forest products, registered user groups were also found to spend some substantial amount of time in forest care activities. A tabulation of the days of care by wealth groups (Table 9) suggests that poor households allocate much more time to forest collection than the less poor. The results also suggest that the poorest income group spend more time in forest collection activities than their richer counterparts. Tabulation by asset groups however suggests that middle income groups on average spend more days in forest collection activities than the poorest groups. However, the richest spend much less days than the poor and middle asset groups. Looking at the time allocated to forest care activities, the poorest income group spent about 13 days in the last 12 months planting trees and weeding in the forest. On average, they also spent a week attending to forest nursery seedlings and in forest meetings. Though the relative number of days for the

middle income and rich groups differ, the time concentration was also in planting, weeding, nursery care and monitoring. There are no marked differences in this pattern for asset groups. This suggests that permanent income may not have any direct impact on participation in forest care activities.

Table 9: Labour allocation to forest care activities by wealth groups

Activity	*Income groups*			*Asset groups*		
	Poor	Middle	Rich	Poor	Middle	Rich
Forest collection	51.00	47.23	38.46	45.48	48.94	41.83
Tree planting	12.45	5.40	3.60	7.88	7.48	6.13
Weeding	13.32	5.61	4.96	8.45	4.85	10.65
Pruning	0.70	0.70	1.00	1.03	0.54	0.83
Nursery care	7.73	7.42	6.31	5.36	6.82	9.31
Monitoring	0.87	2.68	0.10	0.95	0.21	2.52
Meetings	7.15	3.51	3.15	3.94	5.22	4.67

5.1.8 Contribution of forests to income distribution

In this sub-section, we use the Gini index and the Lorenz curve to investigate the contribution of forests to the distribution of income by various sources and forest user groups. The results presented in Table 10 shows the Gini indices and corresponding standard errors. From the table, one can infer that incomes from forest collection are highly unequal across all forest user groups, with a Gini index of between 0.85 and 0.88. Incomes from forest collection and total forest incomes show less inequality among farmers who cultivate in the forest than other households, suggesting that forests do not necessarily lead to higher income inequalities. There is more inequality in own crop farming among farmers cultivating forest plots than among other farmers. This can be explained by the fact that most of these farmers do not own other plots for cultivation outside the forest. Transfer incomes and wages also contribute a lot to inequality, probably due to the low proportion of households accessing transfers and wage earnings. Decomposition of total income inequality suggests that there are no major variations in income inequalities across the three groups, though the registered forest users with no forest plots show a relatively lower Gini index.

Lorenz curves for the distribution of incomes also suggest that there are no major differences in inequality between the three forest user groups. Figure 1 shows the Lorenz curves for total household incomes (excluding livestock). The graph seems to suggest that at the middle level of the distribution, there is more inequality among the registered forest users without plots than the

other groups. Figure 2 suggests that forest incomes contribute a small proportion to total income inequality, because the Lorenz curves for total income with (total_hhincome) and without (hhincome) forest incomes are quite close. From Table 10, one can infer that this contribution is only about 4% (0.57 les 0.53). In spite of the low contribution, this finding supports results in the literature that forests contribute to more equally distributed incomes (Fisher, 2004, Cavendish, 2000,2003, Angelsen and Wunder 2003). We use the difference in Lorenz curves approach to test for the dominance of inequality between the different forest user groups. The results suggest that there is no inequality dominance. This is supported by figure 1 because the Lorenz curves intersect. In other words, there is no evidence that the income of any forest user group dominates the incomes of another.

Table 10. Decomposition of income inequality by income source and forest user group

Source of income	Not registered*	Registered without plot	Registered with plot	All groups
Forest collection	0.85	0.88	0.87	0.89
	(0.02)	(0.03)	(0.03)	(0.02)
Total forest income	0.85	0.88	0.70	0.83
	(0.03)	(0.02)	(0.05)	(0.02)
Crop farming	0.53	0.52	0.72	0.62
	(0.07)	(0.03)	(0.04)	(0.02)
Wages	0.42	0.60	0.53	0.59
	(0.05)	(0.03)	(0.04)	(0.02)
Self employment	0.85	0.87	0.86	0.87
	(0.04)	(0.03)	(0.03)	(0.02)
Transfers	0.99	0.98	0.98	0.98
	(0.01)	(0.01)	(0.01)	(0.01)
Total income less	0.52	0.56	0.53	0.57
forest income	(0.05)	(0.03)	(0.07)	(0.03)
All income	0.53	0.51	0.53	0.53
	(0.06)	(0.04)	(0.03)	(0.03)

*Gini coefficients with standard deviations in parenthesis.

Figure 1. Lorenz curves for total household income by forest user groups

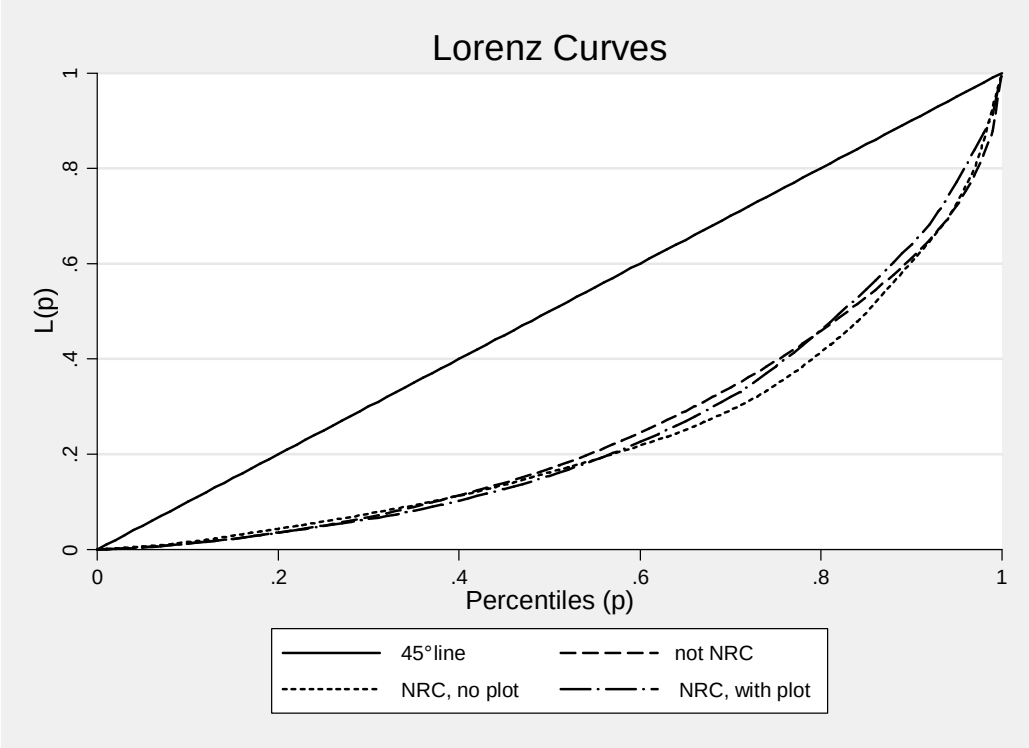
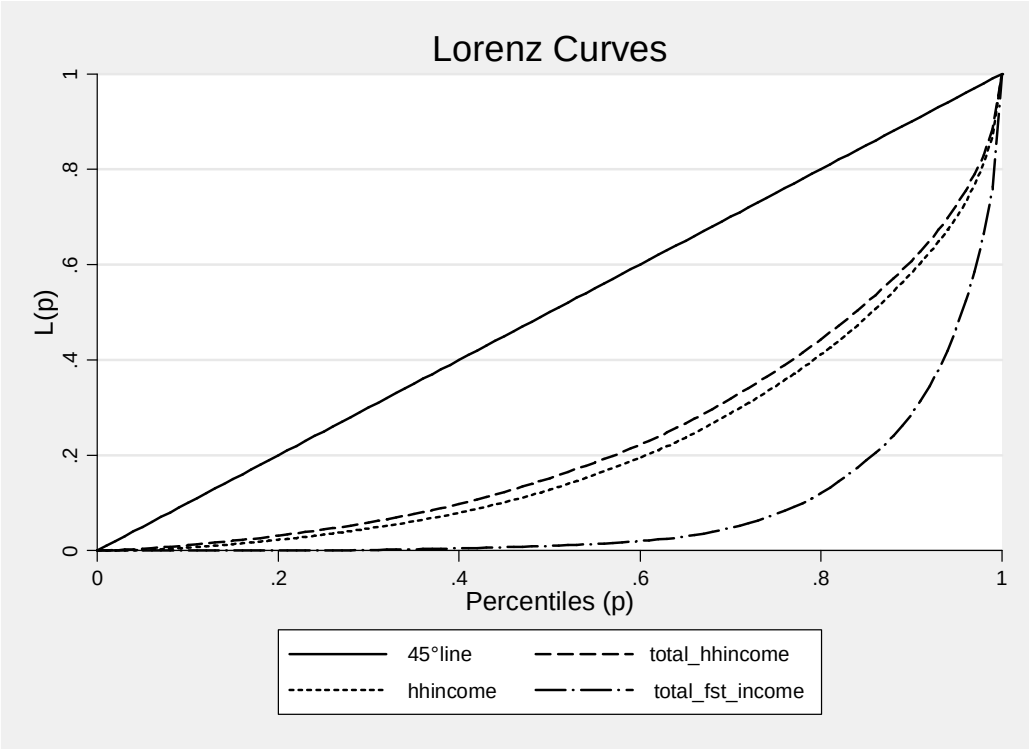


Figure 2. Lorenz curves for household incomes with and without forest incomes



5.2 Regression analysis

5.2.1 Preliminaries

In this section, we empirically investigate to what extent households depend on forests. First we investigate the determinants of participation in forest activities: forest farming and collection of forest products on one hand and forest grazing as a distinct form of participation. Another aspect of participation that we empirically investigate is membership in forest user groups, which is a form of collective action. Second, we explain the variations in resource draw among households defined by the level of incomes for the key forest resource extraction: crop farming; fuel; fodder; construction and other materials; and also the total income from forest activities. Third we investigate the determinants of forest dependence, defined as the share of forest income to total income. We focus on the two distinct groups of incomes: forest crop farming and collection of forest products.

5.2.2 Participation in forest activities

As discussed in the previous section, 112 (38%) of all households in our sample were registered as forest users, an indicator of willingness to participate in forest activities. However, non-registered households also participate in forest collection activities, though to a less extent. In total, 72% of all households in the sample were found to rely in one way on another on forests, 55% of whom were registered members of forest groups and the rest 45 non-registered. Breaking down this participation into different forest collection activities shows that most households relied on forests for fuel (69%) while relatively few households relied on forest for other forest resources namely fodder and construction materials, (each 20%) and other forest products (24%). In addition, only 28% of all households were found to graze in the forest. Of the households grazing in the forest, 63% were registered forest users, but the rest were not registered.

The probit regression results for determinants of participation are presented in Table 11. The Chi-square test statistic for the estimated models with 15 degrees of freedom for participation in general and grazing are 74 and 60 respectively, while that for membership in forest user groups is 89. The null hypothesis that the non-intercept coefficients are jointly equal to zero is rejected at all conventional levels of testing for the three forms of participation. This implies that the underlying empirical probit models are highly significant in explaining the decision to participate in forest activities, and implies the stability of the estimated models.

Table 11: Determinants of participation in forest activities: marginal effects

Variable	*Forest collection*	*Forest grazing*	*Membership in forest user groups*
Sex	0.1013	0.0177	0.0337
	[1.73]*	[0.76]	[0.65]
Age	0.0031	-0.0023	0.0034
	[1.24]	[2.21]**	[1.62]
Log household size	0.1961	-0.0149	0.0102
	[3.40]***	[0.62]	[0.20]
Head has no education	0.13	0.1405	-0.0437
	[1.85]*	[2.03]**	[0.49]
Head has post primary education	0.1153	0.0218	-0.0266
	[1.95]*	[0.83]	[0.54]
Distance to forest (km)	-0.061	-0.0299	-0.0515
	[6.45]***	[4.84]***	[5.02]***
Distance to plot	0.0196	-0.0005	0.0064
	[2.35]**	[1.55]	[2.42]**
Purchased plot	-0.1465	-0.0053	-0.0984
	[2.78]***	[0.27]	[1.91]*
Rented plot	-0.0108	-0.0001	0.0215
	[0.42]	[0.01]	[0.98]
Inherited plot	0.004	0.0086	-0.0604
	[0.11]	[0.62]	[1.67]*
Farm size	0.0176	0.0664	-0.2561
	[0.53]	[2.11]**	[5.98]***
Farm size squared	-0.0019	-0.011	0.0134
	[0.79]	[2.04]**	[5.04]***
Log livestock units owned	0.0903	0.1056	0.0267
	[1.85]*	[4.80]***	[0.68]
Membership in village groups	0.0545	-0.0023	-0.0361
	[0.88]	[0.08]	[0.68]
Membership in forest user groups	0.1998	0.1304	
	[2.92]***	[3.72]***	
Wald chi2(15)	73.81	60.00	88.77
Log likelihood	-83.17	-110.3	-104.93
Pseudo R2	0.5166	0.3444	0.4547
Observations	288	288	288

* significant at 10%; ** significant at 5%; *** significant at 1%; Robust z statistics in brackets

The results suggest that sex of the household head is an important determinant of participation in forest activities and the willingness to participate in collective action. Specifically, households headed by males are more likely to participate in forest activities and this is supported by the data which shows that 66% of all registered forest users are men. However, only the marginal impact for general willingness to participate (forest collection) is statistically significant. Age of the household head is negatively correlated with participation but not membership, but the impact is only significant for grazing. These results imply that although households headed by older heads are more likely to be members of forest user groups, they are less likely to participate in forest activities than households headed by younger heads. Larger households are more likely to participate in forest activities in general but the impact is insignificant for grazing and membership.

Relative to primary education, households headed by heads with no education and heads with post primary education are more likely to participate in forest activities in general and to graze in forests, but are less likely to be members of forest user groups. The magnitudes of the marginal effects however indicate that households headed by heads with no education are much more likely to participate in forest activities than those headed by persons with post primary education. Levels of significance imply that education is a more significant determinant of participation in general and grazing in forests than membership in forest user groups. The relatively lower impact of post primary education implies that education opens alternative income earning opportunities for households. Relative to primary education, the impact of the education dummies on membership is negative but insignificant. An alternative specification that uses years of schooling rather than education dummies show a positive but insignificant impact of years of schooling on general participation and grazing, but a negative insignificant impact on membership.

Distance to forest is negatively correlated with the probability of participation in general, grazing and membership. The marginal impact is however quite low for participation in general. The results for distance to plot show that households with distant plots are more likely to rely on forests in general and also to be members of forest user groups, but are less likely to graze in forests. This probably implies that such households may be constrained from own plot collection by the distance from their own plots, forcing them to relay more on forests and also make them more likely to participate in forest collective action.

Land tenure security seems to play a significant role in determining forest participation. Households that own land purchased by the household head are less likely to participate in forest activities in general and also to be members of forest user groups. Since only relatively wealthy households are likely to afford to purchase land, these results may also be interpreted to imply that such households are less likely to participate in forest activities than the less wealthy. The

marginal impact of grazing is positive but insignificant. We uncover no major impact of rented plots on all forms of participation while inherited plots only have a significant impact on membership, implying that households with security of tenure are less likely to register as forest users.

The impact of household assets is proxied by farm size and number of livestock units owned. Farm size influences participation in forest activities and grazing at a decreasing rate but the impact is only significant for grazing. The hill shaped relationship between farm size and participation implies that at low levels of farm size, a household is likely to depend increasingly on forest resources, but upon reaching some threshold, the household reduces dependence and turns to own resource extraction. The impact of farm size on membership in forest user groups however follow a U shaped pattern implying that households at the two tails of the distribution of farm size are more likely to participate in collective action than those in the middle. In all cases, the marginal impact of the linear term is higher than for the quadratic term. Number of livestock units owned is positively correlated with forest participation and membership in forest user groups. The marginal impact is highest for grazing and implies that a household that owns more livestock is 11% more likely to graze in the forest than a household that owns less livestock. Such households are also 3% more likely to register as forest users in-order to access fodder and grazing rights.

We also do not uncover any important impact of membership in village institutions on participation in forest activities. Though one would expect a correlation between membership in village institutions and in forest user groups, the data suggests low correlation and the regression results yield a negative and insignificant impact. Membership in forest user groups is however positively correlated with participation in general and with forest grazing. A household is 20% more likely to participate in general and 13% more likely to graze in the forest if it is a member of a forest user group than if it is not.

5.2.3 Determinants of resource extraction

To explain the observed variations in resource extraction among households, regression analysis is conducted on gross income levels from the main resources drawn from the forests. These include forest crop farming and collection of fuel, fodder, construction and other materials. The factors determining participation in forest activities are also hypothesized to influence the level of extraction. Tobit specification is used to model resource extraction due to a high degree of censoring of the dependent variable[††]. The results are presented in Table 12.

[††] The alternative of using the Tobit model on our data is to truncate the dependent variable by dropping all households where the dependent variable is censored at zero. We can then apply OLS to the data. However, truncation causes a correlation between the explanatory variables and the error tern, and therefore produces

As in the participation equations, the test for overall fit of the models and the chow tests (LR chi(2)), show that the explanatory variables are jointly significant in explaining each of the dependent variables and also confirm the general stability of the models. For all models, the predictors however explain only between 9% and 29% of the total variation in resource extraction. The results suggest that the household level predictors of resource extraction differ substantially from one resource to another. Only post primary education, distance to forests and registration in forest user groups consistently predict extraction of different resources.

Age and sex of the household head do not seem to matter for resource extraction. Household size is positively and significantly correlated with fuel and total resource extraction, but does not seem to matter much for the other resources. All resource extraction, except forest farming is strongly and significantly predicted by post primary education relative to primary education. Distance to the forest is negatively and strongly correlated with resource extraction, more so fodder and other materials. Distance to plot has an insignificant impact on resource extraction and the coefficients are rather low except for fodder extraction.

Though land tenure security factors are not significant predictors of collection of fodder, construction materials and other products, the results suggest that security of tenure is inversely related with extraction. Specifically, households with own purchased plots and those with rented plots extract significantly less resources from forests than other households. Though inheritance of plots does not seem to be an important predictor of extraction, a test for its joint impact with purchased plots support the argument that tenure security is important for forest extraction of fuel and all extractions combined. Households farming rented land (whether in part or in full), draw much more income from forest crop farming, implying that they may be more likely to get forest plots or even to sub-rent plots from forest group members with plots. Tenure security factors do not seem to matter for other resources, whether individually and jointly.

We investigate the impact of participation in collective action on forest resource extraction through the impact of membership in forest user groups and village institutions. Membership in forest user groups is positively correlated with resource extraction, implying that members of forest user groups are likely to extract more resources than unregistered farmers. The impact is particularly large for forest crop income since a large proportion of the members (63%) farm in the forest. We uncover no significant impact of membership in village institutions on forest extraction. This implies that it is collective action at the forest management level rather than at the village level that predicts forest extraction.

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inconsistent estimates. In spite of its limitations, the Tobit approach therefore remains the best solution when dealing with censored data (see Maddala, 1983).

Table 12: Determinants of household extraction incomes

Resource	All extractions	Fuel	Forest farming	Fodder	Construction & other products
Male sex dummy	0.5483	0.0169	-0.4012	0.8828	1.1378
	[1.20]	[0.04]	[0.33]	[0.59]	[0.61]
Age of head	0.0144	0.0257	0.0055	0.0068	-0.0178
	[0.79]	[1.58]	[0.11]	[0.11]	[0.23]
Log household size	1.2955	1.3449	-0.7695	0.6509	-0.1814
	[2.73]***	[3.14]***	[0.62]	[0.42]	[0.09]
Head has no education	0.9278	0.725	2.1127	0.5418	-6.1202
	[1.15]	[1.01]	[0.94]	[0.20]	[1.38]
Head has post primary education	1.2156	0.905	1.0167	4.1144	2.8235
	[2.66]***	[2.21]**	[0.82]	[2.87]***	[1.70]*
Distance to forest (km)	-0.6267	-0.4917	-0.0708	-0.9566	-1.6647
	[8.50]***	[7.86]***	[0.50]	[3.41]***	[4.07]***
Distance to plot	0.0011	0.0074	-0.0133	-0.2516	-0.0241
	[0.16]	[1.25]	[0.85]	[0.98]	[0.93]
Purchased plot	-0.6173	-0.8009	0.955	-1.2604	1.3497
	[1.79]*	[2.58]**	[0.87]	[0.93]	[0.96]
Rented plot	-0.3184	-0.1872	2.4512	0.1334	-0.9142
	[1.71]*	[1.13]	[3.91]***	[0.22]	[1.22]
Inherited plot	-0.0611	-0.0158	-0.3874	1.1702	-0.6314
	[0.23]	[0.07]	[0.57]	[1.25]	[0.61]
Membership in forest user groups	1.5209	0.9015	18.0624	3.5741	4.0313
	[3.07]***	[2.03]**	[8.63]***	[2.07]**	[2.00]**
Membership in village groups	0.5816	-0.0155	1.3041	-0.8358	2.7847
	[1.19]	[0.04]	[0.94]	[0.54]	[1.42]
Log livestock units owned	-0.0899	-0.2464	0.8561	3.1133	0.1075
	[0.47]	[1.44]	[1.63]	[4.76]***	[0.14]
Farm size	0.1509	0.1304	11.7531	0.9756	-0.259
	[0.54]	[0.52]	[3.94]***	[1.14]	[0.22]
Farm size squared	-0.0153	-0.0134	-2.7668	-0.0258	0.0213
	[0.66]	[0.65]	[3.60]***	[0.42]	[0.24]
Constant	2.2737	1.4309	-20.3106	-12.8756	-3.9042
	[1.93]*	[1.35]	[5.16]***	[3.18]***	[0.81]
Observations	288	288	288	288	288
R-squared/Pseudo R2	0.1682	0.1602	0.2855	0.1567	0.0914
LR chi2(15)	232.86	207.45	226.23	93.11	65.95
Log likelihood	-575.91	-543.81	-283.03	-250.46	-327.90

Robust t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

The impact of household assets, proxied by total livestock units owned and farm size do not seem to be significant predictors of resource extraction for fuel, construction materials, other and total extractions. However, total livestock units owed is an important and significant predictor of fodder extraction. This means that households with more livestock are likely to be more pasture constrained and therefore seek forest fodder to supplement livestock feeding. This supports the results for participation in forest grazing which showed that households with more livestock units are more likely to participate in forest grazing. The impact of farm size is insignificant except as a predictor for forest crop farming, where it exhibits an inverted U-shaped relationship with value of forest crop farming. This hill shaped relationship implies that at low levels of land holdings, households seek to use forest plots for cultivation but beyond some threshold size, reliance on forest plots decline.

5.2.4 Households' economic reliance/dependence on forests

In this section, we investigate the factors associated with two forest types of dependence (share of incomes from forest activities): extraction/collection of forest resources and forest crop farming. Households and forest user groups are heterogeneous in terms of their dependence on resource extraction. Though 46% of total income share is from crop farming, descriptive analysis showed that forest still contribute a substantive share of incomes to households especially for non-resident cultivators with forest plots. This group derives 39% of all incomes from forest crop farming and another 12% from forest resource extraction. For all households combined, only 10% of total income is from forest crop farming and another 7% is from extraction of other forest resources. The poorest income group derives a combined 21% of income from forest, while the poorest asset group derives 20%.

We employ tobit model to investigate the correlates of the share of income from forest activities (Table 13). The same explanatory variables used to explain extraction are also used to explain dependence. The results suggest that some of the predictors of resource extraction also predict economic reliance on forest resources, but some variables differ in sign, magnitudes and significance. Only membership in forest user groups and the farm size consistently predict the two forms of dependence. For reliance on forest products, age of the household head and household size have a positive and significant impact, which is contrary to expectations that households headed by older heads are less likely to participate in gathering activities. However, in this community, it was found that some poor elderly heads were members of forest user groups. Some of them were squatters who were victims of tribal land clashes in the district. We do not uncover any significant impact of age of the head on dependence on forest crop cultivation. Contrary to expectations, relative to primary education, heads with post primary education are more likely to be economically dependent on forest products. The reverse is observed for reliance on forest crops but the impact is insignificant.

Table 13: Determinants of forest dependence

Variable	*Share of gross incomes from*	
	Collection of forest products	Cultivation of forest crops
Male sex dummy	-1.3238	-3.4917
	[0.54]	[0.45]
Age of head	0.2146	0.0318
	[2.17]**	[0.10]
Log household size	4.5469	-10.9018
	[1.76]*	[1.43]
Head has no education	-2.8598	19.83
	[0.66]	[1.45]
Head has post primary education	6.7439	-0.9931
	[2.76]***	[0.12]
Distance to forest (km)	-1.9231	-0.5356
	[5.09]***	[0.58]
Distance to plot	-0.0217	-0.0152
	[0.62]	[0.15]
Purchased plot	0.7929	8.3142
	[0.43]	[1.18]
Rented plot	-0.7778	16.2965
	[0.78]	[4.02]***
Inherited plot	0.7524	2.5914
	[0.53]	[0.60]
Membership in forest user groups	8.6791	94.4744
	[3.29]***	[7.28]***
Membership in village groups	2.8275	3.8948
	[1.07]	[0.44]
Log livestock units owned	0.9613	0.4502
	[0.72]	[0.10]
Farm size	-1.4227	53.5916
	[0.96]	[2.89]***
Farm size squared	0.0039	-13.7053
	[0.03]	[2.83]***
Constant	-10.6583	-86.3941
	[1.68]*	[3.57]***
Observations	288	288
Pseudo R2	0.0611	0.1841
LR chi2(15)	116.63	188.65
Log likelihood	-895.43	-418.108

* significant at 10%; ** significant at 5%; *** significant at 1%; Robust t statistics in brackets

The impact of distance to forest is consistent with results for resource extraction and shows that households located far from the forests depend less on forests than those neighbouring forests. Tenure security does not seem to matter, though households using rented plots are more likely to depend on forest crop farming. Consistent with results for resource extraction, membership in forest user groups positively predicts reliance on forests, both for collection and crop farming. Farm size exhibits a hill shaped relationship with dependence on forest extraction and also on

forest crop farming. This supports results for forest extraction and implies that households with large farms are unlikely to rely much on forests.

6. Conclusions and Policy Issues

This paper explores the contribution of forests to the welfare of forest communities in Kenya. The paper uses primary household level data collected from two forest communities in Nakuru district of the Rift Valley province of Kenya. A sample of 290 households is used, supplemented by a community survey. The paper tests three hypotheses: first that the poor are more dependent than the less poor on forest resources; second, forest user group heterogeneity is an important determinant of the poverty-forest link; and third, forest dependence is conditioned by other household level heterogeneities (such as private resource endowments). Both descriptive and econometric methods are employed. Households are categorized into different groups according to heterogeneities in their participation in forest activities and also by their welfare status (both current and long term). The context of the study allows us to study a peculiar characteristic of forest communities in Kenya: food crop farming though the *shamba* system (a method of forest plantation establishment in which farmers tend young plantation trees as they produce food crops). This portrays a unique form of dependence especially for forest squatters who do not own any land.

The empirical analysis explores the correlates of participation in forest activities and forest collective action. The analysis then proceeds to explore the role of household heterogeneities in resource extraction and also the economic reliance/dependence of households on forests. The analysis indicates that different categories of households/forest user groups have diversified sources of income, but the largest share of incomes for groups that farm in the forest is from forest crops. This group also derives the largest share of income from forest collection. Households registered as forest users, but do not cultivate in the forest also derive a reasonable share of income from forest collection activities (11%). This group however derives a larger proportion of income from own crop farming and wages. For the whole sample, forest crop farming contributes 10% of total income while forest collection contributes 7%. This suggests that though the contribution of forests to incomes of registered user groups is quite substantial, the overall contribution of forests to household income in Kenya is lower than has been found in other countries (Angelsen and Wunder 2003). The contribution is however relatively high taking into consideration that there are very tight controls over use of forest resources in Kenya.

The analysis further shows that the largest resource collected from forests is construction material, constituting about 80% of the total environmental incomes for the whole sample. This is followed by extraction of fuel and fodder. Grazing in forests is a major form of dependence with 45% of all households grazing in the forests at highly subsidized rates. About half of all

registered forest users graze in the forest. Though practically all registered forest users engage in forest gathering activities, only 72% of all households in the sample collect forest products.

The descriptive results point at forests as playing three key roles in household welfare: First, though the results indicate that the poorest groups derive a much larger share of income from forests compared to other groups (Fisher, 2004; Takasaki et al. 2004; Pattanayak et al. 2004; Cavendish 2000; Reddy and Chakravarty, 1999), both the richer and the poorer households are found to depend on forests, which point at the role of forests as safety nets that can cushion households during periods of hardship (Vedeld et al.2004; Angelsen and Wunder, 2003; Cavendish 2000, 2003; Narain et al. 2005). Considering current incomes, a larger proportion of registered forest user groups (63% and 39% for those not cultivating and those cultivating forest plots respectively) is poor compared to non registered households. The results using permanent incomes are mixed, with registered forest users being more represented in the middle than the low income groups. The results suggest that the decision to participate in forest activities may be based on a household's current rather than permanent income. Households that are transitorily poor may therefore engage in forest activities to cater for temporary shortfalls in income rather than to cater for a long term fall in permanent income.

Second, the role of forests as a gap-filler and as a source of regular subsistence use is evident from the finding that the poor in terms of current incomes are more likely to depend on forests than the chronically poor (Cavendish 2000, 2003; Vedeld et al. 2004; Angelsen and Wunder, 2003; Narain et al. 2005). A decomposition of income shares by source and wealth groups show that the lowest income group derive about 20% of incomes from forest crop farming and collection activities, while the middle and upper groups earn about 16% and 12% respectively.

Third, the poverty reduction role is revealed through the contribution of forests to diversification of household income sources and also through specialized forest strategies adopted by households, including: forest grazing; forest crop farming; and gathering activities (Vedeld et al. 2004; Angelsen and Wunder 2003). The finding that registered forest users with forest plots are less income poor than registered groups without plots further points at the potential poverty reduction role of forests. Though we do not distinguish fully between low return and high return forest activities, the results suggest that the transitorily poor are more likely to depend on low return forest activities than the chronically poor. The lowest income group derives 47% of environmental incomes from construction materials, compared to 70% and 83% of the middle and upper income groups respectively. The lowest and middle asset groups however derive a higher proportion of incomes from construction materials than the upper assets group, which derives environmental incomes from more diversified sources.

Decomposition of income inequalities indicate that incomes from forest collection and total forest incomes show less inequality among farmers who cultivate in the forest than other households, but there are no major variations in total income inequalities across the three groups. The results suggest that forests contribute much less to reductions in income inequality (4%) compared to findings in related studies. Our results further indicate that there is no inequality dominance between the three user groups.

The econometric results suggest that membership in village institutions and in forest user groups influence participation in forest activities and in willingness to participate in collective action. The results also suggest that household heterogeneities in terms of private endowments of land and livestock, as well as land tenure security are important drivers of the forest-poverty link. Willingness to participate in collective action activities also enhances resource extraction and household dependence on forest products. Household characteristics such as age, education of the head and household size are also important determinants of forest resource dependence. Though the impact of household characteristics differs from one resource to another, forest extraction in general is responsive to household characteristics. Farm size exhibits a hill shaped relationship with forest crop farming and also with the share of incomes from farming. This hill shaped relationship implies that at low levels of land holdings, households seek to use forest plots for cultivation but beyond some threshold size, reliance on forest plots decline. The results support earlier studies that have found economic heterogeneities to be important determinants of reliance on common property resources (Adhikari, 2005; Bardhan and Dayton-Johnson, 2000; Kant, 2000).

The results of this paper indicate that forests are a safety net for forest communities. There is therefore need to target the poor and also to consider household heterogeneities in forest policy formulation. The landless forest squatters derive a substantial income from forests and would therefore lose their livelihoods with a total ban on forest cultivation. The results also suggest that the government derives substantial benefits through saved labour costs from non resident cultivators. This calls for establishment of more NRC projects in deforested areas to provide a livelihood base for landless communities. Our findings also suggest that the less poor also depend on forests, raising issues of equity in distribution of benefits from community forests. A balanced approach to forest management should ensure that the poor are not marginalized by the less poor in accessing environmental resources. However, since policy reversals have always sprang from the concern of the government and conservationists on forest degradation, there is need to strike a balance between forest extraction by local communities and possible forest degradation. Encouragement of participation in forest user groups and other village level collective activities would play a vital role in forest conservation and establishment of plantations. Thousands of hectares of bare forests can be re-afforested at little cost to the government as the poor forest communities earn a livelihood.

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