Graduate School Form 9
(Revised 7/94)

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis Acceptance

This is to certify that the thesis prepared

By Monica G. Fisher

Entitled

"Explaining Forest Degradation in Malawi: Asset Poverty, Income Shocks, and Activity Choice"

Complies with University regulations and meets the standards of the Graduate School for originality and quality

For the degree of Doctor of Philosophy

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EXPLAINING FOREST DEGRADATION IN MALAWI:

ASSET POVERTY, INCOME SHOCKS, AND ACTIVITY CHOICE

A Thesis

Submitted to the Faculty

of

Purdue University

by

Monica G. Fisher

In Partial Fulfillment of the

Requirements of the Degree

of

Doctor of Philosophy

December 2002

UMI Number: 3104940

UMI Microform 3104940

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

ACKNOWLEDGEMENTS

I am especially grateful to my advisor Gerald Shively whose continuous encouragement, abundance of creative ideas, excellent advice, and constant feedback have guided me through this work. I was very fortunate to work with him during my Ph.D. studies, and I look forward to future collaborations. Discussions with Steven Buccola stimulated some interesting ideas which were applied in the dissertation; I also thank him for being a demanding reader of my work. Edna Loehman was an excellent teacher of welfare economics, and I thank her for her encouragement and useful feedback on drafts. I was very fortunate to work closely with William Masters at some stages of my studies; he deserves special thanks for assisting me in obtaining opportunities to carry out research in Benin and Malawi. I would also like to thank Ken Foster who took the time to respond carefully to my questions about econometrics. I thank Lou Ann Baugh for keeping me informed of deadlines and her support.

A Fullbright grant provided financial support for the field research in Malawi. I thank the Center for Social Research of the University of Malawi and the Likhubula Forestry Department for technical and logistical support during the field research.

In Malawi, I acknowledge the support and help of many friends and colleagues. In particular, I am grateful to my top-rate field assistants and good friends Duncan Chikwita and the late S.A.R. Mjathu for their careful attention to detail and hard work, and my dear friends the Kathindwa family who helped me adjust to life in rural Malawi. *Zikomo kwambiri* to the respondents of my household survey who generously gave their time for the interviews and whose warmth and good humor made the field research a wonderful life experience.

Most of all I thank my family, especially my husband Guenter, for his careful reading of the dissertation, sharp mind for discussing ideas, and unconditional support.

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LIST OF TERMS

CSR	Centre for Social Research
DFID	Department for International Development, UK
FAO	Food and Agriculture Organization
FD	Forestry Department
FRIM	Forestry Research Institute of Malawi
GOM	Government of Malawi
GTZ	German Society for Technical Cooperation
IHS	Malawi Integrated Household Survey
MK	Malawi Kwacha – Malawi's currency
MMBCP	Mulanje Mountain Biodiversity Conservation Project
MMFR	Mulanje Mountain Forest Reserve
MMPTF	Malawi Maize Productivity Task Force
NSO	Malawi National Statistical Office
NSSA	Malawi National Sample Survey of Agriculture
NTFP	Non-timber forest product
PMS	Poverty Monitoring System of the Government of Malawi
RRA	Rapid Rural Appraisal
SPS	Starter Pack Scheme

TIP	Targeted Inputs Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VFA	Village Forest Area
WWF	World Wildlife Fund

ABSTRACT

Fisher, Monica G. Ph.D., Purdue University, December 2002. Explaining Forest Degradation in Malawi: Asset Poverty, Income Shocks, and Activity Choice. Major Professor: Dr. Gerald Shively.

This dissertation asks what policies might be useful to reduce incentives to degrade forests in Malawi, where forest cover is being lost at a rate of 2.4 percent per annum. Conservation efforts have often been limited by an inadequate understanding of the varied ways in which forest users incorporate forest activities into their activity portfolios. The core of the dissertation is a set of essays that use household survey data from rural Malawi to examine the factors associated with smallholder-led forest degradation and to assess the many contributions of forest resources to rural livelihoods.

Essay I uses a systems approach to examine the determinants of activity choice impacting forest use among low-income households in Malawi. Results from constrained ML estimation indicate greater incentives to degrade forests where the returns to forest use are high. Factors that reduce forest pressure include: availability of low-cost fuel substitutes, on-farm tree planting, favorable returns to wage-work, and opportunities in the self-employment sector.

Essay II investigates whether forests provide a safety net for rural households in Malawi. Results from a dynamic Tobit model of forest extraction appear to suggest that access to forests as a source of income assists households, particularly very poor

households, in coping with income shortfalls. Random-effects models of income and savings indicate that households save out of transitory income. The findings of the essay suggest that policies that help to alleviate asset poverty can reduce household dependence on forests for coping with income shocks and subsequently reduce forest pressure.

Essay III examines economic reliance on forests and its effects on rural household welfare. The data show that sample households depended on forests for about 30 percent of household income. Tobit model estimation indicates a positive relationship between asset poverty and forest reliance. Analyses of the impacts of forest use on poverty and income inequality indicate a potentially important role for forests in improving living standards in rural Malawi at the household and community levels.

Based on findings of the three essays, interventions are proposed that aim to slow forest decline in Malawi without harming the current well-being of the rural poor.

CHAPTER I – INTRODUCTION

Is deforestation in Malawi an unsolvable problem? [1] David French (1986), a development analyst working for the Food and Agriculture Organization (FAO), posed this question in the mid-1980s, arguing that few interventions were likely to successfully address the problem of forest decline.[2] Just 25 years ago, Malawi's forests were vast, covering 4.4 million hectares; today forests cover only 1.9 million hectares (GOM 1998a). A recent estimate for the country's deforestation rate is 2.4 percent per annum, the highest for southern Africa (FAO 2001 cited in UNEP 2002). The decline of Malawi's forests is in part related to natural occurrences (e.g. wildfires started by lightning and major aphid attacks), but it is primarily the result of human activity (GOM 1998a). The interplay of high population density, poverty, dependence on forest resources

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[1] The terms forest decline, deforestation, and forest degradation are often used interchangeably; no universally-accepted definitions apply. In this dissertation, forest decline is interpreted as deforestation and/or degradation. Forest degradation occurs when forests are cleared and forest products are extracted at levels exceeding sustainable yields. Deforestation differs from forest degradation by degree; it represents a more permanent loss of forest cover over a larger area.

[2] Tropical forest decline gives rise to a number of potential negative consequences, impacting environmental, economic, social, and cultural realms. For a discussion that focuses on southern African forests see UNEP (2002).

for livelihoods in rural areas, and weak forest management institutions create very real challenges to conservation of Malawi's forests. [3]

The key threat to Malawi's forests is clearing for agricultural expansion (GOM 1998a). Malawi's highly dualistic agricultural sector comprises estate and smallholder sub-sectors. Estates grow mostly cash crops on their relatively large landholdings and have leasehold or freehold tenure. The overwhelming majority of Malawi's farmers are smallholders who grow mainly food crops, especially maize the staple crop, on customary land for which they do not possess ownership or title (Ng'ong'ola et al. 1997). Smallholder agriculture is characterized by small size of landholdings; low agricultural productivity due to slow adoption of improved techniques and the single short growing season each year; and heavy reliance on the labor of household members, especially women (Ng'ong'ola et al. 1997).[4] Smallholder farmers have often had little option but to clear forest land to grow food to feed their families, and in many communities

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[3] Population density is high, 105 people per square kilometer according to Malawi's 1998 census; it is the result of natural growth factors and influxes of Mozambicans attempting to escape forced labor under Portuguese rule and, more recently, fleeing their country's civil war (Whiteside and Carr 1997). According to recent statistics (World Bank 2000/2001), Malawi is the fourth poorest nation in the world in per capita income terms, and it ranks low on quality of life indicators such as life expectancy at birth (42 years), the female illiteracy rate (56 percent), and the under-five mortality rate (229 per 1,000).

[4] According to Malawi's Integrated Household Survey (IHS) 1997/98, "poor" and "non-poor" farm households have mean per capita landholdings of 0.185 and 0.282 hectares (Poverty Monitoring System 2000a). Some observers contend that Malawi's "delayed Green Revolution" (Smale and Heisey 1997) remains stalled (Carr 1997 cited in Gladwin 2001). Although supply conditions have improved during structural adjustment in the 1980s and 1990s, currency devaluations and the collapse of the national credit system has made it increasingly difficult for smallholders to purchase chemical fertilizer and improved maize seed (Masters and Fisher 1998).

customary land is open-access due to weakened traditional controls over land allocation (GOM 1998a). Estates cleared large tracts of forest land prior to 1994 under the former political regime (the late "life president" Dr. Banda) when the number of estates and the size of existing estates grew considerably; often expansion involved the alienation of customary forest land.[5] At present, estate expansion is said to be strictly controlled and, therefore, has relatively little impact on forest resources (Probyn 2001).

High and growing demand for wood-based fuels is another key factor in the decline of Malawi's forests. About 93 percent of the country's total energy needs is provided by biomass (GOM 1998a). Rural households are almost completely dependent on wood-based fuels for their home energy needs and this is unlikely to change in the near future. It is estimated that 66.5 percent of rural Malawians live below the consumption poverty line, unable to secure their basic food and critical non-food needs (Poverty Monitoring System 2000b). Firewood obtained from adjacent forests remains an essentially free and accessible good, and low-cost alternative energy sources are generally not available (Brouwer 1997). Worsening poverty in urban areas and rising tariffs on paraffin and electricity in recent years has encouraged many urban dwellers to use charcoal and firewood to meet their domestic energy requirements (GOM 1998a). Welfare poverty in rural areas means that cheap labor is available to supply wood-based fuels to the urban population at low cost, retarding the transition to non biomass-based fuels in urban areas. A recent estimate is that wood-based fuels make up 94 percent of

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[5] Between 1970 and 1989 the number of estates in Malawi grew from 299 to 14,671 (Eschweiler 1993 cited in GOM 1998a).

urban households' energy sources (Arpaillanje 1996). Tobacco and tea estates use large quantities of wood for curing and constructing storage sheds, representing about 30 percent of total wood demand (GOM 1998a). The majority of the tobacco estates do not comply with the obligatory establishment of a woodlot covering 10 percent of the estate's area (GOM 1998b). The productivity of Malawi's natural forests, mostly of the *miombo* type, is generally low; at current levels of demand, wood harvest rates exceed sustainable yield (GOM 1998b). The Forestry Department estimates that the deficit for wood-based fuels rose from 1.6 to 4.9 million cubic meters from 1983 to 1990, and projected figures for 1995 and 2000 are 7.6 and 7.8 million cubic meters respectively (GOM 1998b).[6]

Uncontrolled forest fires cause considerable damage to forest resources. While some fires are started by lightning, most are said to be human caused. It is said that disgruntled Forestry Department workers, faced with low wages and retrenchment, start fires in forests. Villagers retaliating against restrictions on extraction from Malawi's 71 protected reserves and wildlife parks are also blamed. The Forestry Department lacks the resources necessary for effective prevention and control of forest fires (GOM 1998a).

Observers contend that rural Malawians often equate "democracy" (since 1994) with the right to exploit resources that were denied to them in the past (Walker and Peters 2001). During the 1994 election campaign, some politicians made vote-seeking claims that in the "New Malawi" people would no longer be denied the natural resources that are rightfully theirs (Probyn 2001). Even today politicians trying to win public support tell

people to freely cultivate wherever land is available (de Gabrielle 1999). In many communities, these and other external change factors have served to weaken the authority of the village heads who manage customary lands. About half of Malawi's forested area is on customary land, and many of these forests have become de-facto open-access (GOM 1998a; Place and Otsuka 1997).[7] In state forest reserves (about 22 percent of forested area), restrictions placed on local forest use and the failure to include local communities in management has contributed to over-exploitation by local people (GOM 1998a). Experience shows that in places where natural resource extraction is an integral part of local livelihood strategies, even well-funded state-centered conservation efforts often fail (Agarwal and Gibson 1998; Baland and Plateau 1996).

Given the contextual factors described above, the problem of deforestation in Malawi does appear "unsolvable". However, recent changes in forest policy offer hope for Malawi's forests and the ecosystems and local people they support. For example, Malawi's National Environmental Action Plan (NEAP) recognizes the vital role of communities in resource management. The plan aims to devolve some management roles in certain forest areas to local communities, and to empower traditional leaders and local people to conserve the country's forests. Among many other NEAP programs currently underway are those geared toward increasing smallholder agricultural productivity and

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[6] Local timber merchants extract selected tropical hardwoods, destined primarily for urban centers within Malawi. Largely because there is little remaining valuable timber, the merchants currently play only a minor role in forest degradation (Probyn 2001).

reducing demand for wood-based fuels (GOM 1998b). Other encouraging developments in Malawi include increased financial and technical support from donors and non-governmental organizations (NGOs) for conservation efforts, private sector development of new technologies for reducing demand for wood, and the voluntary actions of local communities to protect and plant trees.

This dissertation asks what policies might be useful to reduce incentives to degrade forests in Malawi. Tropical forest conservation efforts have often been limited by an inadequate understanding of the varied ways in which forest users incorporate forest activities into their activity portfolios (Agarwal and Gibson 1999; Coomes et al. 2002). The core of the dissertation is a set of essays that examine the immediate causes of smallholder-led forest degradation and assess the many contributions of forest resources to rural livelihoods in Malawi. [8] In addition to sharing this conceptual theme, the three essays share a focus on household survey data collected in southern Malawi in 1999/2000. Essay I examines the immediate causes of forest degradation in rural Malawi using an innovative econometric approach. A time allocation model is developed and estimated in which households allocate labor to four sectors: the forest, the farm,

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[7] Malawi's forests are distributed as follows: 50.4 percent (customary land), 22 percent (state forest reserves), 24.8 (wildlife reserves), 2.3 percent (government plantations), and 0.5 percent (private plantations) (GOM 1998a).

[8] Immediate causes are agents' characteristics (e.g. age, education) and decision parameters (e.g. prices, forest access, technology) associated with choices impacting forests. Underlying causes of deforestation are macro-level variables and policy instruments (e.g. demographics, poverty, and government policies) that determine agents' decision parameters and indirectly affect decisions to degrade forests (Kaimowitz and Angelsen 1998).

wage-work, and self-employment. By estimating labor share equations jointly, the analysis provides a theoretically consistent treatment that leads to economic and policy insights obscured by a single-equation approach to studying forest use decisions.

Essay II examines whether rural households in Malawi use forests to cope with income shocks. Two sets of analyses are used to explore this issue. First, a dynamic Tobit model of forest extraction is used to examine whether household forest use is responsive to income shocks. Second, random-effects models of income and savings are estimated to investigate whether households save out of transitory income. Essay II highlights the potentially important safety-net role of tropical forests and the potential for income programs to alleviate poverty and reduce forest pressure.

Essay III aims to quantify some of the ways forests contribute to household welfare in rural Malawi, examining whether access to forests helps to alleviate poverty or reduce income inequality. Poverty analysis involves calculation of measures of the incidence, severity, and depth of poverty among sample households during the survey year. The potential effect of access to forest income on income inequality is investigated by calculating Gini coefficients for household income with and without forest income.

Taken together, the findings of the three essays will add to the current state of knowledge on tropical forest decline, present useful methodological extensions to facilitate the study of forest decline in the developing world, and provide insights concerning the design of effective forest conservation policies which may assist conservation efforts in Malawi and other tropical countries.

CHAPTER II – FIELD RESEARCH METHODS AND STUDY AREA

The purpose of this chapter is to describe the data collection methods and the study area. Data come from a household survey in southern Malawi. From July 1999 to August 2000, 99 farm households were interviewed monthly using formal questionnaires. Direct measurement was used for some types of information when it was believed to be more effective than interviewing. Rapid rural appraisal (RRA) methods were used for socioeconomic stratification of households for sampling purposes and to collect qualitative data concerning local perceptions on forest use and forest management regimes.[9] Figure 2.1 summarizes the stages of the field research (in the diagram each "+" denotes a week).

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[9] Rapid rural appraisal (RRA) refers to a range of investigative techniques used to collect data in rural parts of developing countries. These techniques include, but are not limited to: semi-structured interviews with individuals and households, focus-group interviews, triangulation, sampling techniques adapted to local circumstance, and direct observation. Key characteristics of RRA approaches are short time to completion, low cost, and flexibility relative to formal surveys; and research is carried out by multidisciplinary teams of researchers (Chambers 1994).

	Apr. 1999	May 1999	June 1999	July 1999	Aug. 1999	Sept. 1999	Oct. 1999	Nov. 1999	Dec. 1999	Jan. 2000	Feb. 2000	Mar. 2000	Apr. 2000	May 2000	June 2000	July 2000
Questionnaire design	++++															
Selection of villages	++															
Hiring/training research assistants		++++														
Questionnaire pilot study		++														
Census of households			++													
Selection of sample households			++													
Household interviews				++++	++++	++++	++++	++++	++++	++++	++++	++++			++++	++++
Focus groups discussions													++++			
Measures of food/fuel consumption										++					++	
Measures of wood head load weight											+					
Measures of wood use for income-generating activities														++++		
Measures with women firewood sellers											+					
Maize measurement units																++

Figure 2.1 Time Line of Field Research Carried Out in Southern Malawi, April 1999 to August 2000

The Household Survey

Selection of the Study Villages

The household survey was carried out in southern Malawi, the region of the country that ranks highest in terms of poverty incidence, population density, and scarcity of forest resources (see Table 2.1). Research villages were purposively selected to represent three forest management types and a spectrum of market access. Staff at District Forestry Departments assisted me in identifying field sites meeting the above criteria and accompanied me to these villages to introduce me to the village heads. Figures 2.2 and 2.3 show the study area and the location of the three research villages in relation to each other. Table 2.2 presents key characteristics of the study sites.

Table 2.1 Selected Socioeconomic and Environmental Statistics: Malawi by Region

	Southern Region	Central Region	Northern Region	Malawi
Poverty headcount (percent) [a]	68.1	62.8	62.5	65.3
Population density 1998 (persons/km^2) [b]	146	114	46	105
Population share 1990 (percent of national) [c]	50	39	11	100
Forest cover share 1990 (percent of national) [c]	30	30	40	100
Forest cover as percent of national area 1990 [c]	11	11	15	38

a. Source: Poverty Monitoring System 2000b.
b. Source: National Statistical Office, Zomba, Malawi. http://www.nso.malawi.net.
c. Source: GOM 1998b.

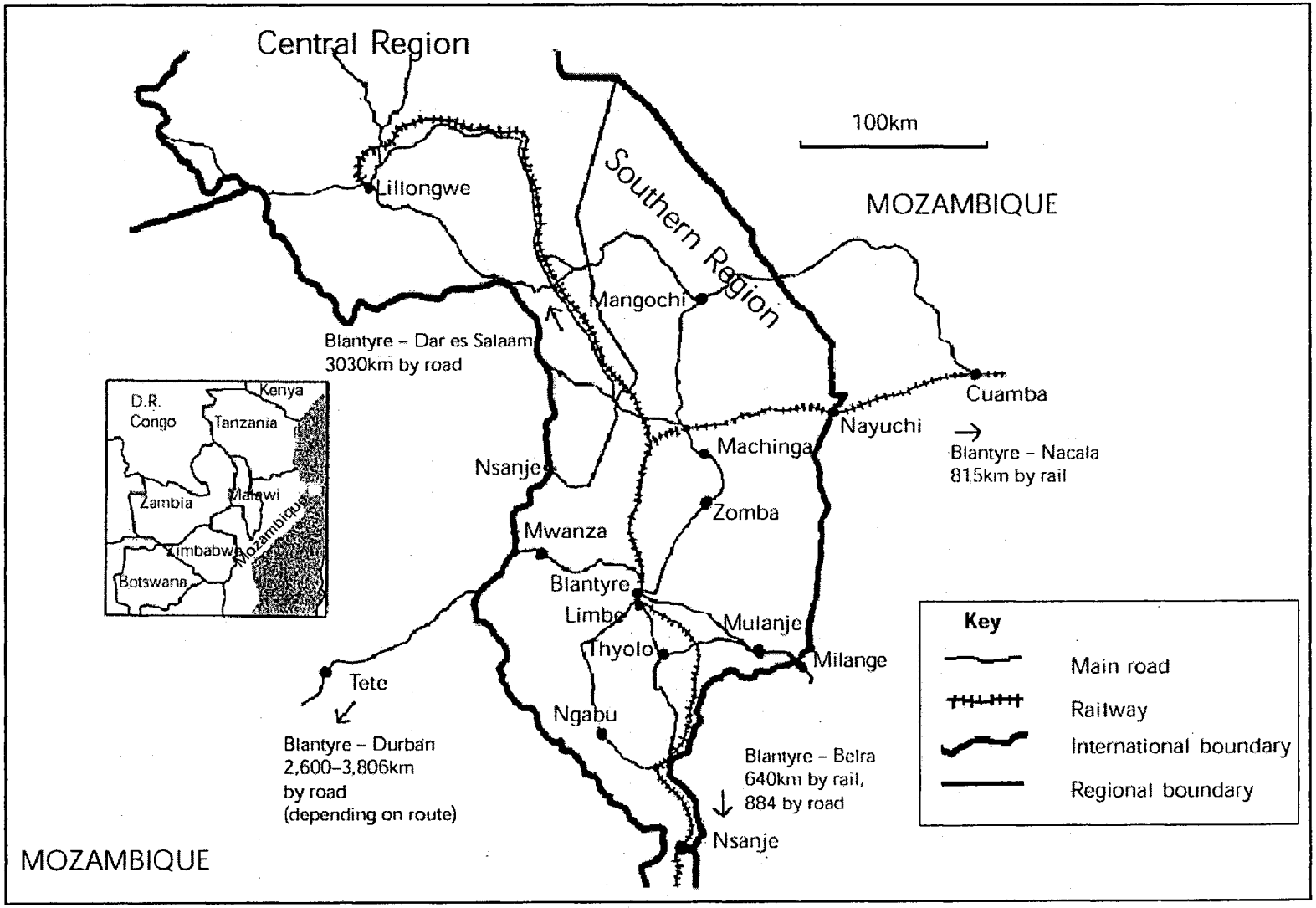

Figure 2.2 Overview Map of the Study Area

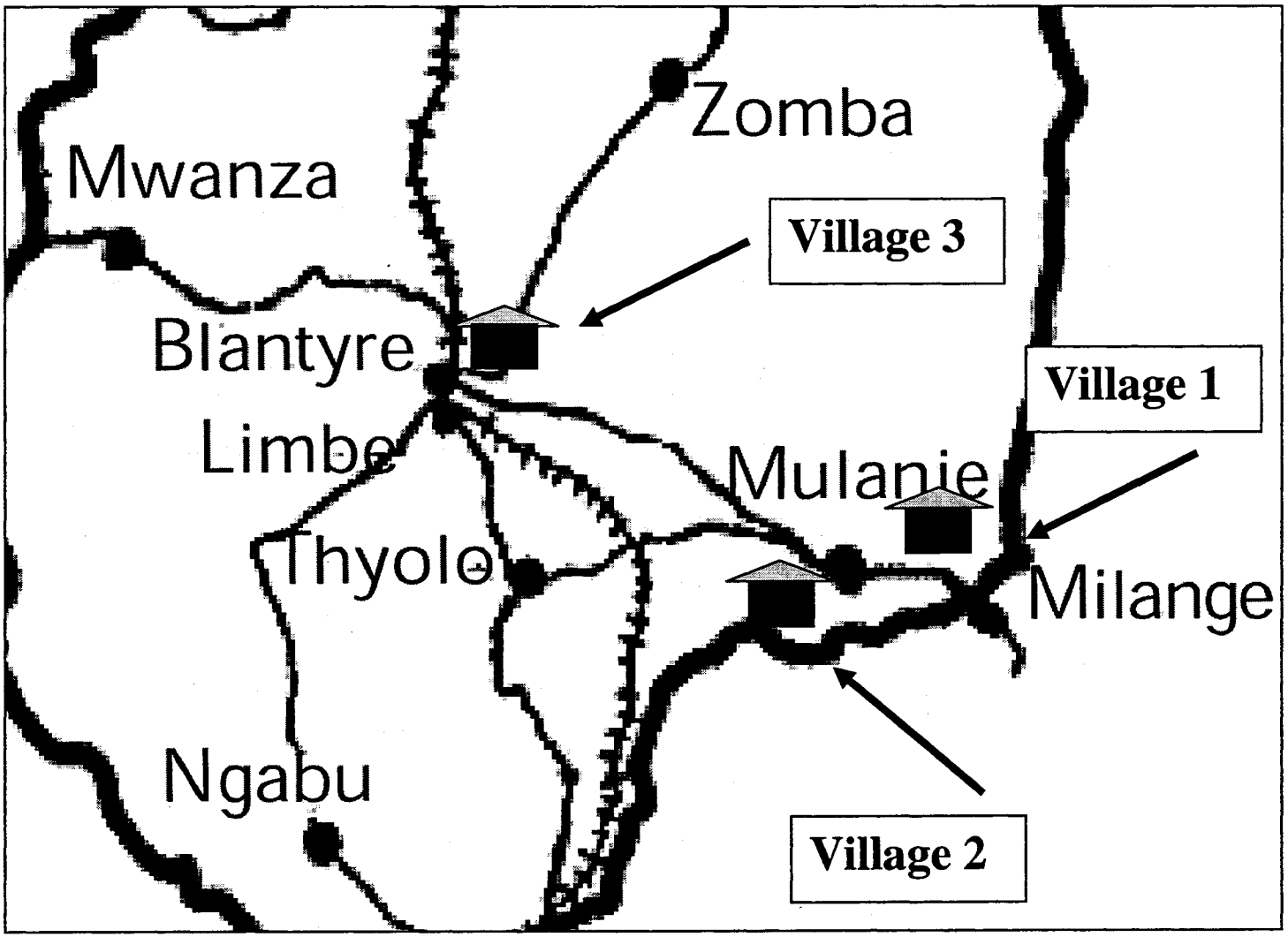

Figure 2.3 Map of the Study Villages

Table 2.2 Key Characteristics of the Research Villages

	Village 1	Village 2	Village 3
Main source of forest resources	Mulanje Mountain covering 640 km^2 comprising miombo woodland and afro-montane forest, and pine plantations.	A hill covering 16 km^2 comprising miombo woodland.	Sparse collections of trees of miombo species.
Forest products available	Most plentiful of the villages: timber and a wide-range of NTFPs (firewood, fruit, mushrooms, bush meat, insects).	Less plentiful than Village 1, but more than Village 3. Mostly NTFPs: firewood, fruit, mushrooms, some bush meat, insects, honey.	Relatively scarce, but available for all. Mainly firewood and charcoal burning occurs.
Forest management regime	State (Forestry Department) management	"Community-based" (Village Head) management	Open-access
Access to markets for forest products	Fair	Poor	Good
Number of households	287	314	230
Staple crop	Local maize	Hybrid maize	Hybrid maize
Other important crops	Hybrid maize, sorghum, pigeon pea, velvet bean, and pumpkin.	Local maize, cassava, sorghum, pigeon pea, velvet bean, sweet potato, and pumpkin.	Local maize, groundnut, pigeon pea, and pumpkin.

Village 1

Village 1 represents state forest management and fair market access. The village is adjacent to the Mulanje Massif, which covers an area of 640 square kilometers. The forest on the mountain ranges from miombo woodland at its base to afro-montane forest near its summit, and pine and eucalyptus plantations established by the Forestry Department. Mulanje Mountain is very important locally, playing a critical role in soil and watershed protection, regulation of local microclimates, and supplying timber (tropical hardwoods, Mulanje cedar, pine) and non-timber products for the local population. From a global perspective, it contains over 600 species of flowering and non-flowering trees, herbs, and shrubs and is one of Africa's key habitats for threatened bird species. It has been identified by the World Wildlife Fund (WWF) as one of 20 areas in the world for the conservation of biodiversity (MMBCP 1996).

Since 1927, the MMFR has been managed for conservation purposes, initially by the colonial government, and since independence (in 1964) by the Forestry Department (FD).[10] Recent regulations governing forest resources reflected the National Forestry Act of 1997. Some activities were strictly forbidden in the reserve: crop cultivation, charcoal production (illegal in Malawi), and hunting. Other forest activities were allowed upon payment of a licensing fee to the FD: collection of head loads of dead wood, grazing of animals, and felling/removal of trees (with controls on the species of trees, closed periods, and quantities). Withdrawal of some non-timber forest products (NTFPs)

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[10] Since 2001 the forest has been co-managed by local communities and the Forestry Department under the Mulanje Mountain Biodiversity Conservation (MMBCP) project.

such as fruit, mushrooms, wild vegetables, and caterpillars was allowed free of charge. In general, the forest products removed from the reserve were to be for domestic use. The Forestry Act outlines punishment for violations of these rules which include: fines, confiscation of collected materials, and imprisonment.

Enforcement of rules has presented a clear challenge for the FD. In 1996, prior to budgetary cuts, the FD had the financial resources to employ only 26 forest guards and 150 patrollers to monitor the 640 km^2 area (MMBCP 1996). Forestry Department guards and patrollers are not paid well and frequently receive their salaries late, and many villagers claim that some guards/patrollers lack motivation and are corrupt (de Gabrielle 1999; see also Appendix C). Budgetary constraints also prevent the FD from maintaining firebreaks, and fire control resources are virtually non-existent (MMBCP 1996). The Forestry Act of 1997 lacks clearly defined procedures for punishing violators of some activities such as forest encroachment, and local people use this to their advantage. The FD's ability to enforce resource use rules is further challenged by limited respect for its authority. For example, a common local sentiment is that indigenous trees are gifts from God; the FD did not plant them, so it does not own them (de Gabrielle 1999).

With weak enforcement, low-rule compliance would be expected, and this is supported by evidence (de Gabrielle 1999; Lowore 1999; Appendix C). Forest clearing for agriculture has been a serious problem in the MMFR since the 1980s when large numbers of Mozambican's fleeing their country's war settled in villages surrounding the MMFR, aggravating the land shortage situation. Over-extraction of some indigenous tree species has resulted in extinct in some cases (Knacck Consultants 1999). Some of the timber extraction is legal, but urban merchants and local people also fell trees illegally at

night, under lamp (Knacck Consultants 1999; Lowore 1999). In focus group discussions it was revealed that some people avoid paying the head load fee for wood by visiting the forest at night or on Sunday mornings (when guards are in church). On forest walks during the survey year, it was not unusual for me to encounter people cutting live trees.

Observations of forest use in Village 1 show some differences from the above description. Only one household in Village 1 reported forest clearing during the survey year. This may be related to the proximity of Village 1 to the FD headquarters. Encroachment is said to more pronounced in villages further away from Forestry Department office (de Gabrielle 1999). Charcoal marketing did not occur among sample households in Village 1 during the survey year. Focus group discussions in 15 villages revealed that in 12 of the villages charcoal production occurred. Village 1 is distant to charcoal markets, but this is also true for some of the 12 villages where charcoal burning occurred. Close proximity to the FD office may be an explanation.

Village 1 is more remote than Village 3, but less so than Village 2. It is located 10 kilometers from a tarmac road and the nearest town. There is a small trading center 2 kilometers away and several weekly markets are held within 5 kilometers of the village. At each of these locations, marketing of wood-based fuels (mostly wood, limited charcoal) is common. In addition, there is potential access to markets for other forest products and forest-based employment opportunities in the village. Tourists who visit the area to climb Mulanje Mountain buy crafts made from *Mulanje cedar*. Local young men work as guides/porters for tourists earning very high wages by local standards. Some of their earnings are used to buy locally-produced products including forest-based products, e.g. furniture and *masese* traditional beer. Pit-sawing is active on the mountain (pine,

Mulanje cedar, some hardwood); the bulk of sawn wood destined for the commercial center of Blantyre for industrial usage. While some locals engage in trade of sawn wood, most of the timber merchants come from outside the local communities. The presence of the sawmills benefits local people who work as pit-sawyers and plank carriers (plank transport from sawmills on the mountain to the roadside is exclusively by manual labor).

Village 2

Village 2 was selected to represent community-based forest management and market remoteness. The main source of forest products is *miombo* woodland on a hill that extends over an area of about 16 square kilometers. According to the village head, he and FD officers designated the forested hill a Village Forest Area (VFA) about 20 years ago to be managed jointly by the head and a committee of twelve village leaders for conservation purposes.[11] At that time a number of rules were established regarding use of the VFA. Access rules specify that only individuals who reside in Village 2 are allowed to enter the VFA. Rules concerning withdrawal of forest products by Village 2 inhabitants include the following. Felling/removal of live trees is prohibited except for special circumstances. For example, when a community member needs wood for coffins or cash for funeral expenses, the head may grant permission. The village head estimates that he grants permission to cut live wood about once every 2 months. Community members are allowed to collect any amount of dead wood, although they are supposed to notify the head before doing so. It is illegal to hunt animals in the VFA, with the

exception of mice. Finally, there are no restrictions on the collection of fruit and mushrooms, and permission is not required for collection.

While the original intent was that the VFA be managed by the village head and a committee, it appeared that management roles rested purely in the hands of the village head during the survey year. Indeed, the head told me that he owns the hill and the trees on it. There appeared to be considerable animosity between the village head and community members over management of the VFA. In interviews with community members, I was told that the village head abuses his authority and engages in marketing of forest products, and allows his relatives and friends to do the same. For his part, the head argued that if the hill were in the hands of community members, there would be few trees remaining. During the survey period there was a period of several weeks during which the head was under so much pressure about management of the VFA that he temporarily handed his headship roles over to a sub-chief.

My sense during the survey year was that the village head was somewhat more successful at enforcing forest access/use rules than the FD. This may reflect the small size of the VFA and the head's proximity to the resource (he lives within sight of the VFA). In addition, in recent years encroachment has been made more difficult with the planting of eucalyptus trees along the VFA boundaries; crops cannot grow within 2 meters of eucalyptus (Kathindwa 2000). The customary view in the area is that the act of planting exotic trees is a claim of land ownership (de Gabrielle 1999). During the survey

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[11] The Village Forest Area (VFA) system was initiated under colonial rule and gained renewed interest in the last few decades. Under the VFA system, communities demarcate and manage woodland areas for conservations purposes.

year, none of the sample households cleared forest for farming. In addition, charcoal production did not occur, although this probably had as much to do with the great distance to charcoal markets as enforcement of VFA rules. Still, because many community members do not respect the village head's authority over the VFA, several individuals reported to me in interviews that they occasionally extract products illegally from the VFA, visiting the hill at night or when the head is away.

Village 2 is the most remote of the three villages, located about 20 kilometers from a tarmac road and the nearest town. One locational advantage of the village is its proximity to Mozambique (5 kilometers) where agricultural commodities and firewood can be purchased at prices far below those prevailing in Malawi. There appeared to be an opportunity to purchase firewood in Mozambique and re-sell it for a profit in markets in Malawi, but none of the sample households engaged in this activity during the survey year. Households did commonly purchase firewood in Mozambique for home use.

Village 3

Village 3 represents open-access woodland and good access to forest product markets. There is no forest or woodland to speak of in the village. The largest collection of trees is in the community cemetery where trees are "protected" by cultural norms. The few scattered collections of trees on common land in the village are, in principle, controlled by the village head who is to be consulted when individuals seek to fell trees to clear land for gardens or to burn charcoal. In practice however, communal land in the village appeared to be open-access. This is largely because the head in Village 3, unlike those in the other villages, was a weak leader and much went on without his counsel.

Although woodland resources are in short supply in this village, community members rely on woodland resources for many basic needs and are also actively involved in marketing of wood-based fuels due to good market access. In addition, relatively abundant indigenous woodlands remain in Mwanza District, about 20 kilometers from Village 3. It is not uncommon for people living in Village 3 to walk or cycle to Mwanza to buy wood and charcoal and then return to sell it for a profit along the roadside in Village 3. Village 3 has the advantage of being next to a tarmac road linking it with Blantyre (Malawi's largest urban center) only 40 kilometers away. In addition, the village is located just after the last police roadblock en route to Blantyre. Individuals driving to Blantyre who purchase charcoal for home use or re-sale in Blantyre are at less risk of having their purchases confiscated by the police if they make their purchases at a location after the roadblock, an advantage for charcoal sellers in Village 3.

Selection of Households [12]

A sample of 110 households was selected from the study villages. In each village, the process of household selection involved five stages: (1) meeting with the village head, (2) introductory meeting with community members, (3) village census, (4) wealth ranking exercise, and (5) random selection of households with the participation of community members. The process took one to two weeks per village.

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[12] For the study I defined the household to be the basic consumption unit. In local terms, a household is a group of people, related or unrelated who make common provision for food. They regularly eat *nsima* cooked from the same pot and share a granary. *Nsima* is a stiff porridge usually made with maize flour, but in some areas with cassava or sorghum flour. It forms the bulk of a rural Malawian's daily calorie consumption.

We met with the village head to obtain permission to conduct the survey in the village, introduce the research assistants, and respond to her/his questions (the head in Village 1 is a woman). Community meetings followed and were attended by about 40-50 adults per village. The main objectives of community meetings were as follows:

- Describe the nature of our study and respond to questions.
- Let community members know that we are not part of a development project and have no connections with any organization.
- Discuss potential benefits of the study without raising false expectations.
- Assure community members of their anonymity.
- Ask community members for permission to carry out the research.

A census of households was conducted in each village to obtain a sample frame from which to draw our sample.[13] In each village, a community member selected by the head acted as our guide leading us from household to household. At each household, we described the nature of our study and asked permission to conduct interviews if the household were selected. Data collected during the census were: the name and gender of the household head and the size of the household's landholding. The census went well with two exceptions. First, I do not know if we visited every household as village boundaries were not clearly defined. Second, we had a large number of "I don't know" responses for the landholding question. This was asked for the purpose of sample stratification, but appeared to be a question too sensitive to ask at the outset of the

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[13] Starter Pack Scheme (SPS) registration lists were available for the study villages. I was advised by another researcher to conduct a census rather than use the SPS lists as he believed that the manner in which the registration lists were compiled was not reliable. For example, in some villages the field assistants assigned with the task of enumerating all village households simply consulted the village head to obtain names rather than going household to household to obtain the list.

study. Since only a handful of census respondents gave us estimates of their landholding size, we employed another approach for sample stratification: a wealth-ranking exercise.

Wealth ranking is a RRA technique whereby key informants categorize village households into wealth ranks based on pre-established criteria (Adams et al. 1997). Validation studies find that wealth ranking results on relative socioeconomic status are in good agreement with those obtained with more formal survey techniques (Adams et al. 1997; Chambers 1994). In each of our study villages, we worked with 15–20 key informants to complete the wealth-ranking exercise.[14] The wealth-ranking exercises were led by a FD extension officer experienced with RRA techniques and I. We began by eliciting a definition of wealth in the local context from key informants. With minor variations across villages, wealth was linked to two elements: landholding size and stable earnings from permanent work or a business. Using the group-determined definition of wealth, key informants categorized all village households either as "very poor", "poor", or "average". No "wealthy" category was used because key informants insisted that none of the members of their community could be so classified. To reduce the time required for completion, we divided informants into two groups, each group together assigning wealth ranks to half the village households. Households were assigned a rank only after group members reached consensus.

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[14] Key informants were selected by village heads based on the following criteria: (1) people thought to be knowledgeable about the economic circumstances of community members, (2) adults of varying ages (about half female and half male), and (3) unrelated people (based on my belief that women would be more vocal if not in the presence of adult male family members).

To assess the empirical validity of the wealth-ranking exercise, I use the household survey data to obtain mean values for socioeconomic indicators across the wealth strata. Table 2.3. provides evidence that, on average, the wealth-rank exercise performed quite well in stratifying the sample households. The data show that, on average, households with higher wealth ranks have higher levels of income and consumption, more household labor, are less likely to be headed by a female, are more likely to have a head with some formal education, and have larger holdings of physical assets; although not all of the mean differences are statistically significant.

Using the wealth categories from RRA, a population proportionate to size sample was drawn with the participation of community members. In each village, 50 – 100 people were present for the household selection. The names of all the household heads for the given village were written on pieces of paper and organized by wealth strata into three baskets. I would choose a community member in the "audience", usually a child, who would come forward and, with eyes closed, draw a piece of paper from the basket that I held. I would then read off the name of the household head, and everyone would acknowledge the selected household. The exercise was enjoyed in all villages, but some villagers were not convinced that the process resulted in a random sample. In Village 2 we had to re-draw names when the majority of those present made clear their belief that the selection process was rigged.

The selected sample consisted of 110 households: 40 households from Villages 1 and 2, and 30 households from Village 3. [15] The number of households selected represented 14, 13, and 13 percent of the respective population of households in Villages 1, 2, and 3 respectively. In each village, the household of the village head was added to our list of interviewees, yielding an initial total sample of 113 households. Over the survey year, our sample size was reduced to 99 households due mainly either to the passing away of household heads or to households moving to other villages.

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[15] My original intent had been to have 40 randomly selected households from Village 3 as well. However, during the census we discovered that the village is very large in area and completion of 40 interviews per month seemed unrealistic.

Table 2.3 Income, Consumption, Labor Supply, Asset Holdings, by Wealth Rank, Sample Households 1999/2000

	Mean or Proportion by Wealth Group			Test Statistic for Group Comparisons [a]		
	Group 1 "Very Poor"	Group 2 "Poor"	Group 3 "Average"	1 vs. 2	2 vs. 3	1 vs. 3
Income and Consumption						
Cash income (MK/year)	2,894	8,527	14,978	-4.38	-1.93	-3.83
Meals (per person per day)	1.98	2.04	2.17	-0.74	-0.97	-1.47
Labor supply						
Population	4.33	4.91	5.24	-0.90	-0.52	-1.23
Dependency ratio [b]	0.39	0.28	0.24	0.91	0.52	1.17
Female-head (%)	76	39	14	2.95	2.04	4.03
Head educated (%) [c]	43	65	81	-1.76	-1.36	-2.54
Physical Assets						
Farm size (ha)	1.00	1.10	1.97	-0.55	-1.85	-1.99
Number cows owned	0	0.16	1.52	-1.12	-1.56	-1.76
Number goats owned	0.48	0.67	1.52	-1.63	-1.32	-1.63
Iron roof owners (%)	5	7	29	-0.36	-2.53	-2.07
Bicycle owners (%)	14	40	57	-2.17	-1.32	-2.90
Number observations	21	57	21			

a. The critical value ($\alpha = 0.10$) for the z-statistic (differences in proportions) and t-statistic (differences in means) is 1.66.
b. Number of children and elderly divided by number of active adults. Boys and girls treated as half an adult equivalent.
c. Percent of heads that ever attended school.

The Household Interviews

I worked with three research assistant teams (two people) during the survey year.[16] Each team was assigned to one of the study villages for the duration of the survey. From July 1999 to August 2000 the research assistants and I interviewed residents of the sample households on a monthly basis using structured questionnaires (see Appendix A). [17] The questionnaires cover the following topics: demographics, asset ownership, forest use, tree planting, agricultural production and land holding, income, and expenditures. Table 2.4 lists key information about the questionnaires.

Interviews were conducted with groups of household residents to obtain more complete information and to establish a lively, enjoyable atmosphere. Interviews were conducted in Chichewa, Malawi's national language.[18] For some of the questionnaires we interviewed female and male household members separately, for example Questionnaire D. [19] For these interviews we matched the gender of interviewer and respondent whenever possible, and the two groups were interviewed far enough apart to ensure that one group could not overhear the conversation of the other group.

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[16] All of the research assistants had completed secondary school, three were university graduates, and four had previous field research experience.

[17] I spent each day participating in the interviews. When we started a new questionnaire, we would stager the interview start date across the villages so I could be present.

[18] All respondents spoke Chichewa fluently, although for many it was a second language.

[19] Interviewing females and males separately was based on my assumption that men and women may withhold information on some items such as income and expenditures if in the presence of their spouse. I had found this to be the case during household interviews in Senegal (Fisher et al. 2000). Two researchers in Malawi recommended gender-separate interviews for collection of certain types of information.

Interviewing male and female household residents separately proved useful as a method of triangulation.[20] I regularly checked the questionnaires of female and male household residents simultaneously. For most households, responses of female residents and male residents were in (surprisingly) good agreement.[21] When responses of female and male respondents did not correspond, we returned to the household for clarification. For example, if a wife recalled that her husband had marketed charcoal, but the husband made no mention of this, we would return to the household to ask the husband if he sold charcoal and, if he answered in the affirmative, obtain his earnings from the activity.

Much care was taken in the collection of data on income and expenditures. The data were collected quarterly to reduce the period of recall. In collecting the data we used comprehensive checklists of income/expenditure sources to aid respondent memory; this is preferable to having an "other income/expenditure" category. When income was received in kind, common for *ganyu* agricultural contract work, households were asked to estimate how much it would cost to purchase the in-kind payment.

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[20] Triangulation refers to the comparison of data across sources for the purpose of improving its validity and reliability.

[21] There was one exception. In the case of expenditures on food, the responses of male-female groups within households rarely agreed when both provided a response. Generally, only one group of household residents (almost always the male group) was able to provide estimates for expenditures on food.

Table 2.4 The Household Survey Questionnaires

Questionnaire	Contents	Timing
A	Household demographics, wood collection and end use, maize production in 1998/99	July 1999
B [a]	Wood collection and charcoal production	August 1999
B (revised) [a]	Wood collection and charcoal production	November 1999
C [b]	Food and fuel consumption	August 1999
D	Income and expenditures	Sept. 1999, Dec. 1999, March 2000, June 2000
E	Agricultural production and land holding	October 1999
F	Household assets	January 2000
G	Seed and fertilizer use, tree planting, Starter Pack	February 2000
H	Maize harvest	June 2000
I	Miscellaneous: food security, distance/time to trees	July 2000
Time Allocation [c]		Jan. and July 2000

a. Some deficiencies of Questionnaire B should be pointed out. The questionnaire was to be used quarterly and asked for recall of wood collection and charcoal production for the previous week. We soon found that this led to incomplete data because some people collected wood or produced charcoal, but not during the reference week. The revised Questionnaire B used in November asked for quantities for a "typical" year and month. The main problem is that seasonal and annual variation are not captured. Data from Questionnaire D, which should be of much better quality, were used to construct the forest extraction index used in Chapter IV.
b. Questionnaire C was problematic; mainly it required too much time. The intent had been to administer it quarterly, but I chose to drop the questionnaire due to the issue mentioned. Food security data were collected with Questionnaire I. Food and fuel consumption data were obtained from a sub-sample of households (N = 18) in January 2000 (the hungry season) and June 2000 (soon after the maize harvest).
c. January was the test run. Data used for the analysis in Chapter III are from July 2000.

The experience from a large number of household surveys is that it is easier to collect accurate data on consumption compared with income, in part because income is often viewed as a more sensitive topic than is consumption (Deaton 1997). Interestingly, compared with collection of income data, we found it difficult to collect food expenditure data. In the first two quarters, we were able to obtain food expenditure data for nearly all sample households. However, in the last two quarters male- and female-respondent groups of several households started to report that they did not know how much they spent on food. Further investigation found that people had previously made guesses to please us, but in fact it was very difficult for them to make estimates for food expenditures. The explanation relates to the fact that, for many households, purchases of food were rarely large, except the occasional purchase of a 50 kg bag of maize. Instead, households would buy a winnowing basket of maize flour and MK10 of fish one day, and on another day MK5 of vegetables, and so forth.

The timing of questionnaires was important. Some data could not be collected until later in the survey year. For example, we clearly could not ask questions about maize output for 1999/2000 until after the maize harvest period (about May in 2000). In addition, we tried, though not always with success, to ask less sensitive questions (e.g. household population) early and wait several months to ask the more sensitive questions (e.g. household assets). My hope was that, with time, the respondents would become

more trusting of us and better understand the intent of the research, therefore being more willing to disclose sensitive information.[22]

The research assistants and a colleague at the Forestry Department assisted me in determining the types of questions that would be sensitive for the cultural setting. Some of the more sensitive questions were asked on more than one occasion. In such instances the data show that respondents were more forthcoming with information in later interviews (see Table 2.5). For example, data from the household census indicate that only 17 percent of sample households knew the size of their landholding. Responses for Questionnaire E, administered four months after the census, showed that all households were able to estimate the size of their landholding.

Data on marketing of wood-based fuels also allow for early versus late comparisons. Since charcoal production/sale is illegal in Malawi and collection of wood for commercialization purposes is not allowed in state forest reserves, information on such transactions were considered sensitive. In July 1999 we asked respondents if they participate in marketing of wood or charcoal (Questionnaire A). Residents of five households claimed to sell charcoal and 15 to sell firewood, whole trees, or bamboo. By the end of the survey year we had determined that at least eight households marketed charcoal

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[22] The research assistants and I also lived in or near the research villages and participated in community events. I believe this was very important for gaining the trust, cooperation, and understanding of our respondents. In addition, after several months we began giving small gifts to express our thanks for their time. This is appropriate in the cultural context where gift giving among relatives, friends, and acquaintances is not only common, but expected. (I was frequently given gifts of eggs, fruit, and other items.) I believe gift giving is a key reason that only one sample household opted to discontinue the interviews.

and 27 sold wood. Some of our respondents began admitting they regularly sell charcoal or wood voluntarily. Other respondents admitted to sales of wood-based fuels when we confronted them on the issue; either because we had spotted them selling charcoal on the roadside, or because residents of other households named them as the persons from whom firewood was purchased.

Table 2.5 Differences Between Data Collected Earlier versus Later in the Survey Year

	Earlier Data Collection	Later Data Collection
Know size of land holding (percent) [a]	17	100
Average size of land holding in 1999 (in hectares) [a]	1.55	1.26
Sell charcoal [b]	5	8
Sell wood [b]	15	27

a. Earlier figures come from the census of households in each village (June 1999); later figures are from Questionnaire E (October 1999).
b. Earlier and later figures come from Questionnaire A (July 1999) and Questionnaire D (quarterly starting in September 1999) respectively.

The manner in which the time allocation data were collected is rather unique. Collecting such data is difficult in most settings, and this is particularly true in rural parts of developing countries where people rarely wear watches. We collected time allocation data in terms of proportion of time spent on five different categories of activities during the survey year: forest use, agricultural and livestock production, wage-work, self-employment, and domestic (this category also included school attendance). Illustrated cards with pictures of corresponding activities were used to describe each category (a local school boy did a terrific job on the drawings). For example, the forest use drawings

showed a man transporting charcoal on his bicycle, a woman brewing *masese* beer, women carrying head loads of wood in the forest, and men sawing planks. In each household interview, we set out the cards for the respondents to view. We then provided an explanation of the intent of the "game" and directions. We went through a comprehensive list of activities included in each category referring each time to the illustrations. We then divided household residents into groups based on gender, age, and whether they attended school or worked off-farm (e.g. "School Boy" or "Woman on Farm Full-Time"). Each group was asked to apportion 20 beans across the illustrations to indicate the portion of their time spent on each activity during the year. In general, it appeared that respondents really enjoyed the exercise and took it quite seriously. I observed much contemplation and discussion within groups as respondents went about placing the beans on the activity pictures. The recording sheet for the time allocation exercise is included in Appendix A and mean values are presented in Table 3.1.

Focus Group Discussions

To supplement the data obtained from the household interviews, focus group discussions (FGDs) were conducted with key informants in 15 villages adjacent to the MMFR in April 2000. The purpose of the FGDs was to obtain local perceptions about: forest resource scarcity, the causes of forest degradation, and the potential effectiveness of different forest management regimes. Appendix A contains the list of questions asked in the FGDs.

A FD extension officer assisted me in identifying the study sites which span about 20 miles along the northern end of the forest reserve. A research assistant and I then visited

these villages to meet the village heads, explain the nature of the study, and obtain permission to carry out the discussions. All of the consulted heads agreed and appointments were made for the interviews. We also asked the heads to identify key informants for the FGDs. The focus groups were very well attended, particularly after people heard that we were handing out small gifts to participants. We had many onlookers who joined in the conversations as well. I led the focus groups with a research assistant acting as translator. Key findings from the FGDs are presented in Appendix C.

Direct Measurements

Direct measurements were used to collect the following data: (1) daily food and fuel consumption during the hungry period and soon after the harvest, (2) the weight of head loads of wood, (3) the local price of firewood per kilogram, (4) quantities of wood used for several income-generating activities, and (5) conversion factors for various measurement units used to report the quantity of maize. Data collected with the measurement exercises are reported in Appendix C.

Daily Fuel and Food Consumption

In January and June of 2000 a research assistant and I directly measured the quantity of wood used for cooking meals by a sub-sample of randomly selected households in Villages 1 and 2 (N = 18). [23] January is at the height of the hungry season. June represents the more plentiful season for food as it is soon after the maize harvest –

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[23] Village 3 was not included for logistical reasons.

generally around April/May. Wood use for cooking purposes should be higher in June than January due to food availability.[24]

For each household, direct measurements were conducted as follows. The household was visited to discuss with female residents the intent of the exercise and make appointments. We asked respondents to be sure that the selected appointment day be a typical day in terms of food consumption for the given month. On the day of the scheduled appointment, we arrived at the household's residence prior to breakfast. Upon arrival, the respondent showed us the stack of firewood (or harvest residues) that she intended to use for the day's meals. We then weighed the stack of firewood or harvest residues and asked our respondent to keep track of the quantities of food consumed by household residents during the day. The next morning we returned to the household and measured the remaining wood to determine the quantity used for cooking the previous day's meals. At this time we also collected information of food consumption.

Weight of Wood Head Loads

One morning in February 2000, a research assistant and I positioned ourselves on one of the main trails women use to travel to wood collection sites in the MMFR. We had with us a scale, banana bread, cookies, and cups of water. We stopped girls and women as they approached our perch and asked if we could weigh the head loads while they rested and ate the cookies and bread. Each person we spoke with was happy to

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[24] June/July also represent the cold season in Villages 1 and 2 and households use wood for space heating. We did not include this use of wood in our measures.

participate. We weighed each head load of wood, recorded the type of wood, weighed each girl/women, and obtained their approximate age.

Local Price of Firewood

In February 2000 I spent a morning with one of the research assistants at Mwanakhu Market the largest bi-weekly market in the study area. The purpose was to meet with women marketing wood collected from the MMFR, find out the price charged per bundle of wood, and weigh the bundles to obtain the per unit price of firewood. We weighed every bundle of wood available on the day of our visit (N = 14). Each woman was given MK5 as compensation for allowing us to weigh their bundles. All women were cooperative, although one woman required considerable explanation before she would allow us to weigh her bundles of firewood.

Quantities of Wood Used for Income-Generating Activities

In May 2000 two research assistants and I weighed quantities of wood used to produce *masese* traditional beer, *kachasu* dry spirit, and wood-fired clay pots. The sample size was five for each activity. Measurements were carried out in three villages close to Village 2. In each case, we measured piles of wood prior to and after the activity. We also observed the production processes and interviewed each entrepreneur to obtain information on who (gender, age, socioeconomic status) typically engages in the given activity, costs of production, and revenues.

Conversion Rates for Maize Measurement Units

Sample household residents rarely gave their answers for the quantity of maize harvested in terms of kilograms. Local people commonly store maize either in granaries

(and do not measure the quantity placed in the granary) or in their homes in baskets of various sizes. Some people store maize (particularly hybrid maize) in 50 kilogram bags, but the actual weight of bagged maize is not 50 kilograms.

I worked with a research assistant in June 2000 to obtain conversion factors for baskets of various sizes and 50 kilogram bags. [25] Sample baskets/bags were measured with households in a village close to Village 1. It was not necessary to conduct the measurements in the sample villages as the basket sizes were the same across villages.

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[25] Time constraints prevented us from measuring the capacity of individual granaries for the sample households, the size of which varied considerably across households.

CHAPTER III – ACTIVITY CHOICE, LABOR ALLOCATION, AND FOREST USE IN MALAWI

Introduction

Increasingly, there is concern among policy makers, scientists, and the general public about tropical deforestation. In the scientific community, this is reflected by the volume of research on the subject – more than 50 publications per year on tropical deforestation since 1990, by some estimates (Rudel et al. 2000). Kaimowitz and Angelsen (1998) provide an excellent review of economic studies focused on the causes of tropical deforestation, synthesizing the results of approximately 150 studies. The authors summarized only eight farm-level regression studies, and explain this as reflecting the scarcity of household survey data required for such analyses. This suggests that there is still much to learn about the factors conditioning farm households' decisions to degrade forests in tropical countries.

This chapter examines the factors related to forest use in Malawi using the household survey data described in Chapter II. The analysis is motivated by methodological and empirical concerns. From a methodological perspective, a time allocation model is developed and estimated in which households allocate labor to four sectors: the forest, the farm, wage-work, and self-employment. The model draws upon the broader literature exploring factors related to labor supply decisions in agricultural households (Abdulai and Delgado 1999; Jacoby 1993; Rosenzweig 1980), and extends existing research by explicitly incorporating the forest as part of a household's

diversification strategy (Dasgupta 1993). From an empirical standpoint, a distinctive feature of the analysis is the inclusion of multiple sources of forest degradation. Forest degradation occurs not only when forest is cleared for agricultural expansion but also when households extract forest products at a level exceeding sustainable yield. Yet the existing literature has tended to focus either on forest clearing (e.g. Coxhead et al. 2002; Godoy et al. 1998; Shively 2001) or on firewood collection (e.g. Amacher et al.1996; Heltberg et al. 2000). By including data on a variety of forest-based activities, the analysis provides a comprehensive assessment of factors leading to forest decline. Estimating the labor share equations jointly provides a theoretically consistent treatment that leads to economic and policy insights obscured by a single-equation approach to studying forest use.

Activity Choice and Forest Use in the Study Area

The analysis of the chapter uses the household survey described in Chapter II. Table 3.1 presents data on household labor allocation. Households in the study villages generally consider themselves maize farmers (maize/cassava farmers in the case of Village 2), and farming occupied the majority of household members' time during the survey period. Data in Table 3.1 also document the sample households' heavy reliance on forests. Without exception, the sample households depend on forests for basic needs – food, fuel, shelter, and health. Observed differences in forest use across the study sites are illustrated in Table 3.2. For example, although all households used firewood for household energy needs, the main household energy source in Village 2 was harvest residues. This reliance may indicate a response to physical scarcity, but more likely

reflects availability of harvest residues at a low cost since cassava (an important crop in Village 2) produces considerable biomass. Wood purchasing was most common in Village 2, where wood was either purchased in Mozambique or within the village.

Table 3.1 Labor Shares by Activity and Village, Sample Households 1999/2000 [a]

Activity	Village 1	Village 2	Village 3	All Villages
Forest use [b] (L_F)	0.32 (0.16)	0.23 (0.07)	0.28 (0.13)	0.27 (0.13)
Agriculture [c] (L_M)	0.55 (0.17)	0.59 (0.15)	0.55 (0.15)	0.56 (0.16)
Wage-work [d] (L_E)	0.08 (0.09)	0.06 (0.07)	0.13 (0.16)	0.08 (0.11)
Self-employment [e] (L_S)	0.05 (0.15)	0.13 (0.14)	0.04 (0.09)	0.08 (0.14)
Number of observations (N)	39	38	22	99

a. Standard deviation in parentheses.
b. Forest activities include forest clearing, firewood collection for home use, and participation in forest-dependent income generating activities (IGAs). Forest IGAs include: (1) employment as pit-sawyers or plank carriers, (2) raw wood and charcoal marketing, (3) sales of food/drink prepared with wood as a key input, e.g. *masese* traditional beer, (4) sales of fired bricks and roof thatching, (5) sales of certain crafts, e.g. wood-fired clay pots, and (6) traditional medicine.
c. Agricultural activities include crop cultivation, livestock production, agricultural marketing.
d. Wage-work includes non-forest off-farm employment: contract agricultural labor, forestry officer, teacher, mechanic, and village head.
e. Self-employment includes non forest-based businesses: resale of agricultural commodities, tailor, money lending, sales of fish, grocery sales, public transport operation, repair, tinsmith, and stone breaking.

Table 3.2 Forest Use, Sample Households 1999/2000

Activity	Village 1	Village 2	Village 3	All Villages
Main cooking fuel is wood (%)	100	18	100	69
Quantity wood collected (kg) [a]	2,128	1,141	3,354	2,267
Cleared forest (%)	3	0	50	12
Area cleared (ha)	0.30	----	0.26	0.26
Purchased wood (%)	18	63	36	39
Sold wood (%)	18	26	45	27
Sold charcoal (%)	0	0	36	8
Planted trees in past 5 yrs (%)	31	71	64	54
Number of trees planted	10	9	19	12

a. These figures come from Questionnaire B. Due to missing observations for this variable, the number of observations used to compute the village averages were: Village 1 (N = 25) and Village 2 (N = 18). There were no missing observations for this variable for Village 3.

A Household Model of Labor Allocation

Conceptual Framework

To investigate factors related to forest use, a household model of labor allocation is developed. The model draws upon the economic theory of farm households (Singh et al. 1986) and empirical studies of household labor allocation in developing countries (Abdulai and Delgado 1999; Jacoby 1993; Rosenzweig 1980). It explicitly accounts for the fact that farm households in Malawi are both producers and consumers of agricultural

and forest goods, and that markets for key factors and products are weak or absent. As a result, production decisions are influenced by consumption needs, so that production and consumption decisions in the model are assumed to be made jointly in response to changes in input and output prices.

Households are assumed to allocate family labor across four major categories of activities: maize production (L_M), forest use (L_F), wage-work (L_W), and self-employment (L_S). The household seeks to maximize household utility:

$$\max_{L_M, L_F, L_W, L_S, X} U = U(M, F, O, L_L; H) \tag{1}$$

where utility is derived from consumption of a representative staple crop – maize (M), a composite forest product (F), leisure (L_L), and other goods (O).[26] Household and individual characteristics ($\boldsymbol{H}$) are assumed to influence preferences. Utility is maximized subject to production functions for maize and forest products, a full income constraint, a time constraint, and non-negativity constraints:

$$Q_M = Q_M[L_M, X, A_0, A_1(L_F; K, I)] \tag{2}$$

$$Q_F = A_1(L_F; K, I) + f(L_F; K) \tag{3}$$

$$Y = p_M(Q_M - M) + p_F(Q_F - F) + p_W L_W + p_S L_S + R^* - p_O O - p_X X \tag{4}$$

$$T - L_L = L_M + L_F + L_W + L_S \tag{5}$$

$$F, M, O, X, Q_F, Q_M, L_F, L_M, L_W, L_S \geq 0 \tag{6}$$

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[26] Maize, the staple crop in Malawi, accounts for 85 percent of total cropland. It is often grown in rotation or association with legumes and other crops (Blackie et al. 1998).

Equation (2) describes smallholder production of maize, which is assumed to be a function of labor (L_M), purchased inputs such as fertilizer and seed (X), the household's land endowment (A_0), and additional land acquired through land clearing, represented by function $A_1(\bullet)$. Cultivated area is endogenously determined. Note that maize production can occur either through intensification (via X) or extensification (via $A_1(\bullet)$) or both. Although customary land ownership implies that land markets are generally absent in much of rural Malawi, land can be "purchased" by using labor (L_F) and capital (K), e.g. an ax, to clear uncultivated and possibly forested land (Barrett 1999). The existence of forest management institutions (I) also enters as an argument in A_1, reflecting the potential for institutions to restrain forest clearing. Equation (3) describes production of forest goods. Production function $A_1(\bullet)$ illustrates that when forest is cleared for agricultural expansion, forest products arise as a joint product.

Technology $f(\bullet)$ describes forest "thinning" activities in which household labor is used to extract products from the forest, but land is not cleared in the process.[27] Note that the existence of forest management institutions (I) appears as an argument in $A_1(\bullet)$ but not in $f(\bullet)$. This is consistent with patterns of forest management in the study area, which tend to be more effective at restraining forest clearing than limiting collection of forest products.

Equation (4) defines the household's full income. Prices and net hourly returns to labor are denoted by a vector of prices $\boldsymbol{p}$. Households earn income from four sources:

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[27] Over time, forest "thinning" may increase the probability of forest clearing, as thinning in the presence of population growth reduces the value of standing forest.

agriculture, forest use, wage-work, and self-employment. Households also receive remittances (R^*), defined here as money received from relatives. Households make expenditures on maize (M), forest products (F), other goods (O), and agricultural inputs (X). A positive (negative) sign for (Q_M-M) and (Q_F-F) indicates the household is a net seller (net buyer) of maize and forest products. Equation (5) describes the household's time constraint. A set of non-negativity constraints (6) completes the model.

Two important assumptions in the model should be noted. One, it is assumed that households sell but do not hire labor. Two, by assumption households do not engage in production of cash crops—beyond sales of surplus maize. While these assumptions are strong, and not appropriate in the context of rural Malawi as a whole, they are reasonable within the context of the sample. Most sample households are net purchasers of food, constrained in both cash and maize and thereby rarely able to hire labor (often paid either with cash or maize). Only a few sample households engaged in cash crop production during the sample period, partly because tobacco, Malawi's main cash crop, has historically been produced outside the study area.

The Lagrangian for the household's maximization problem is:

$$\begin{aligned}\mathcal{L} &= U(M,F,O,T-L_M-L_F-L_W-L_S;H) \\ &\quad -\lambda\begin{bmatrix} Y-p_M\{Q_M[L_M,X,A_0,A_1(L_F;K,I)]-M\} \\ -p_F\{[A_1(L_F;K,I)+f(L_F;K)]-F\} \\ -p_W L_W-p_S L_S-R^*+p_O O+p_x X \end{bmatrix}\end{aligned} \tag{7}$$

After rearranging terms, first-order conditions can be expressed as:

$$\frac{\partial U}{\partial L_M}=\lambda p_M\frac{\partial Q_M}{\partial L_M} \tag{8a}$$

$$\frac{\partial U}{\partial L_F} = \lambda p_M \frac{\partial Q_M}{\partial A_1}\frac{\partial A_1}{\partial L_F} + \lambda p_F \frac{\partial A_1}{\partial L_F} + \lambda p_F \frac{\partial f}{\partial L_F} \tag{8b}$$

$$\frac{\partial U}{\partial L_W} = \lambda p_W \tag{8c}$$

$$\frac{\partial U}{\partial L_S} = \lambda p_S \tag{8d}$$

$$p_M \frac{\partial Q_M}{\partial X} = p_X \tag{8e}$$

$$\frac{\partial U}{\partial M} = \lambda p_M \tag{8f}$$

$$\frac{\partial U}{\partial F} = \lambda p_F \tag{8g}$$

$$\frac{\partial U}{\partial O} = \lambda p_O \tag{8h}$$

$$Y = p_M (Q_M - M) + p_F (Q_F - F) + p_W L_W + p_S L_S + R^* - p_O O - p_X X \tag{8i}$$

Equations (8a) through (8d) indicate that, at the optimum, households allocate labor across activities so as to equate the marginal value of household leisure with that of time spent on each productive activity, that is, with the marginal product of or net hourly returns to labor. Equations (8e) through (8h) equate marginal values with prices. Equation (8i) recovers the full income constraint.

Expressions for labor supply, input demand, and commodity demand can be derived as functions of all exogenous variables:

$$\left.\begin{matrix} L_M \\ L_F \\ L_W \\ L_S \end{matrix}\right\} = g(p_M, p_F, p_W, p_S, A_0, H, K, I, T). \tag{9}$$

Properties of Labor Supply

Below I seek to identify empirically the factors that condition labor allocation and directly or indirectly impact forest use. Before proceeding to the empirical analysis, properties of the labor supply equations are examined. To begin, consider the Slutsky equation giving the effect on the forest labor share of a change in the net hourly returns to wage-work.

$$\frac{\partial L_F}{\partial p_W} = \left.\frac{\partial L_F}{\partial p_W}\right|_{U=\overline{U}} + \frac{\partial L_F}{\partial Y} L_W . \tag{10}$$

The first term on the right-hand side of equation (10) is a substitution effect and is unambiguously non-positive. The second term is an income effect. While L_W is non-negative, the sign of $\partial L_F / \partial Y$ may be positive or negative. With rising income, the demand for leisure (L_L) should increase if leisure is a normal good, but for the same reason the demand for forest products (F) should also increase. More leisure should mean a lower forest labor share. However, higher consumption of forest products could imply an increase in the forest labor share. This would be the case, for example, if the household collected rather than bought additional forest goods. Such behavior might be expected for a household that is a net seller of forest products. In sum, the net effect of a change in the returns to wage-work on the forest labor share is ambiguous. A negative relationship, whereby higher wages reduce forest pressure, is plausible and could arise under several different scenarios: if forest products are inferior goods, if forest products are normal goods but the income-induced demand for leisure outweighs that for forest products, if forest products are normal goods but the household buys rather than collects forest products, or if a negative substitution effect dominates a positive income effect. A

positive relationship between p_W and L_F could arise if the income-induced demand for forest goods outweighs that for leisure, the household is a net seller of forest goods, and the income effect dominates the substitution effect. The analysis of returns to self-employment is analogous.

The Slutsky equation describing the impact of a change in the price of maize on the forest labor share is:

$$\frac{\partial L_F}{\partial p_M} = \left.\frac{\partial L_F}{\partial p_M}\right|_{U=\overline{U}} + \frac{\partial L_F}{\partial Y}(Q_M - M), \tag{11}$$

where, as above, the first and second terms represent substitution and income effects. The substitution effect may be positive or negative. Assume first that households do not clear forest land for maize production. Households should then respond to a rising maize price by allocating more labor to maize production and less to other activities, either (for net sellers of maize) in pursuit of profits or (for net buyers of maize) to avoid having to purchase maize at the now higher price. This implies a negative substitution effect. However, some net buyers might increase labor allocated to both maize production *and* to the forest, particularly if the forest is open-access, forest land is available, and households opt to clear forest to expand maize production. This would indicate a positive substitution effect. Thus, a priori the substitution effect is of ambiguous sign. Turning to the income effect, the term $\partial L_F / \partial Y$ may be positive or negative depending on the relative demand for leisure and forest products and whether the household is a net seller of forest goods. Term (Q_M-M) is also indeterminate, being positive for net sellers of maize and negative for net buyers. In sum, the net effect of an increase in the price of maize on the forest labor share is ambiguous. Van Soest et al. (2002) similarly show that the effect of

an increase in the price of agricultural output on forest clearing is indeterminate. In their case, the result is a reflection of a negative substitution effect and a positive income effect. In the case here, the substitution effect and the income effect are both indeterminate. The sign of these effects and, subsequently, the net effect of an increase in the price of maize on the forest labor share depends on the factors highlighted above.

Finally, the response of the forest labor share to changes in the price of forest products can be found via the relevant Slutsky decomposition:

$$\frac{\partial L_F}{\partial p_F} = \left.\frac{\partial L_F}{\partial p_F}\right|_{U=\bar{U}} + \frac{\partial L_F}{\partial Y}(Q_F - F) \tag{12}$$

The substitution effect in (12) is positive as a higher price of forest goods implies increased net benefits of forest exploitation.[28] The income effect is again indeterminate. The sign of $\partial L_F / \partial Y$ depends on the relative demand for leisure and forest products and whether the household is a net seller of forest goods. Term (Q_F - F) is positive for net sellers of forest products and negative for net buyers. The income effect therefore is positive for net buyers of forest products because both $\partial L_F / \partial Y$ and (Q_F - F) are negative. For net sellers of forest products, the income effect is positive if the demand for forest goods outweighs that for leisure and negative if households opt for relatively more leisure when income rises. The net effect of a change in the price of forest goods on the forest labor share is thus ambiguous, depending on the conditioning factors highlighted above.

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[28] If households had secure rights over forest resources, which they do not, higher p_F would mean higher current and future values of land and the effect on L_F today would be indeterminate.

The foregoing analysis reveals ambiguous relationships between the forest labor share and the returns to villagers' activities. In contrast, several analytical models of tropical forest decline posit a positive relationship between agricultural output prices and deforestation, and a negative relationship between off-farm wages and deforestation. For a review of studies, see Kaimowitz and Angelsen (1998). Why does the model give indeterminate results for every price variable? First, the model is non-separable, permitting both income and substitution effects. These effects often have opposite signs, and either effect can dominate the other (van Soest et al. 2002). Second, net buyers of maize or forest products respond differently to changing prices than do net sellers of these goods (Barrett 1999). Third, because households purchase additional land with labor alone, even substitution effects can be indeterminate, leading to the possibility that the forest labor share could rise or fall in response to a change in the price of maize.

Below I focus on development and implementation of an econometric model to investigate the factors associated with forest labor allocation. In so doing, I take labor shares as the dependent variables, asking how changes in household characteristics and key policy variables directly and indirectly influence rates of forest use.

Empirical Model

The empirical model is a system of four, jointly estimated labor share equations in which each labor share is a function of variables indicated in the household model. These explanatory variables include returns to labor, farm size, household and individual

characteristics, capital, and forest management institutions.[29] Table 3.3 provides definitions and descriptive statistics of the explanatory variables. Note that the price of maize is observed only in households that marketed maize, and net hourly returns are observed only in households engaging in activities. Although a household may not participate in a given activity, it still faces an opportunity price in that sector. Leaving such observations out of the share equations would bias the results. As a result, where prices and net hourly returns are missing they are imputed using sub-sample ordinary least squares (OLS). The imputation procedure is described in detail in Appendix B.[30]

Using subscripts *i* and *j* to represent maize, forests, wage-work, and self-employment, the labor share equations take the general form:

$$L_i = \alpha_i + \sum_j \beta_{ij} LOG(p_j) + \sum_k \delta_{ik} H_k + \gamma_i I + \varepsilon_i \qquad (13)$$

where vector $\boldsymbol{H_k}$ represents household characteristics and *I* represents a binary, village-level variable indicating the absence (0) or presence (1) of a forest management regime. The selection of $\boldsymbol{H}$ variables is consistent with previous econometric studies of tropical deforestation (Amacher et al. 1996; Coxhead et al. 2002; Godoy et al. 1998; Heltberg et al. 2000; Pichon 1997; Shively 2001). The model is non-separable and theory provides little guidance on exclusion restrictions for explanatory variables. As a result, each labor share regression has identical sets of exogenous variables.

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[29] The system includes total labor endowment (T). Since dependent variables are labor shares, T is unity for all households and therefore excluded from the regressions.

[30] This approach is practical, but not without shortcomings. Most important, one cannot be certain that predicted prices are true reflections of reservation prices. See Heltberg et al. 2000 and Chen and Lee 1998.

Table 3.3 Data Definitions and Descriptive Statistics, 1999/2000

	Variable Definition	Mean or Frequency (Stand. Dev.)
p_M	The producer price of maize (MK/kg); values imputed for 72 observations	3.64 (0.79)
p_F	Net hourly returns to forest activities (MK/hour); values imputed for 25 observations	1.70 (2.10)
p_W	The wage-work wage (MK/hour); values imputed for 41 observations	2.52 (3.21)
p_S	Net hourly returns for self-employment activities (MK/hour); values imputed for 58 observations	2.49 (2.70)
AGE [a]	Age of the household head by category (1=15 to 24 years; 2=25 to 34; 3=35 to 44; 4= 45 plus)	----
AGESQ	AGE squared	----
HRCKG	The main household cooking fuel is harvest residues (0=No, 1=Yes)	0.31
IRON	Number of household dwelling units with an iron sheet roof	0.15 (0.46)
PCFSIZE	Area of the household's agricultural land holding divided by household population (ha/person)	0.33 (0.31)
PCTREE	Number of trees planted on household's land holding in the past five years divided by household population	2.89 (6.04)
VILL3	Village 3 residence (0=No, 1=Yes)	0.22

a. Age is categorical because respondents generally were not aware of their age. Our approach was to refer to a list of historical events and then estimate the age of the head based on her/his responses concerning whether she/he was alive and what she/he was doing the year of the important event.

To reiterate, the four dependent variables (L_i) are labor shares allocated to the forest, the farm, wage-work, and self-employment. The labor share model is similar to standard models of commodity or factor demand, such as the almost ideal demand system (AIDS). As in an AIDS model, parameters of the labor share system are constrained

across equations. By construction, observed labor shares sum to one. In order to ensure that predicted labor shares also sum to one, the following constraints are imposed:

$$\sum_j \beta_{ij} = 0 \tag{14a}$$

$$\sum_i \delta_{ik} = 0, \quad \sum_i \beta_{ij} = 0 \text{ and } \quad \sum_i \gamma_i = 0 \tag{14b}$$

$$\sum_i \varepsilon_i = 0 \tag{14c}$$

$$\alpha_M + \alpha_F + \alpha_E + \alpha_S = 1. \tag{14d}$$

Homogeneity restriction (14a) requires that a given labor share be invariant to proportional changes in all prices. Constraint (14b) requires that the individual effects of changes in explanatory variables on labor allocation be offsetting, and therefore that the net effect of a change in a given explanatory variable on labor allocation be zero. Constraint (14c) indicates that, for each observation, error terms across equations are linearly dependent. Constraint (14d), combined with the so-called adding-up restrictions, ensures that the estimated labor shares sum to one. With all constraints imposed, the econometric model reflects the fact that labor allocation decisions are related across activities. To impose the restrictions, I divide the price of maize, the returns to forest goods, and the returns to wage-work by the returns to self-employment. The self-employment equation is dropped to avoid singularity of the disturbance covariance matrix. The system of labor share equations is estimated using constrained maximum likelihood (ML). This approach ensures that outcomes are invariant to the choice of which equation is dropped (Greene 2000).

Estimating equations follow the form:

$$L_i = \alpha_i + \sum_j \beta_{ij} LOG(p_j / p_s) + \sum_k \delta_{ik} H_k + \gamma_i I + \varepsilon_i \quad (15)$$

where i, j = maize, forest, wage-work. In addition to homogeneity and adding-up restrictions, I impose three restrictions for symmetry of cross-price effects.

$$\beta_{ij} = \beta_{ji} \text{ for } \forall\, i, j. \quad (16)$$

In quantity-dependent demand models the symmetry restriction follows from economic theory. In the labor-share model symmetry is not required, and therefore it is important to investigate symmetry in the system of shares via testing.

Results and Discussion

Regression results for the system of four share equations are presented in Table 3.4. The calculated *F*-statistic of 255.48 is significant at the 95% confidence level, providing support for a hypothesis of joint significance of the explanatory variables. Mean observed and predicted labor shares are reported at the bottom of Table 3.4 for comparative purposes.[31] Parameter estimates for the forest, maize, and wage-work equations were obtained directly from the constrained ML estimation. Parameters of the self-employment equation were calculated from the adding-up restrictions. A likelihood ratio (LR) statistic is used to test the symmetry restrictions. The 95% chi-square test

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[31] Constraints (14a) through (14d) ensure that the predicted labor shares sum to one, but do not ensure that predicted values for individual labor shares fall within the (0, 1) range. For all observations, predicted labor shares for forest and maize fall within bounds. Predicted labor shares fall below zero for two wage-work observations and eight self-employment observations.

statistic for three restrictions is 7.81, which exceeds the calculated LR statistic of 3.76. Since the LR is less than the critical chi-square, the null hypothesis of symmetry cannot be rejected. To test the homogeneity and adding-up restrictions, a Wald test is used. The calculated Wald statistic is 85.95. The 95% chi-square test statistic for a model with 12 restrictions is 21.03. Thus, the joint null hypothesis of homogeneity and adding-up is rejected. Although this suggests the data may be inconsistent with the restrictions, it is also possible that the rejection reflects the tendency of the Wald test to over-reject true null hypotheses in small samples (Laitinen 1978).

Table 3.4 includes results for each labor share equation. However, the discussion focuses on results of importance to the forest labor share equation. Six of the point estimates for variables in the forest labor share equation are individually different from zero at a 90% confidence level. The positive sign on returns to forestry in the forest labor share equation indicates that households that obtain higher returns to forest use allocate a greater share of household labor to the forest. This finding is consistent with other studies in the tropical deforestation literature (e.g. Amacher et al. 1996) and provides insight into the Slutsky decomposition for $\partial L_F/\partial p_F$. Importantly, the positive sign could indicate that the positive substitution effect dominates a negative income effect, or that both effects are positive. Under what circumstances would the income effect be positive? One reasonable assumption is that the majority of sample households are either self-sufficient or net sellers of forest products. In such a case, households with extra cash on

hand would most likely use the cash to buy food rather than forest goods.[32] Under this net seller assumption, a positive income effect means the demand for forest products outweighs the demand for leisure. This seems extremely plausible for very poor households, such as those in the sample. Given that food insecurity is widespread throughout southern Malawi (and the sample), with a hungry season that by some accounts averages six months of the year (Stolz 2000), it seems probable that households experiencing a small income rise would opt for more food (and then collect firewood to cook the food) rather than consume leisure.

Findings show a negative association between returns to maize and the forest labor share. What might this result reveal about the Slutsky decomposition for $\partial L_F / \partial p_M$? Recall that the substitution and the income effect is of ambiguous sign. The sign of the substitution effect is of particular interest as it can provide an indication of whether sample households respond to increased maize profitability by expanding production at the intensive and/or extensive margin. However, no plausible assumptions allow one to sign the substitution effect. Furthermore, the tropical deforestation literature remains inconclusive regarding the relationship between agricultural output prices and forest clearing (Kaimowitz and Angelsen 1998). The income effect is more easily signed. Two plausible assumptions mentioned earlier are: (i) most sample households are net sellers of forest products and (ii) the demand for forest products outweighs the

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[32] Although the number of sample households reporting purchases of forest products is greater than that reporting sales (see Table 3.2) the number of households selling wood is likely underestimated in the sample since sales of wood taken from the commons or state forest reserve are prohibited in Villages 1 and 2.

demand for leisure. Taken together these assumptions imply a positive sign for $\partial L_F / \partial Y$. It is also reasonable to assume a negative sign for (Q_M - M) since the majority of smallholder farm households in Malawi are net buyers of maize in any given year (Peters 1996; Kandoole and Msukwa 1992). If the three foregoing assumptions are valid, the income effect should be negative. A negative income effect reflects the fact that a higher maize price reduces maize purchasing power for net buyers of maize. With less maize to cook, firewood requirements are lower. This reduces the time spent collecting firewood. With a negative income effect, the negative sign of $\partial L_F / \partial p_M$ could arise either in the case of a negative substitution effect or a positive substitution effect that is outweighed by the negative income effect, both of which are plausible.

Wages are negatively correlated with the forest labor share, consistent with patterns reported in Nepal (Bluffstone 1995) and the Philippines (Shively 2001). Recall that a negative sign for $\partial L_F / \partial p_W$ implies one of four possibilities: (i) forest products are inferior goods, (ii) forest products are normal goods but the income-induced demand for leisure outweighs that for forest products, (iii) forest products are normal goods but the household buys rather than collects forest products, or (iv) a negative substitution effect dominates a positive income effect. Of these possibilities, most plausible in the sample is that the substitution effect dominates the income effect, yielding a negative sign for $\partial L_F / \partial p_W$. It is unlikely that forest products are inferior goods in rural Malawi, where firewood is the dominant fuel for households of various income levels (GOM 1998). Likewise, it is unlikely that an income-induced demand for leisure outweighs that for

forest products or that households experiencing increased income opt to buy rather than collect forest products, for reasons outlined in the discussion of $\partial L_F / \partial p_F$ above.

Table 3.4 Constrained MLE Results for the System of Labor Share Equations [a]

	Forest Labor Share	Maize Labor Share	Wage-work Labor Share	Self-employment Labor Share
Constant	*** 0.4927	0.2623	0.1558	0.0892
	(0.1424)	(0.1812)	(0.1230)	(0.1500)
Log(p_F)	*** 0.0300	* -0.0171	** -0.0138	0.0009
	(0.0096)	(0.0104)	(0.0072)	(0.0077)
Log(p_M)	* -0.0171	* 0.0321	-0.0063	-0.0086
	(0.0104)	(0.0186)	(0.0104)	(0.0124)
Log(p_W)	** -0.0138	-0.0063	** 0.0242	-0.0041
	(0.0072)	(0.0104)	(0.0111)	(0.0086)
Log(p_S)	0.0009	-0.0086	-0.0041	0.0118
	(0.0077)	(0.0124)	(0.0086)	(0.0124)
AGE	-0.1151	0.0795	0.0017	0.0339
	(0.1052)	(0.1339)	(0.0902)	(0.1110)
AGESQ	0.0223	-0.0039	-0.0051	-0.0133
	(0.0183)	(0.0234)	(0.0157)	(0.0194)
HRCKG	*** -0.0813	** 0.0907	** -0.0610	* 0.0516
	(0.0285)	(0.0376)	(0.0253)	(0.0318)
IRON	** -0.0569	* -0.0655	* 0.0405	*** 0.0819
	(0.0267)	(0.0342)	(0.0236)	(0.0292)
PCFSIZE	-0.0506	0.0304	-0.0211	0.0413
	(0.0383)	(0.0495)	(0.0335)	(0.0424)
PCTREE	*** -0.0062	0.0020	* -0.0027	*** 0.0069
	(0.0019)	(0.0024)	(0.0016)	(0.0020)
VILL3	-0.0119	0.0443	0.0336	** -0.0659
	(0.0303)	(0.0385)	(0.0261)	(0.0323)
N	99	99	99	99
Predicted	0.2740	0.5640	0.0825	0.0795
Observed	0.2740	0.5640	0.0825	0.0795
F-statistic	255.48			

a. Standard errors in parentheses.

*, **, and *** imply significance at the 0.10, 0.05 and 0.01 probability levels respectively.

The allocation of household labor may change over the life cycle of the household head (Godoy et al. 1998). To assess the extent to which forest labor allocation changes over the demographic cycle, age of the household head (AGE) and the head's age squared (AGESQ) were included in the model. There is no statistical support for a hypothesis that age affects labor allocations.

Other things equal, households that primarily use harvest residues for cooking (HRCKG) spend a smaller proportion of their time in forests. [33] All of the sampled households in Villages 1 and 3 use firewood as the dominant cooking fuel, while 72 percent of households in Village 2 reported harvest residues as the main cooking fuel. The magnitude of the HRCKG variable indicates that households which use harvest residues as the primary cooking fuel spent 435 fewer hours in the forest in 1999/2000 compared with those who cook mainly with wood. Using data on quantity of wood collected per hour from another survey in rural Malawi (Brouwer et al. 1997, Table 5), 435 hours translates into about 2,010 kilograms of wood. It is clear from these results that appropriate substitutes for wood for cooking can reduce forest pressure, although the indirect and long-term soil fertility effects of removing crop residues remain unexplored here, and potentially important.

Studies from a number of tropical countries suggest a positive correlation between poverty and dependence on forest resources for livelihoods (for a review see Neumann and Hirsch 2000). To examine this potential link in the context of Malawi, two indicators

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[33] HRCKG is likely endogenous to labor supply decisions. Unfortunately, suitable instruments are not available. Future work to resolve this issue is planned.

of economic well-being were included: holdings of productive capital (land) and of non-productive capital (iron roof). In rural Malawi, land holding size per capita (PCFSIZE) provides a good indication of a household's level of food security (Peters 1996). And an iron sheet roof (IRON) is a key non-productive wealth holding in southern Malawi. [34] The landholding variable (PCFSIZE) has the hypothesized negative sign in the forest labor share equation but is statistically weak. If iron sheet roofs serves well as a wealth proxy, the negative sign on the coefficient estimate may be suggestive of the poverty-environment links widely discussed in the literature (e.g. Duraiappah 1998; Perrings 1989; Takasaki et al. 2000; Zwane 2002). Taken together with the statistically significant results in the other share equations, the findings indicate that wealthy households (proxied by IRON) in the sample allocate a lower proportion of household labor to the forest and the farm and a higher share to wage-work and self-employment. [35] That said, the picture of overall demand for forest products remains unclear. A detailed survey of environmental resource use in Zimbabwe found that poor households depended on these resources more than did rich households, but that aggregate demand for environmental resources was greater among rich households (Cavendish 2000).

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[34] Chapter V focuses on household welfare and forest dependence. The chapter provides a thorough discussion of the potential reasons why the poor may be more dependent on forests for livelihoods.

[35] While the discussion suggests that wealth endowments condition activity choice, it could also be argued that activity choice is a determinant of wealth accumulation. Although wealth is usually endogenous to wages, endogeneity may be less of an issue for the sample data since iron sheet roof ownership is observed prior to the labor allocation decision.

In Malawi, the incorporation of trees in the agricultural landscape is widely practiced (Dewees 1995). Households with trees on their fields or homesteads should require less time to collect wood and other forest products, reducing the forest labor share and freeing up labor for other activities. Findings here suggest a negative correlation between tree planting on private land (PCTREE) and the forest labor share. For the average household, the planting of an additional tree per household resident is associated with 33 fewer hours spent in the forest in 1999/2000. Using figures from Brouwer et al. (1997) the 33 hours represent about 153 kilograms of forest biomass per household.

Finally, to assess the extent to which forest management regimes reduce forest exploitation at the study sites, the regressions included a binary variable indicating Village 3 residence (VILL3). Other studies of tropical deforestation have found that effective management institutions can serve as a restraint on forest exploitation (e.g. Heltberg et al. 2000). Observations during the survey year suggest that existing forest management institutions in Villages 1 and 2 were largely ineffective in restraining forest use with the exception of only two activities: charcoal production and forest clearing. The lack of statistical significance of VILL3 may be consistent with observations at the study sites, as it indicates that there is no systematic difference in forest use between Village 3 and the other two villages. However, VILL3 is an indicator of differences across space, of which there may be many sources.

Chapter Summary

This chapter examined the factors related to forest exploitation in rural Malawi by jointly estimating a system of four labor share equations for forest use, maize production,

wage-work, and self-employment. From a methodological standpoint, the novelty of the study is the use of a systems approach. Alternatively, a single-equation Tobit model of forest labor allocation could have been estimated. However, a systems approach more closely corresponds to theory, as forest use is one of several livelihood strategies simultaneously undertaken by households located at forest margins. Systems approaches reveal relationships among these often-competing livelihood activities. For example, forest use and wage-work are found to be substitute activities. A higher price for forest commercialization increases the forest labor share and simultaneously reduces the wage-work share. Likewise, as returns to wage-work rise, households devote a greater share of their labor to wage-work and a lower share to forests. Importantly, the results indicate that as returns to maize production rise, households spend more time on farm and less time in the forest. Participation in self-employment also appears to substitute for forest use. The empirical finding that self-employment serves as a substitute for forest use is new. Importantly, it suggests that the self-employment sector, similar to the wage-work sector, can absorb labor that might otherwise be engaged in forest exploitation. Findings show that relatively "wealthy" households (those with iron sheet roofs) devote a lower share of labor to the forest and a higher share to self-employment. Households that plant trees on farm and cook mainly with harvest residues also spend less time in the forest and more time on self-employment.

CHAPTER IV – DO TROPICAL FORESTS PROVIDE A SAFETY NET? INCOME SHOCKS AND FOREST EXTRACTION IN MALAWI

Introduction

In rural parts of low-income countries income and consumption risk is pervasive among the poor. Unfortunately, markets that serve to mitigate income shocks – such as those for insurance and credit – are generally absent, ill functioning, or inaccessible to the most vulnerable groups. The implications of these stylized facts for household decision-making and human welfare has been a central theme of recent scholarship in the development economics literature. Research has pointed to the potential negative consequences of adverse income shocks to nutrition and health status (Foster 1995; Sahn 1989) and excess mortality (Rose 1999). More optimistically, a variety of coping mechanisms often emerge to protect consumption when households experience idiosyncratic or covariate shocks. Examples of such mechanisms include precautionary saving of grain, livestock, and financial assets (Paxson 1992; Udry 1995), borrowing in informal credit markets (Besley 1995; Udry 1994), remittances from family members or relatives residing elsewhere (Rosenzweig 1988), and reallocation of household labor from the family farm to the wage labor market (Kochar 1999; Rose 2001).

In the literature, the use of household assets for coping with income shocks has received much attention (Deaton 1992; Fafchamps et al. 1998; Paxson 1992; Rosenzweig and Wolpin 1993; Udry 1995). When borrowing is difficult or impossible, there are strong incentives for precautionary saving – building up assets that can be drawn down in

difficult times. Studies in African countries indicate that livestock are a key asset used by rural households to protect consumption in difficult times (Dercon 1998; Fafchamps et al. 1998; Kinsey 1998). These studies also show that this shock-coping mechanism is less accessible for the very poor.[36] In Malawi, 26 and 40 percent of rural households in the bottom and top income quintile own livestock (cattle, goats, and sheep) respectively, according to the Integrated Household Survey (IHS) 1997/98 (Poverty Monitoring System 2001). The same survey indicates limited access to formal and informal credit sources for consumption smoothing purposes. Thus, coping mechanisms, such as livestock purchases/sales or credit market transactions, may be less available for very poor households in rural Malawi.

The central hypothesis of this chapter is that one way poor households in rural Malawi cope with adverse shocks is by temporarily increasing forest extraction to earn money to buy food. Empirical evidence from tropical countries shows that rural households, particularly the poorest households, depend on natural resource extraction to secure their livelihoods (Neumann and Hirsch 2000). It has often been said that forest resources provide the rural poor with a safety net (Byron and Arnold 1999; Warner 2000). Two econometric analyses have investigated this issue in the Peruvian (Pattanayak and Sills 1999) and Brazilian Amazon (Takasaki et al. 2002).

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[36] "Shock-coping mechanism" is here distinguished from "risk-coping mechanism". The former refers to actions taken by households to protect consumption when they experience income shortfalls. The latter term refers to those mechanisms used to cope with risk ex ante, for example crop diversification.

Pattanayak and Sills (1999) estimated Negative Binomial count models and a Tobit model of household forest collection behavior (N = 325). The dependent variables were reported and imputed number of forest collection trips and time spent on forest collection during the year. The empirical model included a measure of risk (the coefficient of variation of households' reported manioc output of previous years) and a shock variable (household reported agricultural production shortfall). The study found a positive association between the measure of risk and the number of forest collection trips. Results also showed a positive association between reported agricultural shortfall and forest collection.

Takasaki et al. (2002) examined several strategies used by Peruvian smallholders (N = 300) to cope with covariate and idiosyncratic income shocks. These shock-coping strategies included forest product gathering and fishing. They found that forest product gathering was important for coping with covariate flood shocks, with 22 percent of sample households reporting gathering as a coping mechanism. Using a two-stage Tobit model, they also found that those households employing natural resource extraction to cope with covariate flood shock tended to be those possessing relatively few physical assets and having relatively more adult household members. The findings of Pattanayak and Sills (1999) and Takasaki et al. (2002) provide evidence that in some tropical areas poor households use forests to cope with risk ex ante and shocks ex post.

Several characteristics of tropical forests help explain why poor rural households may rely on forests to cope with negative income shocks. Forests in low-income areas are often held under state or communal tenure with forest resources essentially freely available to local populations. Extraction of forest goods generally requires little in the

way of financial and physical capital (Neumann and Hirsch 2000). Forest resources are diverse, providing a range of products and opportunities for income generation. Often forest products are available at times when other income sources are not, for example when crops fail (Byron and Arnold 1999; Pattanayak and Sills 1999).

Three questions motivate the analyses of this chapter. One, when faced with adverse income shocks, do households at the forest margin use forests to protect consumption? Two, are the asset poor more dependent on forests for coping with such income shocks than the better off? And three, do households save out of transitory income, and in the process accumulate physical and financial assets that improve their ability to weather subsequent income shocks? These questions are addressed by estimating a dynamic Tobit model of forest extraction and random-effects models of income and savings using the household survey data described in Chapter II. For each analysis, a positive shock measure is used reflecting whether or not a household received an agricultural assistance package consisting of a free packet of seed and fertilizer. Taken together, the results of the chapter suggest that policies that help to alleviate asset poverty among those living adjacent to tropical forests can potentially yield outcomes that alleviate pressure on forests and improve the welfare of rural households.

Study Area and Data

Quarterly and annual data from the household survey are used for the analyses. The four quarters can be categorized according to the maize cultivation calendar: Quarter 1 is the post-harvest period, Quarter 2 represents the maize planting period, Quarter 3 is

the maize growing period, and Quarter 4 is the maize harvest period. Key data are the income shock measure and the index of forest use intensity.

The Income Shock Measure

The income shock measure is receipt of a "starter pack".[37] The Starter Pack Scheme (SPS) was a government-run, free-inputs program that commenced in the 1998/1999 agricultural year and continued through 1999/2000.[38] It was aimed primarily at improving national- and household-level food security in the short term (Longley et al. 1999).[39] Under the SPS, all of Malawi's estimated 2.86 million smallholder households were entitled to receive a starter pack containing seed (hybrid maize and legumes) and chemical fertilizer sufficient to plant about 0.1 hectare.

The starter pack was a positive shock to income for recipients. Its estimated monetary value in 1998 was greater than the annual cash income of many poor households (Blackie et al. 1998). Use of a starter pack could produce an additional 64 kilograms of maize – enough to feed a family for one month (DFID 1998 cited in

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[37] Receipt of a starter pack was certainly not the only shock to income experienced during the survey year, but data are not available for other shocks.

[38] In the 2000/2001 and 2001/2002 agricultural years a reduced scheme, the Targeted Inputs Programme (TIP), supplied inputs to a smaller number of smallholder households.

[39] The starter pack concept emerged in a Rockefeller Soil Fertility Research Network paper (Mann 1998) and was further developed in a Malawi Maize Productivity Task Force (MMPTF) discussion paper (Blackie et al. 1998). These papers viewed the distribution of starter packs as part of a long-term (five to ten years) technology testing and demonstration program that would enable smallholder farmers to experiment with maize production technologies developed by the MMPTF without having to buy the inputs themselves. The MMPTF maize production technologies take into account differing agro-climatic and economic circumstances of smallholder farmers.

Longley et al. 1999). The starter pack shock was idiosyncratic because not all households received one, and those that did used them differently. Starter pack distribution proceeded well overall, but a few problems were encountered (Gordon 2000). For example, some households received more than one starter pack, and other households did not receive a pack (Longley et al. 1999). In the three villages for this study, 68 percent of sample households received a starter pack in 1999/2000. Corresponding percents of households that received packs in Villages 1, 2, and 3, were 28, 97, and 86 percent respectively. The relatively low percentage of households receiving a starter pack in Village 1 is largely explained by the breakdown of the lorry carrying starter packs destined for the village; some of the packs were stolen while the lorry was being repaired. With packs in short supply, many sample households in Village 1 found that their names were not on the registration list when they showed up at the distribution site.

The starter pack shock is also idiosyncratic, because households used their starter packs differently. Most households used their packs in their gardens, but some sold their starter packs. A survey in rural Malawi found that that few sample households that used the starter packs in their gardens followed recommended use (Longley et al. 1999). For example, some households used only the chemical fertilizer or only the seed. The main extension tool of the SPS was a leaflet with written information on recommended plant spacing, fertilizer application, etc. Many farmers could not read the instructions, and some that could found the instructions confusing (Cromwell et al. 2001).[40]

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[40] The TIP improved on the SPS in some key ways. For example, on-farm demonstration plots in villages instructed farmers in proper use of inputs and OPV seed, which can be recycled up to three years, replaced hybrid seed (Levy and Barahona 2002).

Starter pack receipt should provide a useful "shock" measure for several reasons. First, starter pack receipt is truly a shock to income because it was unpredictable. Household members had limited information available to make judgments concerning the likelihood of receipt or non receipt of a starter pack. They knew only whether a starter pack was received in the previous year and heard from other villagers, radio announcements, and field assistants compiling registration lists that the SPS was continuing in the current year. Prior to distribution of the packs, households were probably hopeful, but it is unlikely that they changed their behavior until they actually received their starter packs.[41] A second reason starter pack receipt should be a useful shock measure is that the SPS can be situated in time. During the study year, starter packs were received sometime between the end of November and the end of December. If households changed their behavior, this may have occurred at the time of or subsequent to receipt of the starter pack, that is, during the maize growing or harvest periods. [42] Finally, the effects of the starter pack were transitory. Receipt of a starter pack should have had a significant effect on current, but not future, household income.

Forest Extraction in the Study Area

Use of forest resources is common at the study sites. During the survey year, all sample households collected firewood, 12 percent cleared forest for farmland, and 75

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[41] This is different from the situation where the shock is, say, weather and household behavior may be influenced by subjective beliefs about moments of the outcome distribution.

[42] It is also possible that response to starter pack receipt was delayed beyond the time period of the household survey data.

percent had cash earnings from forest-based occupations. An index was calculated for the quantity of scarce forest resources (wood and bamboo) extracted by sample households for cash income generation.[43] The forest extraction index provides a rough measure of the impact on forest condition of household participation in forest occupations. Appendix B describes how the index was compiled.

Differences in Forest Extraction Across Households

The mean and standard deviation for the forest extraction index are provided in Table 4.1, by village and overall. The data show considerable variability in extraction levels across villages and across households within villages. The level of forest extraction is highly concentrated among just a few households consistent with observations elsewhere (Cavendish 2000; Coomes et al. 2002). Five households in Village 3 accounted for 73 percent of total forest extraction for the sample.

The observed inter-household differences in forest extraction can be explained as follows. First, some households engaged in forest occupations part time and others full time. Second, 52 percent of households had specialized forest-based occupations (forest degradation is due mainly to charcoal production and timber harvesting). For example, the five households representing 73 percent of total forest extraction for the sample were

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[43] Many studies document the array of subsistence goods that rural households in low-income countries derive from forests (Cavendish 2000; Godoy et al. 2002) and the important safety-net functions these goods provide (Byron and Arnold 1998; Kinsey et al. 1998). Local evidence indicates that forest foods are used to smooth consumption during the hungry season and in emergency situations (Knacck Consultant 1999; Konstant 1999). I do not include forest foods in the index because these goods are either not scarce (Villages 1 and 2) or non-existent at the study sites (Village 3). In addition, data are not available on quantities of forest foods consumed by households at the study sites.

all full-time charcoal producers. Timber harvesting (all in Village 1) is very degrading, but it was a part-time occupation for sample households.

Table 4.1 Forest Extraction by Village, Sample Households 1999/2000

	Mean Quantity Forest Resources Extracted (kilograms)	Standard Deviation (kilograms)	Number of observations [a]
Village 1	1,092	1,912	28
Village 2	200	386	22
Village 3	11,009	19,371	15
All Villages	2,953	10,038	65

a. 75 households reported earnings from forest occupations. The forest extraction index has nonzero values for only 65 households, because some extractive activities were included in "forest earnings" but not in "forest extraction": traditional medicine and marketing of whole trees from private landholdings. See Appendix B.

Differences in Forest Extraction Across Quarters

Figure 4.1 shows moderate temporal variability in forest extraction over the survey year. Seasonal variability of forest use is common in the developing world for several reasons (Byron and Arnold 1999). One explanation relates to changes in labor availability over a typical year. At the study sites (see Figure 4.1), forest extraction was low during the maize growing period due to a peak in demand for household labor for cropping activities. Forest extraction was high in the post-harvest and planting periods when labor was more available. A second reason for seasonality of forest use is that some forest activities are easier to perform at certain times of year. Figure 4.1 shows that charcoal sales were lowest in the peak rainy season (Quarter 3); this may reflect difficulties with kiln management in rainy conditions. Likewise, plank transport was much reduced in the peak rainy season when trails were slippery and the task dangerous

(see the "timber" category in Figure 4.1). A third explanation is variable demand for forest products across seasons. For example, brick making peaks in the post-harvest period when home construction/repair is common. Likewise, though not apparent from Figure 4.1 since all drink and food are combined, at the study sites sales of *masese* beer are higher in the dry season (Quarters 1 and 2) when people have more leisure time and the money to buy beer (beer brewing uses large amounts of wood – see Appendix B).

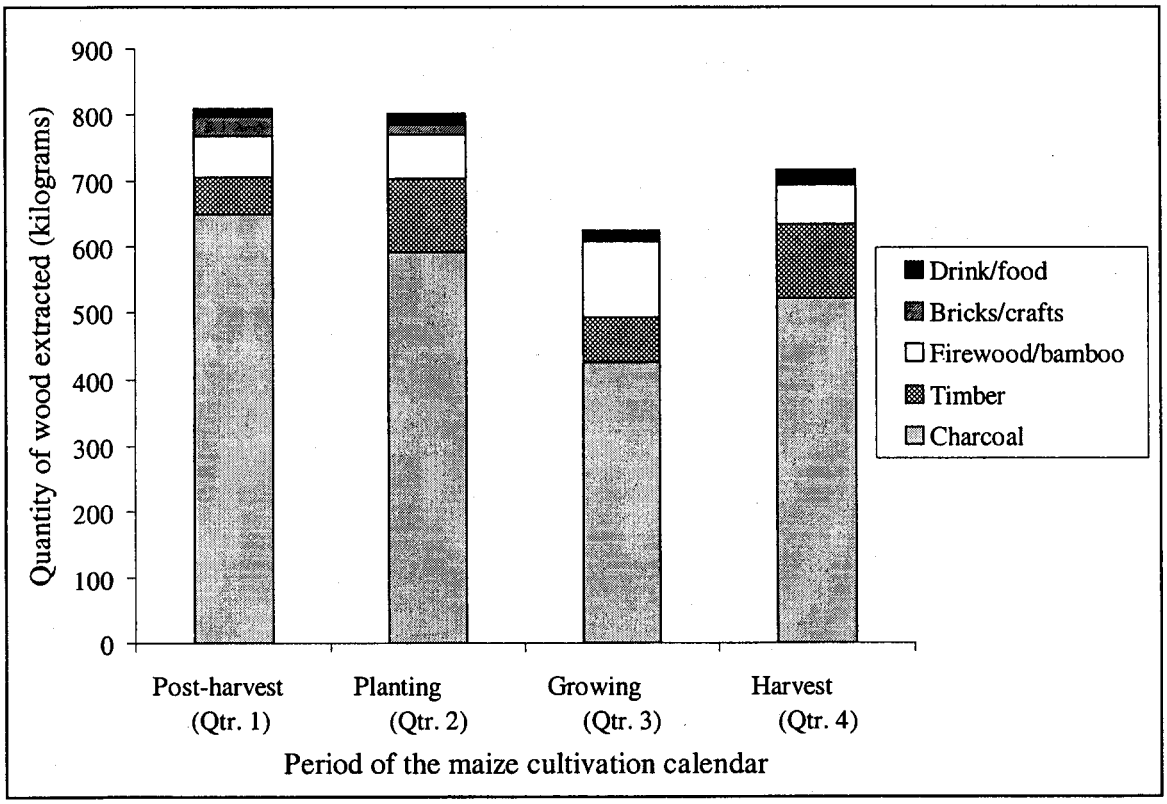

Figure 4.1 Seasonal Variability of Forest Resource Extraction, Sample Households 1999/2000

Another plausible explanation for observed variability of forest extraction over the survey year is that it reflects household ex ante or ex post responses to income

variability. Households may consume less leisure and increase forest extraction to smooth income prior to anticipated food shortages in the hungry period. Households may also use forests to cope ex post with unanticipated income shortfalls. For example, in the event of an adverse income shock, households may temporarily increase forest use to earn cash to buy food. The next section of the paper examines whether rural households in Malawi, particularly the poorest households, use forests to cope with income shocks.

Income Shocks and Forest Extraction

Conceptual Framework

The conceptual framework that underlies the analysis is a two-period farm household model of labor allocation under uncertainty. It draws on the time allocation model developed in Chapter III as well as the theoretical framework developed by Rose (2001) in her investigation of off-farm labor supply responses to risk in rural India. As a starting point, recall the reduced-form forest labor supply equation from Chapter III:

$$L_F = g(\, p,\, A_0,\, H,\, K,\, I, T) \qquad (1)$$

where, as before, $\boldsymbol{p}$ is a vector of prices and net hourly returns to labor in agriculture, forest use, wage-work, and self-employment; A_0 is the household's land endowment; $\boldsymbol{H}$ is a vector of household and individual characteristics that influence preferences; K is physical capital (e.g. forest tools); I represents forest management institutions; and T is the total labor endowment of the household.

Time and income risk are introduced to the forest labor supply model. Time is a representative year divided into two periods: the agricultural period and the slack period

(when agricultural activities are absent or limited). The source of income risk is a random variable ($\tilde{\xi}$) the outcome of which is realized at the start of the agricultural period (see Figure 4.2). The random variable is kept general in the discussion here; it could be weather or human health or a combination of several sources of income risk. Its timing reflects the seasonality of risk in many tropical countries. The agricultural period is the time of year when food is in short supply, human illness is more common, and the prevalence of crop diseases and variable weather, among other factors, make agricultural output uncertain. Households are assumed to be risk averse, which (by Jensen's inequality) implies that the household utility function is concave and, in the current context, that households prefer smooth inter-period consumption.

While farm households prefer smooth consumption, their incomes are highly uncertain, and this can cause consumption instability. The range of measures that households use to mitigate consumption instability can be categorized into income smoothing and consumption smoothing measures (Morduch 1995). Farm households often attempt to protect themselves from adverse income shocks ex ante (income smoothing), for example by making conservative production or employment choices and diversifying their income-generating activities. Households can also take income variability as given, and smooth consumption ex post by borrowing and saving, adjusting household labor supply, and using various formal and informal insurance arrangements. Most commonly poor households in low-income areas use some combination of these two types of measures (Kinsey 1998). In tropical forest areas, forests are a key asset of the poor and households may use forests to smooth income and consumption (Byron and Arnold 1999; Pattanayak and Sills 1999; Takasaki et al. 2002).

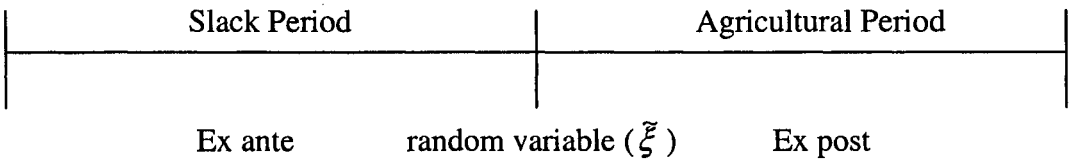

Figure 4.2 Two-Period Model of Shocks to Household Income

In the slack period, the household's forest labor supply decision is a function of the parameters in equation (1) and the household's expectations of the outcome of the random variable assumed to be captured by the mean (μ) and variance (σ) of past outcomes:

$$L_{F1} = L_{F1}(\mu, \sigma, p_0, A_0, H_0, K_0, I_0, T_0). \quad (2)$$

The effect of risk (σ) on forest labor supply (L_{F1}) reflects ex ante income smoothing and includes portfolio and precautionary effects (Rose 2001). One way that risk-averse households try to mitigate risk is by choosing a portfolio of activities. Diversification of income is common in rural parts of sub-Saharan Africa (Barrett et al. 2001), but it can be costly because expected returns are often sacrificed for lower risk (Morduch 1995). Forest use is often characterized as low-return, and it should be less risky than agriculture due to the diversity of forest products available year round; it may offer an important way to cope with risk (Pattanayak and Sills 1999). Households may also try to mitigate risk by taking precautionary measures. They may consume less leisure prior to realization of shocks and allocate more time to income-generating activities such as forest extraction in order to reduce the chance of having low income. A test for portfolio and precautionary effects on forest labor supply is a test of $\partial L_{F1}/\partial\sigma > 0.$.

The household's forest labor supply decision in the agricultural period is a function of the parameters in equation (1); it is also a function of the slack period forest labor supply decision (L_{F1}) and the now realized income shock ($\tilde{\theta}$):

$$L_{F2} = L_{F2}(L_{F1}(\cdot), \theta, p_1, A_1, H_1, K_1, I_1, T_1). \quad (3)$$

The shock ($\tilde{\theta}$) is defined as: $\tilde{\theta} = \tilde{\xi} - \mu$. The presence of L_{F1} in equation (3) reflects habit persistence or the effect of household's ex ante responses to risk on agricultural period labor supply decisions. (I defer a detailed discussion until later in the section.) In the agricultural period, the random variable has been realized and the household can directly respond to the shock using coping mechanisms to protect household consumption. A key hypothesis of the present study, namely that households use forests to cope with income shocks ex post, is a test of $\partial L_{F2} / \partial \tilde{\theta} < 0$. Why might one expect such a relationship? Recent research indicates that one of several important mechanisms that poor households use to cope with shocks is temporary labor supply adjustment (Kochar 1999; Rose 2001). While these studies concern the wage-work sector, in tropical forest areas the forest sector may play a similar role. In the introduction, some factors were listed in favor of tropical forests as an accessible shock-coping mechanism: communal tenure often means forest resources are essentially freely available to local people, forest extraction requires limited financial and physical capital, and forest resource diversity implies a range of income-earning possibilities that can be engaged in when the need arises. By contrast, asset liquidation or credit market transactions may not be a possible means to smooth consumption for the very poor who possess few liquid

assets and face collateral-related constraints to borrowing. For the very poor at the tropical forest margin, key assets possessed are labor and adjacent forests.

In the above discussion, it was argued that forests can provide poor households living at the tropical forest margin with a means to cope with risk ex ante and shocks ex post. These hypotheses are testable, and in the empirical analysis that follows I focus on testing the hypothesis that households use forests to cope with income shocks ex post.

Empirical Model

The empirical model used to examine whether households use forests to cope with income shocks is a dynamic Tobit model of forest extraction. It is similar in structure to equation (3), but the dependent variable for the empirical model is forest extraction rather than forest labor supply. This adjustment allows for explicit consideration of the potential impacts of forest use on forest condition. Since the quantity of forest resource extraction is the average product of labor times labor supply, the empirical model accounts for factors that affect forest labor productivity as well as those affecting decisions to supply labor to forests. The empirical model is:

$$Q_{it} = \gamma_0 + \gamma_1 Q_{it-1} + \gamma_2 \theta_t + \gamma_3 p_i + \gamma_4 H_i + \varepsilon_{it} \qquad (4)$$

where subscripts i and t denote households and time; Q is forest extraction index; θ is a binary variable indicating receipt (1) or non receipt (0) of a starter pack; p is the relative returns to labor in forest occupations and maize production; $\boldsymbol{H}$ is a vector of variables that influence forest labor supply and productivity: farm size, land quality, physical assets, education and age of the household head, number of adult males, and forest management institutions; and ε is a random error with zero expectation. The empirical model is used

to test the hypothesis that household forest use responds to income shocks. In the situation here, where the shock is a positive one, households experiencing the shock may temporarily reduce forest extraction relative to those households that did not receive a starter pack. A test of this hypothesis is a test of $\gamma_2 < 0$.[44]

Inclusion of the lagged dependent variable is important to account for the influence of past on current behavior.[45] There are at least two reasons why decisions to extract forest resources are related across periods. First, households may have physical capital that is specific to use in forest activities (e.g. forest tools) as well as human capital (e.g. charcoal-burning expertise) invested in the forest sector. This might cause households to persist in extracting from forests even though there may be incentives to do otherwise. Season-related incentives to reduce forest use in the agricultural period were discussed earlier: high demand for labor for farming, difficulties performing forest occupations in rainy conditions, and low demand for some forest products. A second reason for the potential link between past and current forest extraction relates to income smoothing. If households made heavy use of forests in the slack period (precautionary effect), they may have less need to do so in the agricultural period.

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[44] The starter pack is assumed to be uncorrelated with other income shocks. If this assumption holds, then γ_2 represents household response to receipt of the starter pack. However, if the starter pack is highly correlated with other income shocks, then γ_2 denotes the net response to the correlated income shocks.

[45] The model is autoregressive due to inclusion of the lagged dependent variable among the set of explanatory variables. Ordinary least squares (OLS) is consequently biased but it remains consistent (Kmenta 1986). Unbiased estimators for autoregressive models include Hatanaka's instrumental variables approach and the Arellano-Bond estimator. These estimators are not feasible for the current data set as each is data intensive.

Table 4.2 Data Definitions and Descriptive Statistics, 1999/2000

	Variable Definition	Mean or Frequency (Stand. Deviation)
p_F / p_M [a]	The ratio of net hourly returns to forest activities (MK/hour) to the producer price of maize (MK/kg)	0.45 (0.54)
AGE	Age of the household head by category (1=15 to 24 years; 2=25 to 34; 3=35 to 44; 4= 45 plus)	----
AGESQ	AGE squared	----
ASSETS [b]	Index of household asset holdings	22.09 (53.57)
DEPEND	Number of children and elderly household residents	0.87 (1.08)
FEMALE [c]	Number of female adult household residents	1.85 (1.09)
FSIZE	Area of the household's agricultural land holding (hectares)	1.26 (1.20)
INTER1	ASSETS*PACK	----
INTER2	FSIZE*PACK	----
IRON	Number of household dwelling units with an iron sheet roof	0.15 (0.46)
MALE [c]	Number of male adult household residents	1.20 (0.84)
MIGRANT [d]	Whether the household head migrated to the current village of residence (0=No, 1= Yes)	0.20
PACK	Household received a Starter Pack (0=No, 1=Yes)	0.68
QTY12	The sum of first and second quarter forest extraction index (kilograms)	1613 (5607)
SCHOOL [e]	Education of household head (0 = no schooling, ..., 9 = completed secondary school)	----
VILL1	Village 1 residence (0=No, 1=Yes)	0.39
VILL2	Village 2 residence (0=No, 1=Yes)	0.38

a. Values were imputed for 25 forest returns observations and 72 maize price observations. See Appendix B for details on the price imputations.
b. Asset score where chickens are assigned a value of one, goats and radios valued at five points, bicycles at 10 points, and cattle at 20 points. Radios and bicycle parts were commonly sold during the study year.
c. Girls and boys are valued at half an adult female and an adult male respectively.
d. Only household heads who migrated to current village of residence to flee the war in Mozambique or to gain access to land were included in this category. Household heads that migrated due to marriage (most people in the study area practice matrilineal inheritance and matrilocal residence traditions) or for employment purposes (these households rented or purchased land) were assigned a value of zero.

Empirical Results

Table 4.3 reports results from estimation of two dynamic Tobit models of forest extraction. The dependent variable in the models is the sum of forest extraction for Quarters 3 and 4 (the agricultural period). The models differ in terms of the set of explanatory variables included; Model 2 includes a subset of the regressors included in Model 1. For Models 1 and 2 respectively, nine and six of the parameter estimates are statistically significant at the 90 percent confidence level.[46] In the discussion that follows I focus on the results for the lagged dependent variable and the starter pack variables.[47]

Results for the lagged dependent variable (QTY12) indicate a strong positive association between forest extraction across periods, all else being equal. The parameter estimate for QTY12 is 0.39 and 0.38 in Models 1 and 2 respectively. This implies that in the agricultural period, households have some motivation to continue using forests in the same manner as in the slack period, possibly a reflection of physical capital that is specific to use in forest activities as well as human capital invested in the forest sector.

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[46] Forest extraction is highly concentrated at the study sites. Models 1 and 2 were also estimated excluding the five households that accounted for 73 percent of forest extraction. For Model 1, the main change when the five households are dropped is that MIGRANT and INTER1 are not statistically significant; for Model 2, the only change is that INTER1 is not statistically significant.

[47] Model 1 includes binary variables for residence in Village 1 and 2 to control for village effects such as forest management and weather. The village dummies are also included to assess whether PACK is acting as a proxy for VILL1; the two variables are highly correlated ($\rho = -0.68$). Given the results in Table 5.3, it seems very unlikely that PACK is picking up a village effect. If PACK were a good proxy for village residence, then Model 1 would suffer from multicollinearity, and it would be unlikely to obtain a statistically significant relationship between PACK and forest extraction.

Findings of Models 1 and 2 indicate that, controlling for other key explanatory variables, households that received a starter pack had lower rates of forest extraction than households that did not receive a pack, all else being equal. For the "average" household with an asset score of 22.09, the marginal effect of starter pack receipt on forest extraction is –374 kilograms of scarce forest resources. This finding may be indicative of the use of forests for coping with shocks. As mentioned earlier, there are strong incentives to move away from forest use in the agricultural period. Thus, it would seem that the observation of higher forest extraction among households that were relatively more vulnerable to having low income (starter pack non-recipients), all else being equal (including forest use in the previous period), indicates coping in difficult circumstances. That being said, to the extent that households used the starter pack in their garden, the observed difference in forest extraction among starter pack recipients and non-recipients should partly reflect the need to use complementary inputs, namely household labor, with the starter pack inputs.[48]

The interaction term (INTER1) is positive and statistically significant at the 95 percent confidence level, suggesting that forest extraction of the (asset) poor households was more responsive to starter pack receipt than forest extraction of the better off, all else equal. A plausible interpretation is that households that are poor in physical assets have

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[48] It could be argued that the observed difference in forest extraction reflects only the need for complementary labor for maize production, that is, the starter pack does not represent a shock to income. This does not seem plausible given results from an earlier estimation of the labor share equations of Chapter III. The binary starter pack variable (PACK) was included in the regressions and was found to be weakly significant in the forest labor share equation. The variable had a positive correlation with the maize labor share and a negative correlation with the self-employment labor share.

little option but to use forests to smooth consumption in the agricultural period. But, as households acquire liquid assets such as livestock, they move away from their use of forests for coping with income shortfalls.

Importantly, the results for PACK and INTER1 suggest that starter pack receipt may have had favorable consequences for forest condition: starter pack recipients were observed extracting less forest resources than non-recipients. This result, however, must be qualified. Recall that the forest extraction variable is the quantity of forest resources extracted for cash income generation; the variable does not include forest clearing nor firewood collection. For the sample households, I argue that the net effect of starter pack receipt on forest extraction should be negative even if one were to account for increased firewood consumption and forest clearing. Forest clearing for agricultural expansion was not common at the study sites (see Table 3.2 in Chapter III), and in southern Malawi in general, because there is limited arable forest land left to be cleared (GOM 1998a). As far as increased firewood consumption, the starter pack is said to produce enough maize to feed a family for an additional month (DFID 1998 cited in Longley et al. 1999). Using figures from Brouwer (1998) for quantity of firewood used to cook *nsima* twice a day for a family of four, an estimated additional 72 kilograms of firewood would be consumed per household with starter pack receipt, well below the 374 kilogram estimate above.

Table 4.3 Tobit Results for the Forest Extraction Equation

	Model 1		Model 2	
	Coefficient (Stand. Error)	Slope	Coefficient (Stand. Error)	Slope
Constant	273.81 (1431.52)	----	-237.96 (625.07)	----
p_F / p_M	* 903.40 (543.45)	453.55	** 997.33 (518.28)	498.19
AGE	-235.22 (311.00)	-118.09	----	----
ASSETS	** -69.02 (29.21)	-34.65	*** -66.44 (27.15)	-33.19
FSIZE	40.41 (350.56)	20.29	----	----
INTER1	* 57.71 (30.80)	28.97	* 54.18 (29.43)	27.06
MALE	** 753.09 (356.44)	378.08	** 683.64 (338.92)	341.50
MIGRANT	** 1636.26 (785.93)	821.48	** 1443.09 (600.09)	720.85
PACK	** -2015.77 (853.32)	-1012.01	*** -1946.01 (681.87)	-972.08
QTY12	*** 0.77 (0.06)	0.39	*** 0.76 (0.05)	0.38
SCHOOL	*** -659.99 (246.53)	-331.34	*** -645.36 (244.59)	-322.37
VILL1	294.73 (1081.89)	147.97	----	----
VILL2	246.39 (1029.38)	123.70	----	----
Number of observations		99		99
Log Likelihood		-462.36		-462.66
Pseudo R^2		0.13		0.13

*, **, and *** imply significance at the 0.10, 0.05 and 0.01 probability levels respectively.

Income Shocks and Household Savings

Two key findings from the previous section motivate the analysis of this section. One, starter pack receipt was found to reduce forest pressure, and it was argued that this is in part a reflection of reduced need to use forests to earn money to buy food. Two, forest extraction of households poor in physical assets was more responsive to starter pack receipt; it was argued that this may suggest that the poor depend on forests to cope with income shocks to a greater extent than the better off. Hence, income programs such as the SPS can have a direct effect on forest condition. In addition, the SPS could have an indirect effect on forest condition if starter pack receipt helped households to acquire some forms of physical capital that enable them to, over time, move away from their use of forests for coping with shocks. In this section of the paper, the data are used to examine this issue.

Empirical Model

I examine whether households save out of transitory income with use of an empirical model based on the permanent-income model of consumption and savings (Friedman 1957). Following Paxson (1992), I assume that household savings is a linear function of permanent and transitory income. Permanent income is defined as expected income at time t given the household's assets (e.g. human capital and physical assets such

as property). Transitory income is the difference between observed and permanent income. An empirical version of a permanent-income model is (Paxson 1992):[49]

$$S_{irt} = \alpha_0 + \alpha_1 Y_{irt}^P + \alpha_2 Y_{irt}^T + u_{irt} \quad (5)$$

where subscripts *i*, *r*, and *t* denote households, villages, and time (quarters); superscripts *P* and *T* represent permanent and transitory components of income; *S* is savings; *Y* is income; and *u* is a random error with zero expectation.

The strict version of the permanent-income model is that people consume out of permanent income and save out of transitory income (Deaton 1997). In terms of equation (5), this implies that the marginal propensity to save out of permanent income (α_1) would be equal to zero, and the marginal propensity to save out of transitory income (α_2) would be equal to one. Another interpretation of the model is that households save a greater proportion of transitory income than they consume (Deaton 1997). This interpretation would be consistent with a finding that $\alpha_2 > \alpha_1$.

A key issue in estimation of equation (5) is that permanent and transitory income are unobserved. Following the approach of Paxson (1992), permanent and transitory income are estimated. It is assumed that permanent income (Y^P) can be expressed as:

$$Y_{irt}^P = \eta_{rt}^P D_{rt} + \beta_1^P X_{it} + \varepsilon_{irt}^P. \quad (6)$$

In equation (6), $\boldsymbol{D}$ is a set of village-quarter binary variables intended to capture the effects on permanent income of seasonality and location-specific factors such as typical weather conditions and market access; and $\boldsymbol{X}$ is a vector of household-specific variables

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[49] Paxson's (1992) model also included a variable representing household income variability and a vector of life-cycle stage variables.

that may determine permanent income: farm size, education of the household head, and the number of dependent, adult male, and adult female household residents. Note that while $\boldsymbol{X}$ is time subscripted, only the farm size variable varied during the survey year. Transitory income (Y^T) is expressed as a linear function of the set of village-quarter binary variables ($\boldsymbol{D}$) and the starter pack variable (θ):

$$Y_{irt}^T = \eta_{rt}^T D_{rt} + \beta_1^T \theta_{it} + \varepsilon_{irt}^T \ . \tag{7}$$

Data availability precludes the inclusion of other income shock variables related to health status and weather, for example.

Equations (6) and (7) are used to form an equation for observed income (Y^O) and substituted into the savings equation (5) resulting in the following equations:

$$Y_{irt}^O = \eta_{rt} + \beta_1^P X_{it} + \beta_1^T \theta_{it} + \varepsilon_{irt} \tag{8}$$

$$S_{irt} = \alpha_0 + \alpha_1(\eta_{rt}^P D_{rt} + \beta_1^P X_{it} + \varepsilon_{irt}^P) + \alpha_2(\eta_{rt}^T D_{rt} + \beta_1^T \theta_{it} + \varepsilon_{irt}^T) + u_{irt} \ . \tag{9}$$

In equation (8), $\eta_{rt} = \eta_{rt}^P + \eta_{rt}^T$ and $\varepsilon_{irt} = \varepsilon_{irt}^P + \varepsilon_{irt}^T$. The reduced form of the savings equation (9) is expressed as:

$$S_{irt} = \alpha_0 + \delta_{rt} D_{rt} + \delta_1 X_{it} + \delta_2 \theta_{it} + v_{irt} \tag{10}$$

where $\delta_{rt} = \alpha_1 \eta_{rt}^P + \alpha_2 \eta_{rt}^T$, $\delta_1 = \alpha_1 \beta_1^P$, $\delta_2 = \alpha_2 \beta_1^T$, and $v_{irt} = \alpha_1 \varepsilon_{irt}^P + \alpha_2 \varepsilon_{irt}^T$.

Equations (8) and (10) are the estimating equations. The structural parameters of interest, α_1 and α_2, can be recovered from parameters of the reduced-form income and savings

equations: $\alpha_1 = \delta_1 / \beta_1^P$ and $\alpha_2 = \delta_2 / \beta_1^T$.[50] One can then test whether households save out of transitory income, that is, test that $\alpha_2 > \alpha_1$.

Empirical Results

Random-effects models of income and livestock savings were estimated with feasible generalized least squares (FGLS).[51] The income measure includes the value of retained maize output from the 2000 harvest and cash income from several sources: sales of crops, forest occupations, wage-work, self-employment, sales of assets (animals,

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[50] There is an identification problem here. It is possible to recover the structural parameters of interest (α_1 and α_2) using three different relationships among the reduced-form parameters. For example, α_1 can be recovered using : $\delta_{rt} = \alpha_1 \eta_{rt}^P + \alpha_2 \eta_{rt}^T$, $\delta_1 = \alpha_1 \beta_1^P$, or $v_{irt} = \alpha_1 \varepsilon_{irt}^P + \alpha_2 \varepsilon_{irt}^T$. To account for this problem, restrictions based on economic theory or extraneous information must be placed on the estimating equations (Kennedy 1998). Future work to resolve this issue is planned.

[51] The random-effects model is more efficient than fixed effects and can include time-invariant predictors (Greene 2000; Hsiao 1986), important for the analysis here since the data span a single year. A drawback is that estimates will be inconsistent if important sources of variation in the dependent variable are omitted from the estimating equation (Greene 2000; Hsiao 1986). Two tests were used to examine whether the random-effects or the fixed-effects model is a better choice for the analysis: the Breusch Pagan Lagrange multiplier (LM) test and Hausman's Chi-square test (Greene 2000). The Breusch Pagan LM test statistic is 36.73 and 0.97 for the income and livestock savings equations respectively. The 95 percent critical value for the Chi-square with one degree of freedom is 3.84. For the income equation, the null hypothesis is rejected in favor of the random-effects model over the classical regression model with a single constant term. For the livestock savings equation, the null hypothesis cannot be rejected. Hausman's Chi-square tests for fixed versus random effects. The calculated test statistic is 7.16 and 78.19 for the income and livestock savings equations respectively. The 95 percent critical value for the Chi-square with 12 degrees of freedom is 21.03. The null hypothesis that there is no systematic difference between fixed- and random-effects estimates cannot be rejected for the income equation. For the livestock savings equation, the null hypothesis is rejected. The results of the two tests together suggest that the random-effects model is a good choice for estimation of income but not for the livestock savings equation.

household durables, etc.), remittances, gifts, and loans. [52] See Appendix B for detailed information on the household income accounts. Livestock savings is quarterly expenditures minus quarterly sales of cattle, goats, and pigs.[53] In rural parts of Africa, the acquisition of cattle and small stock continue to be one of the most important forms of wealth accumulation (Dercon 1998; Fafchamps et al. 1998; Kinsey et al. 1998). In southern Malawi, cattle accumulation is limited by the scarcity of land. Only six sample households owned cattle at the start of the survey year. Goat ownership was more common and represents an important form of household savings in the study area. Goats require minimal management, provide a positive return in the form of off-spring, and are a relatively liquid asset (Upton 1996).

Results for the income and livestock savings equations are presented in Table 4.4. The coefficients of determination suggest that the models fit the household survey data quite well, and there is more variation in income/savings across households than over time. Nearly all of the permanent income variables are statistically significant at the 90 percent confidence level in the income equation. The transitory income variables are statistically significant in both equations. For the average household, the marginal effect

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[52] A few data shortcomings should be mentioned. First, some values for maize output were imputed (N = 31) due to missing observations (see Appendix B). Second, only home consumption of own-produced maize is included in income, because data are not available on other crop output. Household income is underestimated and may appear more variable over the survey year than it actually was, because some crops (e.g. cassava) are harvested outside of the maize harvest period. I do not expect these biases to be large since maize accounts for the bulk of agricultural production.

[53] In the consumption smoothing literature, savings is commonly measured as the difference between observed income and observed expenditures. In the absence of complete expenditure data (see Chapter II), livestock savings is used.

of starter pack receipt on household income is MK772. The interaction term (INTER2) indicates that starter pack receipt had a differential impact on household income based on landholding size; small farmers benefited less in absolute income terms from the starter pack than did large farmers. There are at least three plausible explanations. One, Longley et al. (1999) reports that in 1998/99 about 16 percent of farm households received two or more packs, and this group was made up primarily of the better-off households. Two, not all households used the starter pack in their gardens. Some of the poorer households sold their starter packs and anecdotal evidence suggests that some packs sold for as little as MK100 and MK150 (Longley et al. 1999). Finally, as mentioned earlier, only a small percentage of households that received starter packs followed recommended use of the packs. It may be that small farmers had less experience using improved seed and chemical fertilizer and/or understood the extension leaflet less well and, subsequently, obtained relatively lower yields and less income.

To examine whether households saved out of starter pack-induced income, the marginal propensities to save out of permanent income (α_1) and transitory income (α_2) were calculated; these are –0.05 and 0.24 respectively.[54] The calculated figures provide

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[54] The marginal propensity to save out of permanent income is calculated using the relation $\alpha_1 = \delta_1 / \beta_1^P$. δ_1 is calculated using parameter estimates from the *savings* equation. It is the sum of the parameter estimates for the permanent income variables plus the parameter estimate of INTER2 multiplied by PACK, where PACK was assigned a value of 1 (receipt). β_1^P is calculated in the same manner as δ_1 using parameter estimates for the permanent income variables from the *income* equation. The marginal propensity to save out of transitory income was calculated in a similar manner using the relation $\alpha_2 = \delta_2 / \beta_1^T$ and parameter estimates for the transitory income variables.

support for a (very) weak version of the permanent-income hypothesis, but this is tempered by the fact that the measure of savings used here is not complete (one important omission is grain savings). The results suggest that starter pack recipient households saved a portion of their additional income in the form of livestock savings, which is suggestive of precautionary saving. Hence, the findings suggest that the SPS had a positive impact on current household income (MK772) and food security. Furthermore, starter pack receipt is found to be associated with accumulation of livestock wealth, which could help households to cope with income shocks in subsequent periods. In the chapter summary, the results of the two sets of analyses (from this and the previous section) are integrated into an overall story of the potential effects of positive transitory income on forest condition and household welfare in rural Malawi.

Table 4.4 FGLS Results for Income and Savings Equations [a]

	Observed income (Sept. 2000 MK)	Livestock savings (Sept. 2000 MK)
Constant	-1940.86	181.43
	(2980.97)	(350.63)
Permanent income		
AGE	2248.87	-12.86
	(2285.34)	(264.33)
AGESQ	-498.21	4.08
	(398.54)	(46.10)
IRON	*** 2017.19	54.36
	(685.92)	(79.86)
FSIZE	* 461.35	*** -216.65
	(261.46)	(32.69)
DEPEND	* -459.07	*** -86.20
	(248.63)	(28.89)
FEMALE	** 552.76	35.17
	(246.78)	(28.66)
MALE	*** 1187.05	-22.95
	(302.92)	(35.02)
SCHOOL	*** 708.42	33.61
	(266.16)	(26.14)
Transitory income		
INTER2	*** 1964.24	*** -154.78
	(297.82)	(50.80)
PACK	** -1761.64	*** 393.38
	(883.16)	(138.94)
Number of observations	396	396
R^2 Within	0.30	0.15
R^2 Between	0.56	0.58
R^2 Overall	0.45	0.34

a. Additional regressors not shown in the table are 11 village-quarter binary variables.

Chapter Summary

The chapter involved two sets of analyses. First, a dynamic Tobit model of forest extraction was estimated to examine whether households living at the tropical forest margin depend on forests to cope with income shocks. Second, random-effects models of income and livestock savings were estimated to examine whether households save out of transitory income. The story that emerges from the analyses has important implications for policies directed at tropical forest conservation and rural livelihoods. Results of the dynamic Tobit model may indicate that rural households in tropical forest areas do rely on forests for coping with income shocks and that asset poor households are more reliant on forests for shock coping. For this reason, programs that reduce a household's vulnerability to adverse income shocks, as the starter pack appears to have done, can help to reduce forest pressure in the short term. Indeed, Tobit model results found that starter pack receipt is associated with a reduction in forest resource extraction of 374 kilograms per household, all else being equal. Results of the random-effects models found that households that received a starter pack had additional income in the amount of MK772, and they used some of the starter pack-induced income to purchase livestock. Linking this result with the finding that the asset poor are more reliant on forests for shock coping suggests that income programs that reduce asset poverty can reduce forest pressure in the long term. Taken together, the results of the chapter suggest that policies that help to alleviate asset poverty in tropical forest areas can potentially yield outcomes that reduce pressure on forests and at the same time improve rural household welfare.

CHAPTER V – HOUSEHOLD WELFARE AND FOREST DEPENDENCE IN MALAWI

Introduction

Studies from tropical forest areas document the many roles that forests play in local livelihoods, providing an array of subsistence goods, marketable products for cash income generation, production inputs to agriculture, and vital safety nets in difficult times (Byron and Arnold 1999; Godoy et al. 2002). Empirical evidence suggests that it is often the poorest households in rural communities that are most dependent on forests and other natural resources for income (for a review see Neumann and Hirsch 2000). The poor find it rather easy to enter forest occupations because common-property forest resources are often available essentially for free to local populations and forest extraction generally requires little in the way of financial and physical capital (Byron and Arnold 1999; Neumann and Hirsch 2000). The better off, meanwhile, have less interest in engaging in the easy entry/exit forest occupations which are also characterized by low returns to effort. [55] The common finding of a negative relationship between wealth and forest reliance coupled with evidence that many forest occupations are relatively unremunerative raises at least two important concerns. One, it may be that access to

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[55] Easy-entry occupations in the forest sector can be loosely classified as comprising extraction and sale of non-timber forest products (NTFPs). Employment in the logging industry tends to be relatively capital intensive and remunerative and, therefore, less accessible to the poor.

forest income helps the poor to survive, but does not help them move out of poverty (Wunder 2001). A second more pressing issue is that heavy reliance on forest income may perpetuate poverty and lead over time to a more unequal distribution of income in rural communities (Neumann and Hirsch 2000).

This chapter examines the potential impacts of forest use on the welfare of the rural poor using household survey data from southern Malawi. A Tobit model is used to investigate key factors that condition forest dependence in rural Malawi. Poverty analysis involves calculation of measures of the incidence, severity, and depth of poverty among sample households during the survey year. Finally, a series of Gini coefficients are calculated to investigate the impact of forest access on income inequality.

How Dependent are Sample Households on Forests for Livelihoods?

Byron and Arnold (1999) discuss the various definitions of forest dependence that appear in the literature. At one extreme, some have defined forest-dependent people as those who are completely dependent on forests for all livelihood inputs. Others have considered proximity to forests as sufficient to warrant the term forest dependence. Forest dependence is here defined in terms of the share of income derived from forests. For those households and communities where forest income shares are high, restricting access to forest resources would imply a worsening of their economic well-being, at least in the short term.

Tables 5.1 and 5.2 present cash and total income shares by source for the sample households. The household income accounts are described in detail in Appendix B. The tables indicate that income diversification was common at the study sites, in line with

other observations in rural Africa (Barrett et al. 2001; Bryceson 2002). Where markets for credit and insurance are missing or thin, diversification of income, assets, and activity choice is often important for ex ante risk mitigation, coping with adverse income shocks, and earning the cash required to purchase farm inputs or make investments (Barrett et al. 2001). Figure 5.1 shows diversification of income by a few representative households. The intent of the figure is to indicate that village-level diversification is not merely a feature of aggregation across specialist households. All households in the sample received income from more than one source during the survey year.

Table 5.1 shows that the share of cash income from forests was highest of all sources in Villages 1 and 3, in part a reflection of high participation rates in forest occupations: 82 percent and 73 percent of households in Villages 1 and 3 reported forest-based earnings in 1999/2000. Why is forest use so prevalent? One explanation is the ease with which households can initiate forest enterprises. Some forest activities, such as sales of firewood require only labor and commonly owned tools for participation. And in both villages, forest access appears to have been unrestricted during the study year. The Forestry Department in Village 1 has been largely unable to control forest access. And in Village 3, forest resources on common land are largely treated as open access resources. The high forest income shares also reflect opportunities and relatively high returns to some forest occupations arising from local resource endowments (in Village 1) and market access (in Village 3). The forest reserve near Village 1 has high-value timber. Many local people work as plank sawyers or plank transporters for the timber merchants who market planks in urban areas. A few better-off households sold planks to timber merchants. These occupations are relatively lucrative compared with other forest

occupations. Village 3 households have access to urban markets where demand for charcoal is substantial and growing. For example, 36 percent of Village 3 households reported charcoal sales during the survey year. These sales resulted in earnings that were high by local standards.

Table 5.1 Cash Income Shares by Source and Village, Sample Households 1999/2000 [a]

	Forest	Farm	Self-empl.	Wage-work	Sales assets	Transfers	N
Village 1	0.37 (0 – 1.00)	0.11 (0 – 0.88)	0.04 (0 – 0.97)	0.23 (0 – 0.96)	0.05 (0 – 0.46)	0.20 (0 – 0.99)	39
Village 2	0.20 (0 – 0.89)	0.23 (0 – 0.93)	0.22 (0 – 0.95)	0.09 (0 – 0.68)	0.07 (0 – 0.34)	0.19 (0 – 1.00)	38
Village 3	0.41 (0 – 0.97)	0.08 (0 – 0.38)	0.09 (0 – 0.64)	0.26 (0 – 0.97)	0.07 (0 – 0.75)	0.09 (0 – 0.71)	22
Full sample	0.31	0.15	0.12	0.18	0.06	0.17	99

a. Range in parentheses.
b. Forest income includes earnings or profits from forest-dependent income-generating activities (see Table 5.3).
c. Farm income includes cash income from sales of crops including fruit crops.
d. Self-employment includes non forest-based businesses: resale of agricultural commodities, tailor, money lending, sales of fish, grocery sales, public transport operation, radio and bike repair, tinsmith, and stone breaking.
e. Wage-work includes non forest off-farm employment: contract agricultural labor, forestry officer, teacher, mechanic, watchman, and village headperson.
f. Sales of assets includes: sales of livestock (cattle, goats, pigs) and poultry, property rental, and sales of personal and household items (radio, bicycle parts, clothing, etc.).
g. Transfers includes: remittances from household residents (mainly husbands working elsewhere), gifts from relatives, and loans.

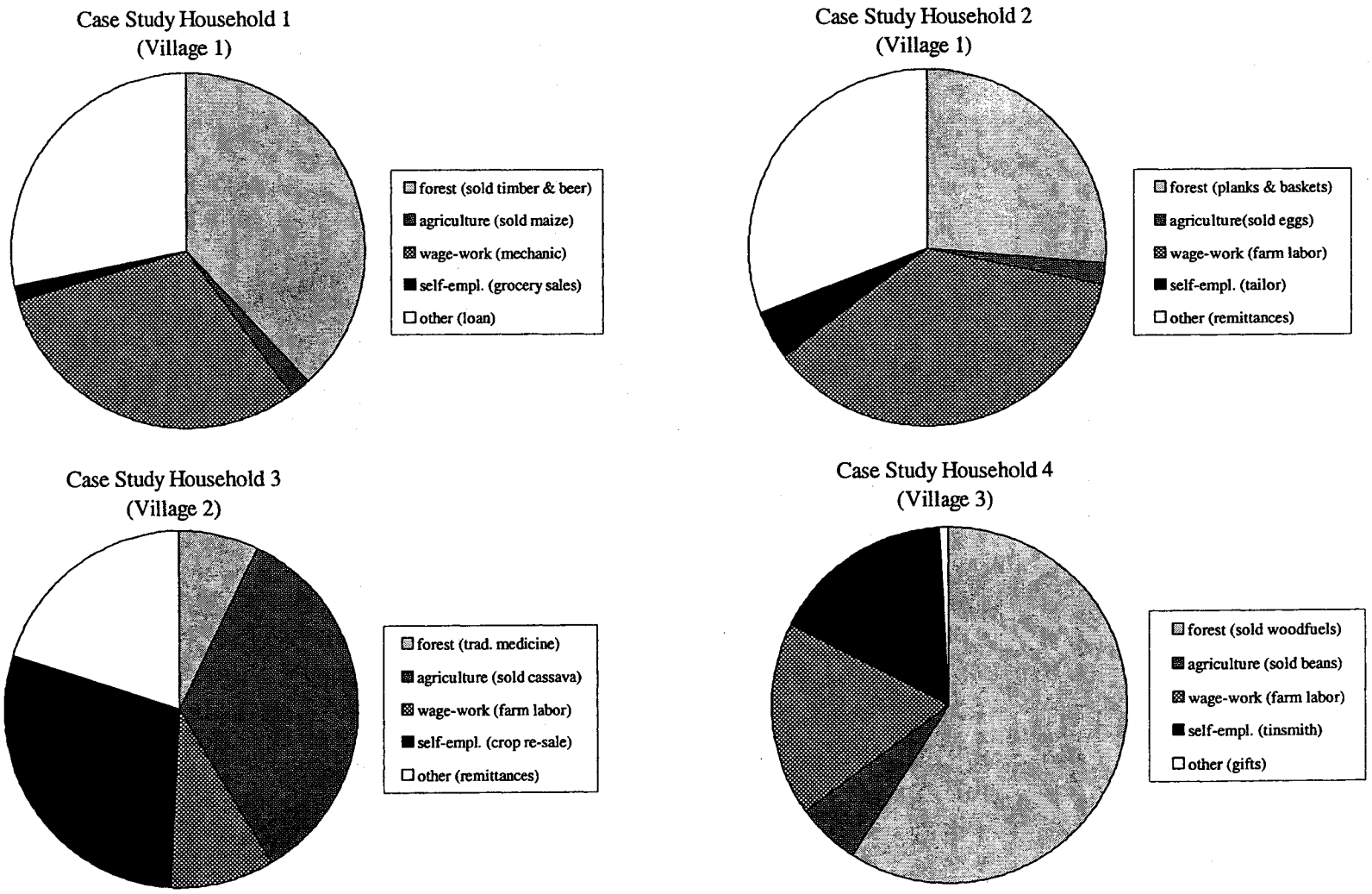

Figure 5.1 Income Diversification Among Representative Households

Table 5.2 Income Shares by Source and Village, Sample Households 1999/2000 [a]

	Forest	Farm	Self-empl.	Wage-work	Sales assets	Transfers	N
Village 1	0.38 (0.05 – 0.85)	0.35 (0.05 – 0.77)	0.03 (0 – 0.75)	0.10 (0 – 0.52)	0.02 (0 – 0.14)	0.11 (0 – 0.77)	39
Village 2	0.21 (0.01 – 0.80)	0.42 (0.07 – 0.91)	0.15 (0 – 0.77)	0.06 (0 – 0.44)	0.04 (0 – 0.29)	0.11 (0 – 0.64)	38
Village 3	0.41 (0.04 – 0.96)	0.25 (0.02 – 0.58)	0.06 (0 – 0.43)	0.18 (0 – 0.83)	0.05 (0 – 0.58)	0.05 (0 – 0.31)	22
Full sample	0.33	0.36	0.08	0.10	0.03	0.10	99

a. Range in parentheses.

The average share of cash income derived from forests by Village 2 households is considerably lower than averages in the other villages. There are several plausible explanations. First, the village head in Village 2 appeared somewhat more successful at reducing forest access compared with the Forestry Department in Village 1 and the head in Village 3. Second, forest producers in Villages 1 and 3 had a competitive advantage compared with their counterparts in Village 2. Village 2 has neither accessible timber, nor access to urban charcoal markets. In Village 2, many households engaged in forest-based craft making (bamboo baskets or wood-fired clay pots), occupations with generally low returns to effort (see Table 5.3). Finally, self-employment activities competed with forest occupations in Village 2 due to proximity to the Mozambique border. Compared with their Malawian counterparts, farmers in northern Mozambique have abundant land and fertile soils, but reduced access to markets for agricultural commodities (Whiteside 2001). A common occupation of Village 2 households is to travel to Mozambique on

foot and dug-out canoe to buy agricultural goods from Mozambican farmers and (illegally) transport these goods across the border into Malawi for sale at a profit.

Table 5.2 reports average shares of total income derived from the forest and other sectors. In the total income figures, farm income includes cash earnings from crop sales and the value of own-consumed maize production; forest income includes earnings from participation in forest occupations and the value of own-consumed collected firewood. [56] Table 5.2 indicates that the farm income share is higher than the forest income share in Village 2. In Villages 1 and 3, the forest is the most important income source. The forest income share remains uniformly high across the study sites due to inclusion of own-consumed collected firewood in the income accounts. This is appropriate since all sample households used collected wood for cooking and for most (69 percent) it was the dominant fuel. Simple calculations demonstrate the high value of collected firewood, typically left out of household income accounts, to rural Malawian households. A rural Malawian family of four cooking three meals per day would use about 6.3 kilograms of firewood on average (Brouwer 1998). Using an estimated local market price for firewood of Malawi Kwacha (MK) 1.09 per kilogram from a survey of (N = 14) firewood sellers, the annual cost to buy firewood would be about MK2,925. To put this figure in perspective, compare it with the average expenditure on animals (MK74) or the average household income (MK14,698) of sample households during the survey year.

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[56] The total income data have a few shortcomings. Retained maize and collected firewood should represent the bulk of home consumption, but households did consume other crop production and other products collected in the forest. Another source of measurement error is imputation of values for the two variables where data are missing. See Appendix B for a detailed description of the income accounts.

Table 5.3 Percent of Households Participating in Forest Income-Generating Activities by Village, Sample Households 1999/2000

	Wood sales	Charcoal sales	Sawing & planks	Construc-tion	Sales food/ drink	Sales forest crafts	Tradn. med.
Village 1	18	0	36	18	59	13	5
Village 2	26	0	0	13	26	34	8
Village 3	45	36	0	9	23	5	5
All Villages	27	8	14	14	38	19	6

a. Wood sales includes marketing of firewood, planks, whole trees, and bamboo.
b. Sawing and planks includes employment as pit-sawyers and plank carriers.
c. Construction includes roof thatching and brick burning.
d. Sales of food/drink includes food/drink items that use wood as a key input: *masese* traditional beer, *kachasu* dry spirit, *chikondamoyo* cakes, cooked velvet beans, etc.
e. The forest-based crafts found at the study sites are: bamboo baskets and mats, grass brooms, and wood-fired pots.

In sum, the data show that forest income was very important for households in the study villages, accounting for about 30 percent of income on average. This finding contrasts with statements that forest products income is rarely important in absolute magnitude, but instead important in filling gaps at key times (Byron and Arnold 1999). The high income shares from resource extraction reported above are not, however, unprecedented. For example, a detailed survey of environmental resource use in Zimbabwe found that resource extraction contributed 35 percent of rural household income on average (Cavendish 1999).

Are the Poor More Dependent on Forests?

The previous section of the chapter reports village-level differences in forest reliance. It was argued that the observed differences are likely a function of differing

opportunities arising from natural resource endowments, market access, and forest management. Table 5.1 also indicates household-level variation in forest dependence. Some households reported no cash earnings from forests, while others derived the bulk or all of their cash income from the forest. Why are some households so heavily dependent on forest income?

A compelling question is whether poorer households in rural communities are more dependent on forests for livelihoods. Several studies from tropical forest areas support this thesis (see Neumann and Hirsch 2000 for a review of studies). Where a positive relationship between poverty and forest dependence is observed, it is often explained either by the characteristics of many forest occupations (e.g. limited capital requirements and low returns), or by limitations for other sources of livelihood (e.g. landlessness or low levels of human capital). These characteristics often mean that the poor find it relatively easy to engage in forest occupations and that the better off have less interest in doing so. In the research area, qualitative evidence from discussions with key informants indicates that forest-based activities such as firewood marketing are more often the occupations of the poorest in the communities. This is because these activities are physically demanding and earn relatively low returns. Key informants often reported that, given possibilities for non forest-based employment or self-enterprise, many individuals would opt to exit forest occupations. Research from the Philippines also suggests that when household members seek off-farm employment, forest-degrading activities are among the first to be eliminated from the household portfolio (Shively and Pagiola 2001).

For the analysis of poverty-environment links here, an asset definition of poverty is used (Takasaki et al. 2000). Where markets (e.g. for credit, insurance, and labor) fail or function poorly, economic agents make production and investment decisions on the basis of their asset holdings (Dercon 1998; Eswaran and Kotwal 1986). Asset poverty (wealth) is treated as multidimensional, encompassing natural resource, human resource, and physical assets. A household may be well endowed in some assets and poor in others; the composition of the household's asset holdings should condition resource use (Reardon and Vosti 1995). For example, if asset poverty alleviation entails introduction of chainsaws, "wealth" is unlikely to reduce forest reliance. Thus, rather than asking if a household is poor, the relevant question is "poor in what?" (Reardon and Vosti 1995).

Table 5.4 presents mean values for households' initial (i.e. start of survey year) asset holdings stratified by level of forest dependence. The level of forest dependence is defined in terms of the share of cash income derived from forests: less dependent (0 – 32 percent of cash income), dependent (33 – 66 percent), and very dependent (67 – 100). Using an asset composition definition of poverty, the data appear to indicate that households that were rich in labor, but poor in educational assets, land, and livestock were more dependent on forests.

Table 5.4 Human Resource and Productive Physical Assets by Level of Forest Dependence, Sample Households June 1999

	Mean or Proportion by Forest Dependence Category		
	Less Dependent	Dependent	Very Dependent
Human Resource Assets			
Household population	4.53	4.68	5.95
Adults [a]	2.80	3.21	3.62
Adult males [a]	1.02	1.39	1.52
Dependency ratio [b]	0.32	0.20	0.30
Education [c]	1.15	1.11	0.71
Age [d]	3.36	3.37	3.29
Physical Assets			
Farm size (ha/person)	0.36	0.33	0.23
Cows	0.68	0.00	0.05
Goats [e]	0.97	0.37	0.95
Forest tools [f]	0.75	0.65	0.57
Iron roof owners (%)	15	5	5
Number observations	59	19	21

a. Number of active adults where boys and girls are treated as half an adult equivalent.
b. Number of children and elderly divided by number of active adults.
c. Categorical variable ranging from 0 (no schooling) to 9 (completed secondary school).
d. Age of the household head by category (1=15 to 24 years; 2=25 to 34; 3=35 to 44; 4= 45 plus). Age is categorical because respondents generally were not aware of their age. Our approach was to refer to a list of historical events and then estimate the age of the head based on her/his responses concerning whether she/he was alive and what she/he was doing the year of the important event.
e. The goats category also includes pigs owned by one of the sample households.
f. The ratio of forest tools (axe, handsaw, and pit saw) to hoes. Handsaws and pitsaws are valued at five times and ten times an axe or hoe.

To explore these patterns in more detail, a Tobit model is used to examine the relationship between asset poverty and forest dependence. The dependent variable is the share of cash earnings derived from the forest during the survey year.[57] Explanatory variables are those that reflect household demographics, human resource assets, productive physical assets, and natural resource assets. Table 5.5 provides definitions and descriptive statistics of the explanatory variables. The selection of explanatory variables is consistent with previous econometric studies examining factors related to income diversification (de Janvry and Sadoulet 2001) and forest reliance (Coomes et al. 2002).

Regression results are presented in Table 5.5. Five of the point estimates for explanatory variables are individually different from zero at a 95% confidence level. Binary variables for Village 1 and Village 2 residence were included to capture differences in market access and natural resource endowments that condition opportunities in the forest sector across villages. Village 2 residence is negatively associated with forest reliance as expected given differences between Village 2 and the other villages in forest access, opportunities, and forest returns.

Within villages, differences in endowments of assets across households are associated with variations in forest dependence. Other things equal, households that have a larger number of adult male family members (MALE) were more reliant on forests for cash income generation. Coomes et al. (2002) also found a positive relationship between

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[57] While full income is preferable from a conceptual standpoint, cash income is used because complete data are available for this variable.

availability of household labor and reliance on resource extraction. The marginal effect for MALE is 0.10, calculated at the mean value for all explanatory variables. All else being equal, for the "average" household with 1.20 adult males, an additional adult male is associated with a 0.10 increase in the forest income share. Availability of household labor is crucial for participation in the labor-intensive forest occupations. The finding of a positive association between male adult labor and the forest income share may be related to the very unequal returns to the different forest occupations, with males having higher participation rates in the more remunerative forest occupations (e.g. charcoal marketing, timber sales, plank sawing) compared with females. Thus, households with more adult male laborers have the capacity to earn above average forest income. [58]

The data indicate a positive relationship between possession of forest tools (FTOOL) and forest reliance. The cost of engaging in forest occupations is lower for those who own forest tools. Availability of forest tools and labor are the only limiting factors for many forest occupations, e.g. plank transport, firewood marketing, basket making.

Regression results indicate that households with lower levels of education are more reliant on forest income. For the average sample household with some primary education, completion of primary school is associated with a reduction in the forest income share of 0.07, all else being equal. It may be that education has a negative role on forest reliance because educated individuals are better able to take advantage of

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[58] An earlier regression included a variable for the number of female household residents. The variable was positive but not statistically significant; its inclusion does not add explanatory power and tends to reduce the efficiency of other point estimates.

opportunities in more remunerative labor markets and, therefore, have less need to rely on forests for livelihoods. Education may signal to employers one's potential productivity, increasing the likelihood of being hired into better-paying jobs (Abdulai and Delgado 1999; de Janvry and Sadoulet 2001). For sample households, there is a strong positive correlation between education of the household head and whether he/she held a permanent job ($\rho = 0.42$) or had earnings from self-employment ($\rho = 0.16$). Permanent jobs and self-employment occupations are the most coveted jobs in the study area.

The results suggest that households with more physical assets (ASSETS) in the form of animals (cattle, goats, and poultry), bicycles, and radios are less dependent on forests. Livestock and other animals are productive investments with good returns that can be drawn down in response to price signals, to smooth consumption, or to buy farm inputs (Dercon 1998). Households that possess a greater number of liquid physical assets may therefore have less need to rely on forests for consumption or income smoothing. In addition, physical asset ownership may indirectly provide the financial capital needed to engage in the more lucrative self-employment activities, through asset sales or improved access to credit. The income diversification literature generally finds that better-off households diversify into the more favorable labor markets compared with poorer households (Barrett et al. 2001).

To assess the extent to which forest reliance changes over the demographic cycle, the age of the household head (AGE) and age of the household head squared (AGESQ) are included in the model. Findings do not support a hypothesis that age affects forest dependence. Regression results also do not show a significant relationship between landholding size and forest reliance.

Table 5.5 Tobit Results for the Forest Dependence Equation

Variable	Definition	Coefficient (Standard Error)	Slope
Constant		0.1510 (0.4427)	
AGE	Age of the household head by category (see note d. at the bottom of Table 5.4)	0.2822 (0.3261)	0.2116
AGESQ	AGE squared	-0.0610 (0.0569)	-0.0457
ASSETS [a]	Index of household's asset holdings	** -0.0040 (0.0018)	-0.0030
FSIZE	Area of the household's agricultural landholding at the start of survey year (ha)	-0.0123 (0.0427)	-0.0092
FTOOL	Ratio of forest tools (axe, handsaw, pit saw) to agricultural tools (hoe) (see note f. at the bottom of Table 5.4)	** 0.0955 (0.0477)	0.0716
MALE	Number of adult male household residents (see note a. at the bottom of Table 5.4)	*** 0.1372 (0.0473)	0.1029
SCHOOL	Educational level of the household head (see note c. at the bottom of Table 5.4)	*** -0.0886 (0.0315)	-0.0665
VILL1	Village 1 residence (0=No, 1=Yes)	-0.0416 (0.1046)	-0.0312
VILL2	Village 2 residence (0=No, 1=Yes)	*** -0.3324 (0.1098)	-0.2492
Number of observations			99
Log Likelihood			-47.57
Pseudo R^2			0.25

a. Asset score where chickens are assigned a value of one, goats and radios valued at five points, bicycles at 10 points, and cattle at 20 points. Radios and bicycles are included because the household survey data show that sales of radios and bicycle parts were common.

** and *** imply significance at the 0.05 and 0.01 probability levels respectively.

In sum, results from the Tobit model indicate several factors associated with forest dependence at the community and household levels. At the community level, Village 2 households are less reliant on forests compared to households in the other villages, possibly a function of reduced forest access, the absence of high-value timber, and distance to urban charcoal markets. At the household level, the results suggest that forest-dependent households are rich in labor and forest tools, but poor in animal holdings and human capital.

What is the Impact of Forest Income on Poverty?

Results from the previous section indicate that households that were poor in human capital and physical assets had higher forest income shares than the non (asset) poor during the survey year. Thus, forest occupations appear to be relatively accessible to the asset poor. However, while some forest occupations at the study sites are relatively lucrative (e.g. timber sales, charcoal marketing), net hourly returns to labor in the forest sector are lower on average compared with other sectors (see Table 3.3 in Chapter III). The generally low returns to forest occupations coupled with the finding that the asset poor have higher participation rates raises at least two concerns. One, it may be that access to forest income helps the poor to survive, but does not help them move out of poverty (Wunder 2001). A second more pressing issue is that heavy reliance on forest income may perpetuate poverty (Neumann and Hirsch 2000). In this section, the data are used to examine whether access to forest income improves the living standards of sample households.

Table 5.6 Household Income and Meal Consumption by Level of Forest Dependence, Sample Households 1999/2000

	Mean or Proportion by Forest-Dependence Group			Test Statistic for Group Comparisons [a]		
	Group 1 Less Dependent	Group 2 Dependent	Group 3 Very Dependent	1 vs. 2	2 vs. 3	1 vs. 3
Income						
Cash income (Sept. 2000 MK/ year)	8,600	11,565	13,613	-0.74	-0.44	**-1.69**
Total income (Sept. 2000 MK / year)	13,114	15,679	18,259	-0.56	-0.51	-1.55
Per capita cash income (Sept. 2000 MK/person/year)	2,367	2,944	2,616	-0.54	0.30	-0.36
Per capita total income (Sept. 2000 MK/person/year)	3,493	4,109	3,473	-0.51	0.52	0.03
Meal consumption (number/person/day)	2.02	2.14	2.07	-0.91	0.48	-0.39
Number of observations	59	19	21			

a. The critical value (α=0.10) for the z-statistic (differences in proportions) and the t-statistic (differences in means) is 1.66
b. Quarter 1 is the post-harvest period, Quarter 2 the maize planting period, Quarter 3 the maize growing period, and Quarter 4 the maize harvest period.

As a starting point, note that sample households that started off the survey year poor in assets (human capital and physical assets) were very dependent on forests (Table 5.4). How did this group fare over the course of the year in terms of welfare indicators? Table 5.6 presents survey year averages for income and meal consumption of sample households. Households that were very dependent on forests had higher incomes (cash and total) as a group. The difference in mean cash income for the less dependent and very dependent groups is statistically significant at the 90 percent confidence level. For income per person, households that were dependent on forests for 33 – 66 percent of their cash income had the highest income and meal consumption levels on average. However, none of the group-wise differences in per capita income and meal consumption are statistically significant.

The incidence, depth, and severity of poverty are calculated for the sample households taking income as the welfare measure and using the Foster-Greer-Thorbecke (FGT) class of poverty measures (Foster et al. 1984). With households ordered by income per household resident (y), the FGT(α) class of poverty measures is defined as:

$$FGT(\alpha) = \frac{1}{N}\sum_{j=1}^{N}\left(1 - \frac{y_j}{z}\right)^{\alpha} I(y_j \leq z) \qquad (1)$$

where $I(\cdot)$ is an indicator function that takes the value of one if its argument is true and zero otherwise, N is the number of households, j indexes households, z is the poverty line, and α is a poverty measure parameter. When $\alpha = 0$, equation (1) yields the poverty headcount ratio, a measure of the incidence of poverty. For $\alpha = 1$, the equation can be used to calculate the poverty gap index, a per capita measure of the total shortfall of individual income levels below poverty (Deaton 1997). For example, a calculated

poverty gap index of 0.50 indicates that the total amount by which the poor are below the poverty line is equivalent to half the poverty line multiplied by the population. The poverty gap is often interpreted as measuring the depth of poverty. The squared poverty gap index, a measure of the severity of poverty, is calculated with equation (1) for $\alpha = 2$. The squared poverty gap accounts for the income shortfall of the poor from the poverty line and is also sensitive to income distribution among the poor; income transfers from poor to poorer households reduce measured poverty (Deaton 1997).

There is no apparent discontinuity in the income data for sample households. Therefore, the poverty line (z) is determined with external information. The Poverty Monitoring System (PMS) of the Government of Malawi (GOM) has established a poverty line for rural southern Malawi of MK15.33 per person per day, based on the cost of basic needs for an individual, taking into account food requirements and critical non-food consumption (Poverty Monitoring System 2000b).[59] The PMS reports a poverty headcount of 68 percent for rural southern Malawi using this poverty line and per capita consumption data from the IHS for 1997/98. Using the PMS poverty line and per capita income data for the sample of households described in Chapter II, the calculated headcount ratio is 83 percent. I suspect the discrepancy in calculated poverty headcounts reflects under reporting of income in the household survey data relative to consumption reporting in the IHS. Survey-based estimates of income are often substantially less than those of consumption because questions concerning income are often viewed as sensitive by respondents (Deaton 1997). Note that the average

income per capita per day for the sample households of this study is MK9.10 (excluding the value of own-consumed collected firewood) and MK9.88 (with collected firewood); the IHS reports a total income figure of MK7.97 (Poverty Monitoring System 2001).

Table 5.7 presents calculated poverty indicators for sample households for 100, 75, and 50 percent of the PMS poverty line. Several poverty lines are used since poverty comparisons are often sensitive to the choice of poverty line. I calculate the poverty indicators using total income figures that include and exclude the value of collected firewood. Comparison of measured poverty across forest dependence categories indicates that the incidence, depth, and severity of poverty were lower, on average, for the very (forest) dependent compared with the dependent and less dependent households. There are only three exceptions (in bold text in the table). The finding of lower measured poverty among the very dependent households is robust to the two income measures. The result may be suggestive of a poverty alleviating role for forests in rural Malawi, given that the very dependent group began the survey year relatively poor in terms of asset definitions of poverty. However, this conclusion rests on the validity of the chosen poverty lines and the extent to which observed values for income accurately reflect true values.

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[59] The poverty line and all monetary figures reported in this chapter are in Sept. 2000 MK.

Table 5.7 Poverty Headcount, Poverty Gap, and Squared Poverty Gap by Level of Forest Dependence, Sample Households 1999/2000

Poverty Indicator	Income Includes Value of Firewood			Income Excludes Value of Firewood		
	Less Dependent	Dependent	Very Dependent	Less Dependent	Dependent	Very Dependent
Poverty Line = MK5,595						
Headcount ratio FGT (0)	0.86	0.79	0.76	0.86	0.84	0.81
Poverty gap FGT (1)	0.54	0.49	0.46	0.58	0.53	0.50
Squared poverty gap FGT(2)	0.38	0.33	0.31	0.42	0.38	0.36
Poverty Line = MK4,197						
Headcount ratio FGT (0)	0.83	0.74	0.67	0.83	0.74	0.71
Poverty gap FGT (1)	0.44	0.40	0.37	0.49	0.45	0.41
Squared poverty gap FGT(2)	0.28	0.24	0.23	0.33	0.30	0.27
Poverty Line = MK2,798						
Headcount ratio FGT (0)	0.63	0.63	0.57	0.76	0.74	0.57
Poverty gap FGT (1)	0.28	**0.25**	**0.25**	0.33	0.31	0.30
Squared poverty gap FGT(2)	0.17	**0.12**	**0.13**	0.21	**0.17**	**0.17**
Number of observations	59	19	21	59	19	21

Given the evidence presented in the section that forest use may help the poor move out of poverty, it is important to examine whether it is all or just some forest activities which provide a basis for socioeconomic improvement. Close inspection of the data shows that very (forest) dependent households that started the year poor in assets but fared well during the survey year in terms of welfare indicators (income, consumption, poverty), were generally involved in three types of forest activities: timber extraction (sales of planks, pit sawing, plank transport), sale of food and drink produced with wood as a key input (e.g. *masese* beer and baked goods), and charcoal marketing. With the exception of plank sales to timber merchants, each of these categories comprises some activities that require little in the way of financial and physical capital and are, therefore, accessible to the poor.

In sum, the data seem to suggest that access to forest income may help the poor to improve their economic well-being, rather than perpetuate poverty. Among the three forest-dependent groups, those that were dependent on forests for 67 – 100 percent of cash income had the highest average for cash income and the lowest levels of measured poverty. Forest activities that hold the most promise for poverty alleviation at the study sites are timber extraction, sale of food and drink, and charcoal marketing.

What is the Impact of Forest Income on Income Inequality?

One of the more interesting patterns that emerges from this analysis is that households that were very dependent on forests for income had total household income roughly equivalent to and levels of measured poverty lower than households that were less dependent on forests during the survey year. This begs the question of whether

access to forests as a source of income serves to reduce income inequality at the study sites. To examine this question, income inequality measured by the Gini coefficient is decomposed by income source, which is indexed by i. Note that in the current context, the term "income" refers to "income per household resident". The Gini coefficient (G) decomposed into its income source components is given by (Yao 1999):

$$G = \sum_{i=1}^{I} w_i C_i \tag{2}$$

where I is the total number of source incomes i and w_i represents the share of source income i in aggregate household income. C_i, the concentration ratio of source i, is:

$$C_i = 1 - \sum_{j=1}^{N} p_j 2(Q_{ij} - w_{ij}) \tag{3}$$

where p_j is the population share of household j in the total population and w_{ij} is the income share of household j for source i. The variable Q_{ij} is the cumulative income share up to household j for income source i defined by:

$$Q_{ij} = \sum_{k=1}^{j} w_{ik} \tag{4}$$

For each source income i, the concentration ratio (C_i) is computed using equation (3) relying on observations sorted in ascending order of aggregate income. Source income Gini coefficients (G_is) are calculated using equation (3) sorting the observations in ascending order of the given source income i. The Gini coefficient for aggregate income is calculated with equation (2).

Table 5.8 Decomposition of Income Inequality by Sources of Income (Gini Coefficient), Total Income for Sample Households 1999/2000

	Forest	Farm	Wage-work	Self-empl.	Sales assets	Transfers	Total
Gini coeff. (G_i and G)	0.63	0.52	0.84	0.90	0.90	0.83	0.49
Share in G	0.28	0.25	0.13	0.16	0.06	0.12	1.00
Concentration ratio (C_i)	0.46	0.40	0.53	0.66	0.63	0.58	-----
Mean income from source I (MK/person)	1,105	1,104	425	436	160	377	3,607
Share in total income (w_i)	0.31	0.31	0.12	0.12	0.04	0.10	1.00
$w_i C_i$	0.14	0.12	0.06	0.08	0.03	0.06	0.49

Results for total income are presented in Table 5.8. The first row of the table provides Gini coefficients by source income and aggregate income. The aggregate income Gini has a value of 0.49. The World Bank (1995) has estimated the Gini coefficient for rural smallholders in Malawi to be 0.57, which is 14 percent higher than the estimate here. The discrepancy may be due to any number of factors, including measurement error in the household survey data. It is also possible that the World Bank's estimate is based on a measure of income that did not include forest resource uses. The income data used by the World Bank were from the 1992/93 National Sample Survey of Agriculture (NSSA) conducted by Malawi's National Statistical Office (NSO). It is unlikely that the survey collected information on home consumption of forest products. Note that if collected firewood is excluded from the household income accounts, the estimated Gini coefficient is 0.52. And if all forest income is excluded, the estimated

Gini coefficient is 0.56, very close to the World Bank's estimate. Figure 5.2 provides a graphical illustration of the potential impact of forest income on income inequality. The diagonal line denotes perfect income equality. The Lorenz curves are constructed with the household survey data for total income including and excluding forest income. The figure shows that the addition of forest income to household income tends to reduce income inequality, all else being equal. The amount by which measured income inequality is reduced when forest income is included is12 percent.

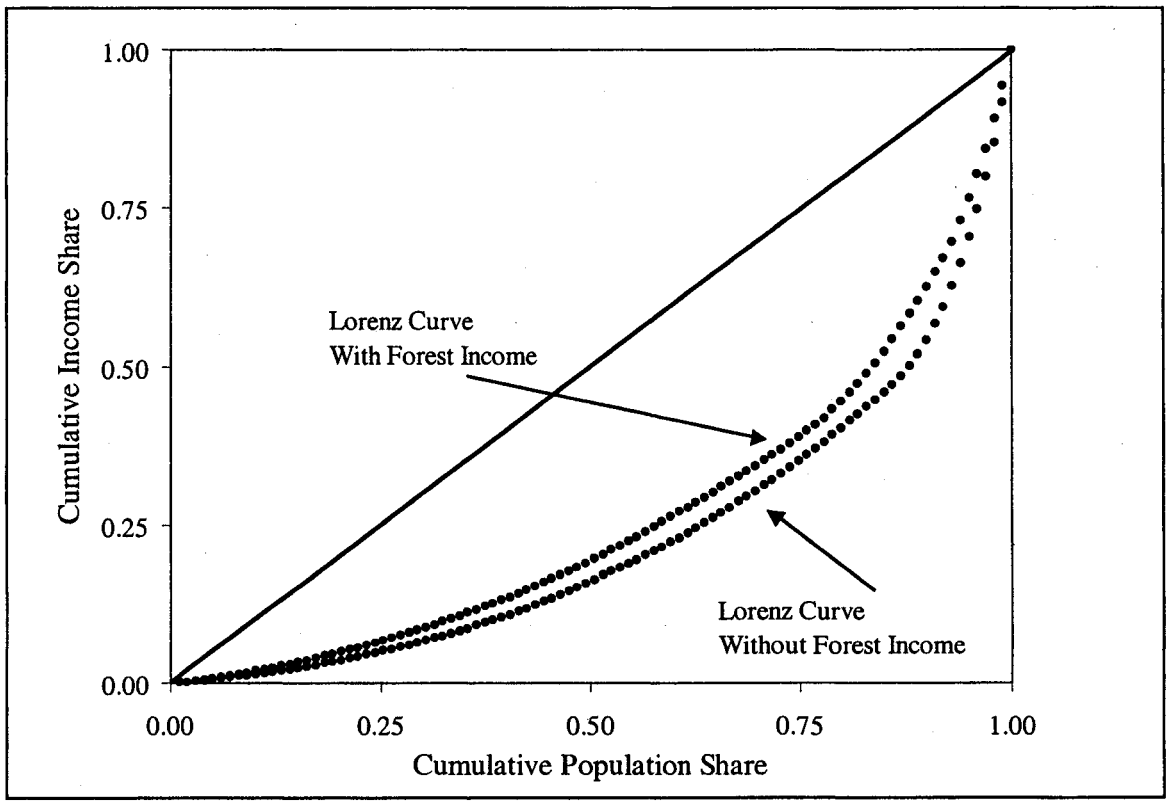

Figure 5.2 Lorenz Curves for Total Income With and Without Forest Income, Sample Households 1999/2000

Turning now to the source income Gini coefficients, we see that each is higher than the aggregate income Gini. The very high Gini coefficients for self-employment, wage-work, sales of assets, and transfers reflect zero entries for many observations for these income sources. The finding that source Gini coefficients are higher than the aggregate income Gini indicates that diversification of income serves to reduce income inequality across the sample households. However, not all income sources reduce income inequality. The second row of Table 5.8 gives the share of total income inequality attributed to each income source. Forest and farm income contributed the largest shares to total income inequality, largely because income from these sources made up high shares of aggregate income (see the fourth row of the table). To assess whether a given source of income reduces or increases income inequality, refer to equation (2). All else being equal, if $C_i > G$ and the share of source income (w_i) is increased (decreased), then income inequality (G) will increase (decrease). This implies that sources of income with concentration ratios (C_i) having values lower than 0.49 (the aggregate income Gini) help reduce total income inequality. Results in the third row of Table 5.8 indicate that, all else being equal, an increased share of income from the forest or the farm help lower income inequality at the study sites; increased income shares from other sources would yield higher income inequality. Gini coefficients are also calculated for cash income (see Table 5.9). For the forest sector, the same conclusions are reached whether one uses the cash income or the total income data , although the total income data provide stronger evidence of reduced income inequality with forest access.

Table 5.9 Decomposition of Income Inequality by Sources of Income (Gini Coefficient), Cash Income for Sample Households 1999/2000

	Forest	Farm	Wage-work	Self-empl.	Sales assets	Transfers	Total
Gini coeff. (G_i and G)	0.77	0.80	0.84	0.90	0.90	0.83	0.58
Share in G	0.32	0.10	0.16	0.21	0.07	0.15	1.00
Concentration ratio (C_i)	0.57	0.49	0.54	0.70	0.63	0.58	-----
Mean income from source i (MK/person)	820	312	425	436	160	377	2,531
Share in total income (w_i)	0.32	0.12	0.17	0.17	0.06	0.15	1.00
$w_i C_i$	0.18	0.06	0.09	0.12	0.04	0.09	0.58

To sum up the findings of this section, the data seem to suggest that forests offer a more egalitarian source of income compared with most other income sources at the study sites. This is no surprise given that collected firewood from adjacent forests represents an important input to household income for all sample households.[60] In addition, forest occupations tend to be easy entry; some require only labor for participation. Other forest occupations may require physical or financial capital for entry and operation, but in general these requirements are below those for (non forest-based) wage-work and self-employment. Thus, rural people can move in and out of forest occupations with relative

[60] The results may underestimate the contribution of forests to a more equal income distribution in rural Malawi. This is because the measure of total income does not include the value of many subsistence uses (e.g. forest foods and home construction materials) due to data availability. The value of these subsistence uses is likely to be of particular importance to the poorest households.

ease to manage or cope with income risk, to earn cash to purchase agricultural inputs, and to acquire capital through investments in their children's education, animal purchases, etc. The finding that forest income helps lower income inequality is consistent with patterns reported elsewhere. Cavendish (1999) reports that environmental income brought about a 20 to 30 percent reduction in measured inequality among his sample of Zimbabwean smallholders. Likewise, Reddy and Chakravarty (1999) found that forest income was associated with a small reduction in income inequality for their sample of northern Indian farm households. This analysis is one of the first to formalize the measurement of how forest income influences aggregate income inequality with the use of decomposed Gini measures.

Chapter Summary

This chapter examined the effects on household welfare in rural Malawi of economic reliance on forests. The data indicate high levels of dependence on forests as a source of income, with sample households deriving about 30 percent of total income from forests on average. This suggests that poverty would likely increase in rural Malawi if forest access were reduced, at least in the short term. Regression analysis found that households that were well endowed in terms of adult male labor and forest tools but poor in terms of human capital (education) and animal holdings were more reliant on forest income for their livelihoods. Yet, over the course of the survey year, the asset poor, very (forest) dependent households had roughly the same income and consumption levels and lower levels of measured poverty compared with households that were less dependent on forests for livelihoods. Thus, the analyses of the chapter find no evidence that forest

reliance perpetuates poverty in rural Malawi, in the short term. Rather, the data suggest that access to forest income helps the rural poor maintain their livelihoods and, for households engaged in certain forest occupations, potentially provides a pathway out of poverty. Finally, findings presented in the chapter suggest that access to forests as a source of income can reduce income inequality across households. The addition of forest income to the household income accounts leads to a 12 percent reduction in measured income inequality. Taken together, the findings here suggest a potentially important role for forests in improving welfare in rural Malawi at the household and community levels.

CHAPTER VI – CONCLUSIONS AND POLICY RECOMMENDATIONS

This dissertation used household survey data from rural Malawi to examine the immediate causes of smallholder-led forest degradation and some of the contributions of forests to the welfare of the rural poor. I begin this chapter with a summary and synthesis of key findings from Chapters III through V, highlighting some important methodological and empirical contributions. I then use the findings of the study to suggest some ways in which policies might help to slow the rate of forest decline in Malawi.

Analytical Findings

In Chapter III, a farm-household model of labor allocation was developed. The model focused on household labor allocation to four sectors: the forest, the farm, wage-work, and self-employment. Slutsky decomposition of the reduced-from forest labor supply equation was used to obtain analytical results for own- and cross-price effects on forest labor supply. The analysis revealed ambiguous relationships between the forest labor share and each price variable (maize price, returns to wage-work, and returns to forest use). These ambiguous relationships stand in contrast to the results from less complex analytical models of deforestation. The latter often find a positive relationship between deforestation and agricultural prices and a negative relationship between off-farm wages and deforestation. Three explanations for the indeterminate relationships found in Chapter III can be offered. First, the farm-household model is non-separable,

permitting both income and substitution effects that may have opposite signs, and either effect may dominate. The assumption of perfect markets is common in the tropical deforestation literature, but it is unlikely to be valid in rural parts of low-income countries (de Janvry et al. 1991). Second, the model shows how net buyers of maize and forest products might respond differently to changes in prices compared to net sellers of these goods. This subtlety is important in light of evidence that many low-income farm households are net food buyers (Weber et al. 1988; Barrett and Dorosh 1996). Third, because land acquisition was modeled as a function of labor alone (a characteristic of much slash and burn agriculture), indeterminate substitution effects surface in the model, leading to the possibility that the forest labor share could rise or fall in response to a change in the price of maize.

Empirical Findings

The empirical analysis of Chapter III used a systems approach to analyze forest labor supply decisions. This approach enabled a theoretically consistent treatment that leads to economic and policy insights obscured by a single-equation approach to studying forest use. For example, the empirical analysis revealed that self-employment serves as a substitute for forest use. This finding is a new one and, importantly, it suggests that the self-employment sector, similar to the wage-work sector, can absorb labor that might otherwise be engaged in forest exploitation.

Chapter IV examined the role of forests as a shock-coping mechanism, a perspective that has thus far received little empirical investigation by development researchers. The analysis sought to measure the extent by which the use of forests is

mitigated or exacerbated by transitory income shocks. A novel income shock measure was used for the analysis, receipt of a starter pack. Results of a Tobit model and random-effects models of income and savings suggest that policies that help to alleviate asset poverty in tropical forest areas can potentially yield outcomes that alleviate pressure on forests and also improve household welfare.

Finally, Chapter V contributes to an improved understanding of the household economies of rural households at the tropical forest margin. Only a handful of studies have included forest-collected goods in their income measures and treated forest-derived cash income comprehensively as was done here. These sources of income may be important for rural households in tropical forest areas: the sample households of this study derived about 30 percent of household income from forests. Findings of analyses of poverty and income inequality suggest a potentially important role for forests in improving welfare in rural Malawi at the household and community levels.

What Factors Drive Rural Households' Decisions to Degrade Forests in Malawi?

The results of Chapters III through V suggest three key factors that condition forest use decisions in rural Malawi: current production and work incentives, asset poverty, and limited availability of substitutes for wood-based fuels.

Current Production and Work Incentives

The analysis of Chapter III found that sample households respond well to production and work incentives, an essential element in economic development. In each of the estimated labor share equations, the own-price effects are positive. Likewise, negative cross-price terms in nearly all of the share equations indicate that labor can be

drawn away from one sector through price incentives in another. These results indicate that households' decisions to degrade forests take into account the relative returns to labor in the forest, farm, wage-work, and self-employment sectors.

In Chapter IV, the analysis found that households that received a starter pack had lower forest extraction levels during the agricultural period, all else being equal. If the reduced forest labor was allocated to the farm, as one would expect, then this suggests that households respond well to improved opportunities to work on their farms.

In Chapter V, it was found that, on average, households that were very dependent on forests for income had higher cash income in 1999/2000. For these households it appears that the forest is not an employer of last resort, but one which offers opportunities to improve living standards. The forest occupations that may provide a pathway out of poverty are marketing of food/drink, timber extraction, and charcoal marketing.

Asset Poverty

Findings suggest that households that are poor in productive and non-productive physical assets and human capital have higher levels of forest use, extraction, and dependence. The analysis of chapter III showed that households that are poor in holdings of non-productive physical capital (iron roofs) devote a smaller share of household labor to forests and a larger share to wage-work and self-employment. Results from the regressions reported in Chapter IV suggest that (physical) asset poor households have higher rates of forest extraction in the agricultural period than do better-off households. It was argued that this result indicates that the rural poor in Malawi rely on forests for coping with income shortfalls to a greater extent than the better off.

Regression results reported in Chapter V revealed that households that are poor in physical assets (animals, bicycles, and radios) and human capital (education of the household head), are more dependent on forests for livelihoods, all else being equal.

Limited Availability of Substitutes for Wood-based Fuels

The analysis of Chapter III found that households that use harvest residues for cooking spend significantly less time on forest activities than did those that cooked mainly with wood. Results also suggest that tree planting on farm reduces the share of household labor allocated to forests, all else being equal. These results indicate that where low-cost alternatives to forest-collected wood are available, households may, at least partially, move away from cooking with wood from adjacent forests.

What Are Some of the Contributions of Forest Resources to Rural Livelihoods?

The results of Chapter IV appear to indicate that forests provide an important means for coping with income shocks that is particularly important for asset poor households. Chapter V documents some of the ways in which access to forests improves the living standards of rural Malawians. It was found that sample households depended on forests for about 30 percent of income during the study year. This suggests that poverty would likely increase in rural Malawi if forest access were reduced, at least in the short term. Poverty analysis found that households that were very dependent on forests for income had lower levels of measured poverty. Access to forest income also reduced measured income inequality by 12 percent for the sample. Taken together, these findings indicate that the decline of Malawi's forests has serious consequences for the welfare of the rural poor. In addition, there is an apparent dilemma. If forest access is restricted

today to enable forest regeneration, the current welfare of the rural poor will suffer, but future populations will have more abundant forest resources available to secure their livelihoods. Under present circumstances, there appears to be an inextricable link between the fate of the rural poor and the fate of forests in Malawi.

Policy Implications

What policies might be useful to reduce incentives to degrade forests in Malawi and other tropical countries? Based on the findings of the dissertation, interventions are proposed that have the following objectives: (a) provide employment opportunities outside the forest sector, (b) increase land productivity in the smallholder sub-sector, (c) assist forest producers engaged in activities with high net hourly returns, and (d) reduce the demand for firewood obtained from adjacent forests. In addition, if forest conservation efforts are to prove effective, strengthening of forest management institutions will be crucial.

Provide Employment Opportunities Outside the Forest Sector

The findings in Chapter III and elsewhere suggest that public investment in the wage-work sector is a potential strategy to reduce forest pressure (Bluffstone 1995; Shively 2001). However, it should be stressed that considerable job creation and human capital improvements will likely be necessary for the success of such a strategy. High-wage jobs in the wage-work sector are few and available to the minority of educated workers. Investments in education will be important for the long term. Agricultural contract work, the main form of wage-work in rural areas, is low paying and provides limited competition with the forest as an income-generating activity. Also at issue, from

the standpoint of agricultural development, is that agricultural contract work naturally occurs during the agricultural period. Participation in such work, therefore, reduces the time available for tending one's own garden. In the near future, food-for-work interventions during the dry season may offer more promise for absorbing low-skill labor and, subsequently, reducing forest use.

Self-employment was also found to be a substitute for forest use; this suggests that increased opportunities in the self-employment sector may help reduce forest pressure. The range of self-enterprise activities in rural Malawi is vast, but a common denominator is that financial capital is required for participation. Key to the success of any program aimed at encouraging self-employment is improved access to cash. Better-off farmers have savings and/or can more easily obtain credit for start-up costs. At issue is how to get cash into the hands of poorer households. Food-for-work interventions and credit schemes that are self-selecting for poorer individuals may prove useful.

Two innovative self-enterprise projects that appear to be conserving forests and alleviating poverty are the Wildlife and Environmental Society of Malawi's *malembe* juice project (Earth Year 2002) and the Ndirande Nkhuni Biomass Briquette Programme (Mabona 2001). The *malembe* juice project, funded by the German Society for Technical Cooperation (GTZ) and the United Nations Development Programme (UNDP), involves about 18,000 rural people, primarily women, who harvest and make the juice with fruit from the baobab tree. The drink is very popular (about 2,000 liters per month is currently sold). The involved villagers are making good income and are actively involved in the protection and planting of baobab trees in their communities. The briquette program helps to equip women's cooperatives with the necessary skills and start-up capital to

produce and market cooking briquettes that are low-cost relative to firewood. The project, funded by the Canadian government, has been successful at increasing the income of the entrepreneurs and reducing pressure on forest resources in the area.

Increase Land Productivity

Forest degradation and forest insecurity are closely linked in Malawi. A random-sample survey of over 10,000 households across Malawi found that only 34 percent of households had reported calorie consumption at or above the recommended daily requirments (RDR) for calories (Poverty Monitoring System 2000c). Smallholder farmers with limited access to improved agricultural techniques may have no other means to secure their families food needs other than encroaching on forest land (GOM 1998a).

Findings from Chapters III and IV suggest that households respond to production incentives in the agricultural sector by reducing forest extraction. The policy implications are appealing: improvements in the agricultural sector appear to reduce pressure on forests. Nevertheless, these results should be interpreted with caution. The analysis of Chapter III found a negative correlation between the forest labor share and the price of maize. However, the forest labor share is an imperfect measure of forest degradation, and one can imagine scenarios in which a rise in the price of maize would be accompanied by a reduction in labor allocated to forest uses, expansion of crop area, and increased forest degradation.[61] The analysis of Chapter IV found that households that

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[61] For example, in the absence of land-saving intensification, an increase in the returns to maize production could precipitate an increase in area devoted to maize (Coxhead et al. 2002). Such a pattern would be consistent with a positive substitution effect if the cleared land were forested, since the forest labor share variable includes forest clearing

received a starter pack had lower forest extraction, all else being equal. Yet the measure of forest extraction used was extraction for cash income generation, that is, forest clearing for agricultural expansion was not included. It is plausible that households receiving starter packs moved away from forests for cash income generation, and expanded maize production at the intensive and extensive margins. It is also important to note that the theoretical and empirical literature regarding the relationship between forest degradation and agricultural productivity remains inconclusive. In general however, agricultural technologies that are labor- and capital- intensive are less likely to result in increased forest pressure (Kaimowitz and Angelsen 1998).

Observers of conditions in Malawi contend that low and declining maize yields are mainly a function of declining soil fertility, and nitrogen deficiency is the dominant soil fertility problem (Blackie et al. 1998; Smale and Heisey 1997). Improvements in land productivity through adoption of techniques that enhance soil fertility may prove useful for increasing smallholder maize production without increasing incentives to expand gardens into forest land. These techniques include use of chemical fertilizers, intercropping and rotations of maize, agroforestry trees, and legumes, and increased use of compost manure. The National Environmental Action Plan (NEAP) is currently implementing programs to encourage widespread use of these soil fertility enhancements.

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activities. If the income effect for the forest labor share were negative and large, reflecting a sizeable reduction in fuelwood collection time, it could easily outweigh a positive substitution effect. In this example, the net effect of an increase in the returns to maize on the forest labor share would be negative. However, the fall in the forest labor share would be accompanied by increased forest degradation where fuelwood collection is less degrading than forest clearing.

Assistance to Forest Producers in Growing Markets

Some forest-based activities at the study site have high returns. Occupations that fit this description are: charcoal marketing (Village 3), timber extraction (Village 1), and sale of food/drink (all villages). At issue is that most of these activities, particularly charcoal production and timber extraction, result in considerable forest degradation. There may, however, be ways to ensure that forest users continue to operate in these markets improving their living standards while simultaneously reducing pressure on natural forests.

As part of the National Environmental Action Plan (NEAP), many of Malawi's protected forests are now being co-managed by the Forestry Department (FD) and local communities. The government of Malawi (GOM) has also relinquished control of forest resources on customary land to local communities (GOM 1998b). Meanwhile, the demand for commodity wood for construction purposes and furniture manufacturing in Malawi's urban areas is likely to be increasing; Malawi's urban population growth rate is estimated at over 6 percent per year (UNCHS 2001a cited in UNEP 2002). These factors imply improved opportunities for timber marketing by rural people residing close to urban centers. Community-company forestry partnerships exist in at least 57 low-income countries and have proven useful for protecting forests and reducing poverty. For example, 10,000 farmers in KwaZulu-Natal, South Africa have entered into forestry partnerships with international paper and pulp companies. The companies provide the necessary material goods (e.g. seedlings and tools), low-interest loans, and technical assistance for establishing and managing the small eucalyptus woodlots. In return, the companies have rights to purchase the trees when they are mature (Scherr et al. 2002).

Charcoal production is an activity that causes considerable forest degradation. For this reason, the GOM banned charcoal burning in the 1990s, but this has proven largely ineffective at curbing charcoal production (Openshaw 1997). Charcoal marketing is simply too profitable, and rural people have few viable options for earning a living. The GOM intends to reduce tariffs on paraffin and electricity in the near future, and this should put downward pressure on demand for charcoal in urban areas. In the interim, it will be important to find alternative sources of wood for charcoal production in order to conserve scarce indigenous forest resources. One possibility is to make use of currently under-utilized eucalyptus timber supplies in FD plantations (as has been suggested by some analysts – see Knacck Consultants 1999). Eucalyptus matures quickly, and it produces a dense charcoal that should be well-accepted by consumers (Knacck Consultants 1999). Technical assistance will be necessary to ensure that efficient charcoal production technologies are used. For example, in Village 3 all sample charcoal producers used traditional earth mounds for making charcoal rather than the more wood-efficient half-orange brick kilns. Perhaps the greatest challenges will be faced by village heads and rural communities, to organize themselves and collectively establish and enforce rules forbidding charcoal burning on customary land.

Reduce Extraction of Forest-Collected Firewood

In rural Malawi, extraction of wood for home energy use is occurring at a rate that exceeds sustainable yield and is a key driver of forest degradation (GOM 1998a). Forest pressure can be reduced with increased availability of low-cost alternatives to forest-

collected wood-based fuels (e.g. trees on farm and community woodlots) and widespread adoption of fuel-efficient cooking technologies.

The household survey data indicate that households have incentives to cultivate trees and that doing so reduces forest pressure. More than half the sample households had planted trees on their farm in the past five years, and in most instances seedlings were purchased or collected locally. Likewise, in focus group discussions people expressed considerable interest in planting trees on their farms (see Appendix C). During the survey year, seedlings were affordable even for the very poor, costing about MK1 each. In some areas, people collect naturally recruited seedlings and transplant them (Konstant 1999). Therefore, policy interventions to encourage people to plant trees on their farms do not seem necessary.

However, there may be a role for policy in three main areas. First, focus group discussions revealed that some households who want to plant trees on farm are constrained by the small size of their landholdings. Community woodlots on land allocated by the village head may be the most viable tree-planting option for households with very small farms. A second important area for intervention is technical assistance to villagers to ensure they are well-informed on tree planting and management practices. For example, at the study sites local people have been observed felling on-farm fruit trees the first year the trees do not bear fruit due to their belief that this indicates low productivity (Kathindwa 2000). Finally, there may be a role for policies to promote adoption of agroforestry species (Dewees 1995). Incentives to plant specific trees with capacity to improve soils were largely absent at the study sites. Planting of agroforestry

trees can increase agricultural productivity and may have the side benefit of increased availability of harvest residues for cooking, which can further reduce forest pressure.

The success of on-farm tree planting initiatives will depend to a large extent on whether communities and village leaders can organize themselves and act collectively to protect their forests. Since forest resources continue to be treated as free goods, and rural women in Malawi have low status and are the ones responsible for domestic firewood collection, there is little incentive to switch from forest-collected firewood to private fuel sources, such as on-farm trees. In the study area, on-farm trees are often over-mature and not utilized because households are saving the trees for future use when forest resources are more scarce (Knacck Consultants 1999).

Widespread adoption of improved cooking stoves can significantly reduce demand for wood. All sample households used the traditional three-stones method of cooking. Evidence suggests that improved stoves available in Malawi increase from three days to five the amount of time a head load of wood will last for a typical family. Cost, availability, design features, and know-how have been associated with slow adoption of stoves up to now (Knacck Consultants 1999). As part of the NEAP, rural women are being trained in the construction and use of improved mud stoves. Thus, adoption constraints related to cost, availability, and know-how should be reduced, but appropriate stove design remains a key issue. Adoption of improved stoves in rural parts of low-income countries has often been slow because the characteristics of the stoves did not match the concerns of stove users (World Energy Council and FAO 1999). For example, "improved" is usually defined as fuel efficient, but stove users often care more about the speed of cooking. Important design features include fuel and time efficiency,

ease of use, the possibility to use harvest residues as fuel, and reduced smoke.[62] In addition, to encourage widespread adoption, women will need to be educated on the many benefits that can come with use of improved stoves. For example, direct measurements found that female wood collectors carried an average of 40 kilograms on their heads traveling from collection sites to their homes, often several kilometers away (see Appendix C). This has serious consequences for women's health, as does inhalation of large amounts of smoke when cooking with traditional stoves (Jiggins 1994).

Policies such as those outlined above are just a sample of many possible strategies that together may prove useful for "solving" Malawi's deforestation problem. The policies described above aim to slow forest decline in order to protect biodiversity and the livelihoods of rural populations in the future without harming, and perhaps even improving, the current well-being of the rural poor.

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[62] Improved stoves are useful for cooking food. Space heating, beer brewing, and fish smoking are some purposes for which the three-stone stove will still be necessary.

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APPENDICES

Appendix A – Household Survey Questionnaires

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Household Census

Page 1. Cover Sheet

	NAME or DESCRIPTION	CODE NUMBER
District		
Traditional Authority		
Village		

INTERVIEWER	
Name	Signature

This survey is being administered by Monica Fisher a Ph.D. student at Purdue University, USA and an affiliate of the Centre for Social Research, Malawi. All enquiries may be addressed to:

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University of Malawi
P.O. Box 278
Zomba, Malawi
Tel: 522-916

Date of Interview Mo/Day/Year	Name of Household Head	Gender of Household Head 1.Female 2. Male	How many months of the year does the household head reside in the household in a typical year? (months)	What is the size of the household's landholding?		Are household residents willing to participate in our study if their household is selected for monthly interviews? 1. Yes 2. No
				Quantity	Units (specify)	

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire A
General Information Regarding The Household Head, Household Population, Forest Use, and Agriculture

Type of Interview: Group of Household Residents (male and female)
Frequency: Once at Start of Survey (month of July)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5. 6.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. The Household Head

Research Assistant(s): The information on this page is intended to refer to the individual identified by the respondents as the household head, named on the cover sheet.

A1 What is the age of the household head? ☐
[Research Assistant(s): First ask the age of the household head.
If household residents are unsure, refer to our list of important dates on page 8.]

1. 15-24 years
2. 25-34 years
3. 35-44 years
4. 45 and above

A2 Was the household head born in this village? ☐

1. Yes (*Skip to question A5*)
2. No (*Go to question A3*)

A3 How many years has the head lived in this village? ☐
(*Research Assistant(s): Again you may need to refer to the list of important dates.*)

A4 What circumstances led the head to move to this village? ☐

1. Marriage
2. Employment
3. Access to land
4. Access to other resource (*specify*) _____
5. Other (*specify*) _____

A5 To which ethnic group does the head belong? ☐

1. Chewa
2. Ngoni
3. Tumbuka
4. Tonga
5. Lomwe
6. Sena
7. Yao
8. Other (*Specify*)_____

A6 What is the head's religious affiliation? ☐

1. Muslim
2. Catholic
3. Other Christian (specify)_____
4. No religion
5. Other (specify) _____

A7 What is the highest level of schooling completed by the head? ☐

1. No schooling
2. Some Primary
3. Completed Primary
4. Some JCE
5. Completed JCE
6. Some MSCE
7. Completed MSCE

Page 3. The Household Head (continued) and Household Population

A8 Is the head a member of a farm club? ☐
1. Yes
2. No

A9 Is the head a member of a cooperative or village association? ☐
1. Yes (*Describe*) _____
2. No

Research Assistant(s): The next set of questions refer to the household. Please remind respondents of our definition of household before you proceed.

A10 How many people will reside in your household for more than half of this year (i.e. 1999/2000 agricultural year)? ☐

Research Assistant(s): In the next set of questions we are interested in breaking down this total figure for household population into different types of household residents: (1) Young Children, (2) Boys, (3) Girls, (4) Men, (5) Women and (6) Elderly. You should tell respondents that we are defining Young Children as those too young to assist adults with agricultural activities. Boys and Girls are old enough to assist adults with agricultural activities. Elderly are those household residents who are now too old to help with agricultural activities.

How many of the following people will reside in your household for more than half of this year?

A11. Young Children		☐
A12. Boys	attending school	☐
A13.	not attending school	☐
A14. Girls	attending school	☐
A15.	not attending school	☐
A16. Men	schooling or working off-farm	☐
A17.	not schooling or working off-farm	☐
A18. Women	schooling or working off-farm	☐
A19.	not schooling or working off-farm	☐
A20. Elderly		☐

Research Assistant(s): Before proceeding to the next page, check that the figure in A10 corresponds to the total for A11 through A20.

Page 4. Wood Collection

Research Assistant(s): Before continuing to the next questions let your respondents know that you will now be asking questions related to forest use.

A21 Are residents of your household involved in collecting and/or cutting wood? ☐

1. Yes (*Go to question A22*)
2. No (*Skip to question A25*)

A22 How do household residents use the collected wood?

Code	Use	1. Yes 2. No
1	Cooking	
2	Heating	
3	Charcoal production	
4	Market the raw wood	
5	Brick burning	
6	Tobacco curing	
7	Beer brewing	
8	Construction	
9	Carpentry	
10	Storage for later use	
11	Other (specify) _____	
12	Other (specify) _____	

A23 What are the four main uses of wood by household residents, in order of importance?

_____

_____

_____

_____

Page 5. Wood Collection (continued) and Other Forest Uses

A24 Do household residents face constraints in the collection and/or cutting of wood (describe)?

A25 Aside from wood, what other products do household residents extract from the forest?

Page 6. Changes in Wood Cutting and Charcoal Production

A26 Are household residents involved in the production of charcoal? ☐

1. Yes *(Go to question A27)*
2. No *(Skip to question A28)*

A27 Do household residents face constraints in charcoal production (describe)?

A28 Over the last few years has there been an increase, decrease or no change in [...] by residents of your household?		
Code	Activity	1. Increase 2. Decrease 3. No change
1	Wood Collection and/or Cutting	
2	Charcoal Production	

A29 Can you explain the increase or decrease in [...]?

Change in wood collection and/or cutting:

_____

_____

_____

Change in charcoal production:

_____

_____

_____

Page 7. Maize Production during the 1998/99 Agricultural Year

Research Assistants: Information on this page concerns the 1998/99 agricultural year. Please make this clear to respondents.

A30 Did residents of your household grow ___ in 1998/1999?			A31 What was the quantity harvested in 1998/99?		A32 How much of the quantity produced was home consumed or put in storage?		A33 How much did you sell immediately after harvest?		A34 How much did you receive for the total quantity sold?
Code	Crop	1. Yes 2. No	Quantity	Units (see key)	Quantity	Units (see key)	Quantity	Units (see key)	(MK)
1	Hybrid Maize								
2	Local Maize								

Units key: [1] kg; [2] 50 kg bag; [3] 90 kg bag; [4] Basket; [5] Bunch; [6] Ox-cart; [7] Other (specify)

Page 8. List of Important Dates

Year	Event
1946	Sinking of the ship "Vipya" off Chitimba – 150 lives lost.
1946	Floods in the Lake Shore and the Lower Shire areas.
1947	Smallpox epidemic throughout the southern province.
1953	Beginning of the Federation (amalgamation of Rhodesia and Nyasaland).
1956	Sir Robert Armitage became governor of the Protectorate.
1958	Arrival of Dr. H. Kamuzu Banda from his medical studies abroad.
1959	State of emergency declared by the colonial government. Dr. Banda, 1339 of his followers and prominent citizens arrested.
1960	Dr. Banda was released from prison and made life president of Malawi.
1961	Malawi's first general election. Malawi Congress Party won.
1964	Malawi becomes an independent country.
1971	Introduction of Malawi's new currency – kwacha and tambala; Previously used pounds, shillings and pence.
1975	Lilongwe became the capital city.
1981	A 93 kilogram meteorite fell in Machinga, became known as Machinga Meteorite.
1984	A visit by Mozambican President Samora Machel. Thousands of Malawians welcomed him at Chileka Airport in Blantyre.
1986	A visit by Zimbabwean Prime Minister Robert Mugabe.
1988	The Government of Malawi devalued the Malawi kwacha for the first time.
1989	Pope John Paul II visited Malawi at the invitation of Dr. H.K. Banda.
1991	Disastrous flood in Phalombe District.
1994	General elections. UDF candidate, Bakili Muluzi and his party won.

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire B (Revised)
Wood and Charcoal Production

Type of Interview: Groups of Women and Groups of Men Separately
Frequency: Once (November)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Sources of Wood

B1 Do you collect and/or cut wood? ☐

1. Yes (*Go to question B2*)
2. No (*Go to question B10*)

B2 From which of the following locations do you collect and/or cut wood? *Research Assistant: Please fill in the rows of B2 first and then proceed to B3, B4, etc.*			B3 On average how many months a year do you collect wood from [...]?	B4 For a typical month in which wood collection occurs, what is the average number of times you visit [...] to collect wood?	B5 On average how much wood do you collect from [...] per visit?		B6 In your household who collects wood at [...]? [*Fill in the box with all that apply.*] 1. Girls 2. Boys 3. Men 4. Women 5. Worked Alone
Code	Location	1. Yes 2. No			Quantity	Units	
1	State forest reserve						
2	Customary land						
3	Your private land holding						
4	Other (specify) _____						

Unit Key: [1] bundle; [2] head load; [3] bicycle load; [4] mendulo (m3 st); [5] kilogram; [6] tonne; [7] bag; [8]animal cart; [9] other (specify)

Page 3. Hired Labor & Marketing of Raw Wood

B7 Do you hire any laborers to work with you on wood collection and/or cutting activities? ☐

1. Yes *(Go to question B8)*
2. No *(Skip to question B10)*

B8 What is your estimate of the amount of time hired laborers help you with wood collection and/or cutting during a typical **year**? ☐ hours

B9 How much would you pay hired laborers for this many hours of work on wood collection and/or cutting? ☐ MK

B10 Do you sometimes buy wood? ☐

1. Yes *(Go to question B11)*
2. No *(Skip to question B15)*

B11 From whom do you usually purchase wood?
[Research Assistant: Have your respondents be as specific as possible about the person or person(s) from whom wood is purchased, e.g. is it a person from the same village or from a neighboring village? Perhaps your respondents will even disclose the name of the person.]

B12 On average how many months a year do you purchase wood? ☐ months

B13 For a typical month in which you buy wood, what is the average amount of wood purchased for the month?
[Research Assistant: Be sure to specify both quantity and units (e.g. headload).]

_____ _____
Quantity Units

B14 What is the average price you pay when you purchase wood?
[Research Assistant: Be sure to specify price in per unit terms.]

_____ / _____
Price (MK) Units

B15 Do you sometimes sell raw wood? ☐

1. Yes *(Go to question B16)*
2. No *(Go to question B21)*

Page 4. Marketing of Raw Wood (continued) and Charcoal Production

B16 At which locations do you sell wood? *Research Assistant: Please fill in B16 first and then proceed to B17, B18, etc.*			B17 On average how many months a year do you sell wood at [...]?	B18 For a typical month in which you market wood, what is the average number of times you wood sell wood at [...]?	B19 On average how much wood do you sell each time you sell wood at [...]?		B20 What is the average price you receive for selling wood? (MK/ unit)
Code	Location	1. Yes 2. No			Quantity	Units (see key)	
1	Roadside						
2	Market						
3	Your farm						
4	Other (specify) _____						

Unit Key: [1] bundle; [2] head load; [3] bicycle load; [4] mendulo (m3 st); [5] kilogram; [6] tonne; [7]50 kg bag; [8]animal cart; [9] other (specify)

B21 Do you produce charcoal? ☐

1. Yes *(Go to question B22)*
2. No *(Skip to question B25)*

B22 In your household who is involved in charcoal production? ☐

[*Research Assistant: Fill in the box with all that apply.*]

1. Girls
2. Boys
3. Women
4. Men
5. None (work alone)

Page 5. Charcoal Production and Marketing

B23 What is your estimate of the amount of charcoal you produce in a "typical" month?
[Research Assistant: Be sure to specify both quantity and units (e.g. 50 kg bag).]

_____ _____
Quantity Units

B24 How much raw wood would you use to produce this amount of charcoal *(the amount from B23)*?

_____ _____
Quantity Units

B25 Do you sell charcoal? ☐

1. Yes *(Go to question B26)*
2. No *(Skip to question B30)*

B26 At which locations do you sell charcoal? *Research Assistant: Please fill in B26 first and then proceed to B27, B28, etc.*			B27 On average how many times a month do you sell charcoal at [...]?	B28 On average how much charcoal do you sell each time you sell charcoal at [...]?		B29 What is the average price you receive for selling charcoal? (MK/ unit)
Code	Location	1. Yes 2. No		Quantity	Units (see key)	
1	Roadside					
2	Market					
3	Your farm					
4	Other (specify) _____					

Unit Key: [1] bundle; [2] head load; [3] bicycle load; [4] mendulo (m3 st); [5] kilogram; [6] tonne; [7] 50 kg bag; [9]animal cart; [10] other (specify)

Page 6. Hired Labor for Charcoal Production & Charcoal Resale

B30 Do you hire laborers to work with you on charcoal production operations? [ ]

1. Yes (*Go to question B31*)
2. No (*Go to question B33*)

B31 What is your estimate of the amount of time hired laborers help you with charcoal production during a typical year? [ ] hours

B32 How much would you pay hired laborers for this many hours of work on charcoal production operations? MK [ ]

Research Assistant: Questions B33 and B34 concern only those respondents who sell charcoal but do not produce charcoal themselves. Insert the quantity in B28 in the blank space in question B33 before asking the question.

B33 On average how much do you pay for MK [ ]

_____ of charcoal?

B34 From whom do you purchase charcoal?

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire D
Household Income and Expenditures

Type of Interview: Groups of Women and Groups of Men Separately
Frequency: Once Every Three Months (Sept., Dec., March and June)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Agricultural Cash Income

D1 Did residents of your household earn income from the sale of agricultural production in the past three months, i.e. during the months of [...], [...] and [...]? *Research Assistant: Please complete the column for D1 before proceeding to subsequent questions.*			D2 What was the quantity of [...] sold?		D3 What is the approximate value of the total quantity sold of [...]? (MK)	D4 Who generated the major part of this income? 1. Head 2. Wife 3. Son 4. Daughter 5. Other
Code	Crop Name	1. Yes 2. No	Quantity	Units (see key)		
1	Hybrid Maize					
2	Local Maize					
3	Rice					
4	Sorghum					
5	Cassava					
6	Sweet Potato					
7	Groundnuts					
8	Pigeon Peas (nandolo)					
9	Velvet Beans (kalongonda)					
10	Tobacco					
11	Other (specify) _____					

Units key: [1] kg; [2] 50 kg bag; [3] 90 kg bag; [4] Basket; [5] Bunch; [6] Ox-cart; [7] Other (specify)

Page 3. Other Cash Income

D5 Did residents of your household derive income from any of the following sources in the past three months, i.e. during the months of [...], [...] and [...]? *Research Assistant: Please complete the column for D5 before you proceed to the subsequent questions.*			D6 What is the approx. value of total household earnings from [...] during the past three months? (MK)	D7 Who generated the major part of this income? 1. Head 2. Wife 3. Son 4. Daughter 5. Other
Code	Source	1. Yes 2. No		
1	Sale of animals (specify) _____			
2	Sale of animal products _____			
3	Sale of assets (other than animals, specify) _____			
4	Sale of prepared food or drinks (specify) _____			
5	Resale of agricultural crops (specify):_____ (specify location of purchase): _____ (specify quantity & units purchased/sold) _____		Purchase Price: _____ Resale Price: _____	
6	Thatching, brickmaking, basketry, pottery, carpentry, other crafts (specify) _____			
7	Sale of wood or charcoal (specify quantity & units) _____			
8	Employment by household residents (specify, e.g. work as traditional healer, ganyu) _____			
9	Remittances from non-residents (specify location) _____			
10	Loans and gifts (specify whether loan or gift)			

Page 4. Household Expenditures

D8 Did residents of your household spend money on any of the following items during the past three months, i.e. during the months of [...], [...] and [...]? *Research Assistant: Please complete the column for D8 before you proceed to the subsequent questions.*			D9 What is the approximate amount spent on [...] in the past three months? (MK)	D10 Who was responsible for the major part of the expenditure on [...]? 1. Household head 2. Wife 3. Son 4. Daughter 5. Other
Code	Item	1. Yes 2. No		
1	Educational expenses (school fees, books, uniforms, etc.)			
2	Health care items (medicines, herbs, doctor fees, hospital costs, etc.)			
3	Food for Home Consumption			
4	Housing Materials (roof, bricks, flooring materials, etc.)			
5	Other(non-food) household supplies and clothing			
6	Ingredients used to prepare food or drink for sale			
7	Agricultural Equipment			
8	Bicycles and other vehicles			
9	Rent			
10	Transport			
11	Loans and gifts (specify whether loan or gift)			

Page 5. Livestock Expenditures

D11 Did residents of your household make any purchases of animals during the past three months, i.e. during the months of [...], [...] and [...]? *Research Assistant: Please complete the column for D11 before you proceed to the subsequent questions.*			D12 What is the approximate amount spent on [...] in the past three months? (MK)	D13 Who was responsible for the major part of this expenditure? 1. Household head 2. Wife 3. Son 4. Daughter 5. Other
Code	Animal	1. Yes 2. No		
1	Bulls, Cows or Calves			
2	Goats			
3	Chickens			
4	Other (specify) _____			

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire E
Agricultural Production and Land Holding

Type of Interview: Groups of Household Residents (female and male)
Frequency: Once (October 1999)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5. 6.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Field and Plot Allocation for 1999/2000 Agricultural Year

Research Assistants: This questionnaire concerns agricultural production for the 1999/2000 agricultural year. Please make this clear to our respondents.

The following questions are just to get household residents to begin thinking about their agricultural land holding. Listen attentively, but you need not record any information.

Can you please tell us where are the field(s) that household residents will cultivate during the 1999/2000 agricultural year?

What crops will you cultivate in those fields?

Will you practice inter-cropping this year?

Will any land be left fallow this year?

Are there any trees on your agricultural land holding?

At this point we'll say something like the following to our respondents:

You know, I think the information you are providing would be more easily understood by us if you could draw us a diagram. Would one of you mind doing this?

(Usually a school kid will want to do this. We'll give them a blank sheet of paper and pencil.)

First, please draw us a diagram that shows the location of your fields in relation to your household dwelling unit.

After they have drawn their house and the field(s)...

Can you now please divide each field into plots if this is appropriate. (A plot is a subdivision of a field containing a single crop or inter-cropped mixture of crops).

Which crops will be cultivated in each plot this year? (You will need to write this on the diagram.)

Also please show us in your diagram any land left fallow and any trees planted on your agricultural land holding.

Page 3. Area Cultivated

Research Assistants: Fill in the field number, plot number, crops cultivated and fallow land based on the drawing(s) made by household residents. After you have filled in this information, ask respondents for the area of each plot.

Field Number	Plot Number	Crop(s) Cultivated Inside the Plot and/or Fallow Land	E1 What is the area of each plot?	
			Total Area Planted	Units 1. Acres 2. Hectares

E2 Do you practice crop rotation? ☐

1. Yes
2. No

If yes, please describe the system of rotation used.

E3 How did your household acquire its agricultural landholding? ☐

1. Inheritance
2. Purchase
3. Renting
4. Other (specify) _____

Page 4. Land Clearing and Harvest for 1999/2000 Agricultural Year

E4 Comparing the agricultural years 1998/99 and 1999/2000, has there been any change in the size of your agricultural landholding? ☐

1. Increase *(Go to E6)*
2. Decrease *(Go to E5)*
3. No Change *(Go to E10)*

E5 What was the reason for the decrease? *(Go to E10)* ☐

1. Land allocated to family member starting own household
2. Land sold
3. Land lost in land dispute
4. Land allocated to other use (e.g. housing structure)
5. Other (specify) _____

E6 What was the reason for the increase? ☐

1. Previously uncultivated land cleared for cultivation
2. Inheritance of land
3. Land purchased
4. Land obtained from land dispute
5. Other (specify) _____

(If land was cleared, continue with questions E7 through E9 , otherwise skip to E10.)

E7 How much land was cleared? (*Specify units*)

E8 Were there previously trees on the land that you cleared? ☐

1. Yes
2. No

E9 Did you need permission to clear this land? ☐

1. Yes
2. No

(*If yes, specify <u>how</u> permission was obtained and <u>from whom</u>.*)

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire F
Household Assets

Type of Interview: Group of Household Residents (male and female)
Frequency: Once (January 2000)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Zomba, Malawi
Tel: 522-916

Page 2. The Household Dwelling

Research Assistant(s): On this page you will record information concerning the dwelling of the head of household. You should conduct this interview at or near the dwelling so that you are able to verify by observation information provided by respondents.

F1 What is the main construction material of the outside walls of the house of the household head? ☐

1. Earth bricks (not fired)
2. Fired bricks
3. Wood
4. Cement
5. Other (specify) _____

F2 What is the main flooring material of the house of the household head? ☐

1. Earth
2. Cement
3. Other (specify) _____

F3 What is the main construction material of the roof of the house of the household head? ☐

1. Grass (thatch)
2. Iron sheets
3. Other (specify) _____

F4 Does the household own or rent this house? ☐

1. Own
2. Rent
3. Other (specify) _____

F5 What is the main source of lighting that the household uses? ☐

1. Wax candles
2. Paraffin candles
3. Paraffin lamp
4. Wood
5. Other (specify) _____
6. None used

F6 What is the main type of cooking fuel that the household uses? ☐

1. Collected fire wood
2. Purchased fire wood
3. Made charcoal
4. Purchased charcoal
5. Paraffin
6. Crop residues
7. Other (specify) _____

Page 3. The Household Dwelling & Other Assets

F7 Where does the household get most of its drinking water? ☐

1. Borehole
2. Protected well (e.g. with some type of covering)
3. Unprotected well
4. Communal water tap
5. Tap outside house (used only by household residents)
6. Tap inside house
7. River/stream
8. Lake
9. Other (specify) _____

F8 How far is this water source from the household's dwelling? ☐

1. On premises
2. Less than 100 meters
3. 100 to less than 500 meters
4. 500 meters to 1 kilometer
5. More than 1 kilometer
6. Don't know

How many of the following assets are owned by the resident household members?

F9.	Buildings	with thatched roofs	☐
F10.		with iron sheet roofs	☐
F11.	Vehicles	bicycles	☐
F12.		motorbikes	☐
F13.		other: _____	☐
F14.	Animals	cattle	☐
F15.		goats	☐
F16.		chickens	☐
F17.		other: _____	☐
F18.	Farm Equip.	cart	☐
F19.		plough	☐
F20.		hoe	☐
F21.		granaries	☐
F22.		other: _____	☐

Page 4. Assets (Continued) and Equipment Used for Charcoal Production

How many of the following assets are owned by the resident household members?

F23.	WCC Equip.	axe	
F24.		hand saw	
F25.		panga knife	
F26.		file	
F27.		other: _____	
F28.	Hhld. Equip.	radio	
F29.		cooking stove specify fuel used: _____	
F30a.	Other (specify	_____	
F30b.	Other (specify)	_____	

F31 What type of charcoal kiln(s) do household residents build and use?

Code	Type	1. Yes 2. No	Number Used
1	Earth mound kiln		
2	Pit kiln		
3	Brick kiln		
4	Other (specify) _____		
5	None		

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire G
Fertilizer/Seed Use, Tree Planting, and Starter Pack

Type of Interview: Groups of Household Residents (female and male)
Frequency: Once (February 2000)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Seed Use

G1 Which crops are household residents cultivating during the 1999/2000 agricultural year? *(Complete G1 first before proceeding to G2)*	G2 What type of seed was used for planting [...] and in what quantity? *Research Assistants: Fill in the box corresponding to the type of seed used.*					G3 How did you obtain this seed? 1. Purchased with cash *(Skip to G5)* 2. Purchased on credit 3. *(Skip to G5)* 4. Gift/Donation *(Go to G4)*	G4 What was the source of the seed gift/donation? 1. Relative 2. Friend 3. Starter Pack 4. Other (specify) *(Skip to G6)*	G5 What was the per unit price of seeds at the time of purchase? (MK/unit)
	Own		Purchased					
	Quantity	Units	Specify Type	Quantity	Units			

Page 3. Chemical Fertilizer and Manure/Compost Use

G6 Was chemical fertilizer applied to any crops cultivated by household residents this year? ☐

1. Yes *(Go to G7)*
2. No *(Skip to G12)*

G7 To which crops did household residents apply chemical fertilizer?	G8 What type of fertilizer was applied to [...]? 1. CAN 2. Urea 3. 23-21-0 4. Other (specify)	G9 What was the quantity of fertilizer applied to [...]?		G10 How was this fertilizer obtained? 1. Purchased 2. Starter Pack 3. Gift from friend or relative 4. Other (specify)	G11 What was the per unit price of fertilizer at the time of purchase? (MK/unit)
		Quantity	Units		

G12 Was manure and/or compost applied to any crops cultivated by household residents this year?		G13 To which crops was manure and/or compost applied?	G14 What was the quantity of manure and/or compost applied?	
	1. Yes 2. No		Quantity	Units
Manure				
Compost				

G15 Aside from the use of fertilizer, manure and compost do residents of your household use any other methods to improve soil fertility? If yes, describe the method(s) used.

Page 4. Tree Planting and Starter Pack Program

G16 In the past 5 years have residents of your household planted any trees on your private landholding? ☐

1. Yes (*Go to G17*)
2. No (*Skip to G21*)

G17 What type of trees were planted on your private land holding in the past 5 years?	G18 How many of this type of tree were planted on your private land holding in the past 5 years?	G19 How did you obtain the seedlings to plant these trees? 1. Purchase 2. Development project (specify) 3. Other (specify)	G20 What is the reason you chose to plant this type of tree?

G21 Did you receive a Starter Pack this year? ☐

1. Yes (*Go to question G23*)
2. No (*Go to question G22*)

G22 What is the reason your household did not receive a Starter Pack this agricultural year?
(*Proceed to G24 after completion of this question*)

G23 What did you do with your Starter Pack? ☐

1. Used the seeds/fertilizer for household's garden
2. Sold Starter Pack (specify to whom it was sold and why it was sold)

   _____

   _____
3. Gave Starter Pack away (specify to whom it was given and why it was given away)

   _____

   _____
4. Other (specify) _____

Page 5. Starter Pack Program

G24 Do you think the Starter Pack program has helped local farm families? Why or why not?

G25 What suggestions do you have for improving the distribution of the Starter Pack?

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire H
Maize Production1999/2000

Type of Interview: Groups of Household Residents (female and male)
Frequency: Once (June 2000)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Local Maize Production for Agricultural Year 1999/2000

Research Assistant(s): Begin by finding out the number of plots in which local maize was cultivated in 1999/2000, then proceed to obtain the plot level data for local maize production to fill in the table below.

Plot	H1 What is your estimate of the total area of this plot?		H2 Which crops, if any, were intercropped with local maize in this plot?	H3 What is the quantity of local maize seed used for this plot in 1999/2000?		H4 What is the quantity of chemical fertilizer applied to local maize in this plot in 1999/2000?	
	Quantity	Units 1. Acre 2. Hectare		Quantity	Units (see key)	Quantity	Units (see key)
1							
2							
3							
4							
5							

Units key: [1] kg [2] 50 kg bag (full) [3] 70 kg bag (full) [4] 90 kg bag (full) [5] small winnowing basket [6] medium winnowing basket [7] nsima plate [8] ndiwo plate [9] hand washing basin [10] small dengu [11] medium dengu [12] large dengu [13] small ntanga [14] medium ntanga [15] large ntanga

H5 How much local maize was harvested by household residents in 1999/2000?	Shelled local maize		Unshelled local maize (on the cob)	
	Quantity	Units (see key)	Quantity	Units (see key)

Page 3. Hybrid Maize Production for Agricultural Year 1999/2000

Research Assistant(s): Begin by finding out the number of plots in which hybrid maize was cultivated in 1999/2000, then proceed to obtain the plot level data for hybrid maize production to fill in the table below.

Plot	H6 What is your estimate of the total area of this plot?		H7 Which crops, if any, were intercropped with hybrid maize in this plot?	H8 What is the quantity of hybrid maize seed used for this plot in 1999/2000?		H9 What is the quantity of chemical fertilizer applied to hybrid maize in this plot in 1999/2000?	
	Quantity	Units 1. Acre 2. Hectare		Quantity	Units (see key)	Quantity	Units (see key)
1							
2							
3							
4							
5							

Units key: [1] kg [2] 50 kg bag (full) [3] 70 kg bag (full) [4] 90 kg bag (full) [5] small winnowing basket [6] medium winnowing basket [7] nsima plate [8] ndiwo plate [9] hand washing basin [10] small dengu [11] medium dengu [12] large dengu [13] small ntanga [14] medium ntanga [15] large ntanga

H10 How much hybrid maize was harvested by household residents in 1999/2000?	Shelled hybrid maize		Unshelled hybrid maize (on the cob)	
	Quantity	Units (see key)	Quantity	Units (see key)

Page 4. Prior Use of Hybrid Maize Seed & Chemical Fertilizer

H11 Had residents of your household ever planted hybrid maize seed before 1998/99? ☐

1. Yes [*Go to question H12*]
2. No [*Skip to question H15*]

H12 What was the first year that household residents planted hybrid maize seed? ☐
[*Research Assistant: Indicate year, e.g. 1993*]

H13 Since first trying out hybrid maize seeds in [...], what has been the frequency of use of hybrid maize seeds by household residents? ☐

1. Hybrid maize seeds planted most years
2. Hybrid maize seeds planted some years
3. Hybrid maize seeds rarely planted

H14 Please provide an explanation for the answer you provided in the last question.

H15 Do residents of your household want to use hybrid maize seeds in 2000/2001? ☐

1. Yes (specify type(s) of seed, e.g. NSCM41, MH17, etc.)

_____

2. No

(specify reason)_____

H16 Had residents of your household ever used chemical fertilizer on maize fields before 1998/99? ☐

1. Yes [*Go to question H17*]
2. No [*Skip to question H20*]

H17 What was the first year that household residents used chemical fertilizer on maize fields ☐
[*Research Assistant: Indicate year, e.g. 1993*]

Page 5. Prior Use of Hybrid Maize Seed & Chemical Fertilizer (Continued)

H18 Since first using chemical fertilizer on your maize fields in [...], what has been the frequency of use by household residents? ☐

1. Chemical fertilizer used on maize fields most years
2. Chemical fertilizer used on maize fields some years
3. Chemical fertilizer rarely used on maize fields

H19 Please provide an explanation for the answer you provided in the last question.

H20 Do household residents want to use chemical fertilizer on maize fields in 2000/2001? ☐

1. Yes (specify type(s), e.g. 23:21:0, Urea, etc.)

_____

2. No (specify reason)_____

H21 If your household is able to use chemical fertilizer in 2000/2001 to which type(s) of maize would you like to apply chemical fertilizer? ☐

1. Only on hybrid maize, not on local varieties
2. Mostly on hybrid maize, but some on local varieties
3. Both hybrid maize and local varieties
4. Mostly on local varieties, but some on hybrids
5. Only on local varieties, not on hybrids

H22 Please provide an explanation for the answer you provided in the last question.

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Questionnaire I
Miscellaneous Information

Type of Interview: Groups of Household Residents (female and male)
Frequency: Once (July 2000)

Page 1. Cover Sheet

	NAME or DESCRIPTION
District	
Traditional Authority	
Village	
Household Head	
Respondents (specify relationship to household head)	1. 2. 3. 4. 5.

	DATE ACCOMPLISHED	BY WHOM?	
	Month/Day/Year	Name	Signature
Interview			
Data Check			
Data Entry			

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Page 2. Time Allocation and Distance/Time to Trees

I1 About how many hours a day do the following household residents spend on work and/or school?	
Type of Household Resident	Hours
Boys Not in School	
Boys in School	
Girls Not in School	
Girls in School	
Women in School or Working Off-farm	
Women on Farm Full Time	
Men in School or Working Off-farm	
Men on Farm Full Time	

I2 At which locations do household residents collect wood?		I3 What is the approximate distance from your home to this location? (kilometers)	I4 How long does it take you to travel from your home to this location? (hours)
Location	1. Yes 2. No		
State Forest Reserve			
Customary Land			
Private Landholding			
Other (specify) _____			

Page 3. Food Security

I5 How many meals did household residents eat in a typical day during the month of [...]?	
Month	Number of Meals Taken on Average
June 1999	
July 1999	
August 1999	
September 1999	
October 1999	
November 1999	
December 1999	
January 2000	
February 2000	
March 2000	
April 2000	
May 2000	

PURDUE UNIVERSITY: MALAWI SURVEY ON
SMALLHOLDER AGRICULTURE AND FOREST USE

Recording Sheet for Time Allocation Exercise

Type of Interview: Group of Household Residents

Name of Household Head: _____

Date of Interview: _____

	Forest Activities	Agricultural and Livestock Activities	Off-farm Work	Income-Generating Activities	Domestic Work	Schooling
Girls attending school						
Girls not attending school						
Women attending school or working off-farm						
Women on farm full-time						
Boys attending school						
Boys not attending school						
Men attending school or working off-farm						
Men on farm full-time						

Forest Activities: Any activity related to trees and forests. Collection and sale of items from the forest such as wood, timber (planks), thatch, medicinal plants, wild fruit, caterpillars, mushrooms; charcoal production/sale; production and sale of items that require wood such as masese, thobwa, kachasu, chikondamoyo, chitumbua, pottery, baskets, bricks, wooden or chiwale furniture, wooden crafts; employment as plank transporter, sawyer; work as an African doctor.

Agricultural and Livestock Activities: Anything related to agricultural production and marketing and animal production/tending and marketing.

Off-farm Work: Any salaried employment that is not included under forest activities or income-generating activities. Includes ganyu and permanent jobs like forestry officer, teacher, mechanic, watchman.

Income-generating Activities: Enterprise activities not included in forest activities. Includes re-sale of crops (maize, cassava, etc.), grocery sales, tin smith, stone breaking, driver, repair person.

Domestic work: Any work considered domestic, other than wood collection (which is already accounted for). For example: water collection, cooking, cleaning, childcare, laundry.

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Focus Group Discussion Question Sheet

April 2000

General Questions about Tree Species and Use of Forest Resources:

[*The intent of the first set of questions is to break the ice and get the conversation started with questions that community members will find easy to answer.*]

1) On Mulanje Mountain there are many kinds of trees. Which kinds of trees do people in your village prefer to use and why?

2) What are the main uses of collected wood in your village?

3) Aside from wood, are there any other things that people collect from the forest?

Scarcity/Deforestation Questions:

[*The next set of questions concern peoples' perceptions about the state of forest resources in the Mulanje Mountain Forest Reserve.*]

4) Would you say there are more, less or the same number of trees in the MMFR now compared with the number of trees in 1990?

5) How can you tell that the number of trees has changed in the past 10 years?

6) Would you say that right now there are enough trees in the MMFR for the needs of all of the people living around the mountain? What makes you say so?

7) You say that there are fewer trees today than 10 years ago. What do you think are the main reasons for the decrease in the number of trees?

8) What (if anything) can community members do to make sure that in the future there will be enough trees in the MMFR to meet peoples' needs?

9) What have community members done thus far to conserve tree resources for future generations?

Forestry Department Regulations:

[*The last set of questions are the most sensitive and concern Forestry Department regulations. First we want to know if community members are aware of the rules laid out by the Forestry Department to protect the MMFR. Then we want to find out how people feel about the rules, including enforcement of rules and punishment for violations.*]

10) Are you familiar with the rules regarding the MMFR as laid out by the Forestry Department? What are the rules?

11) How do members of your community feel about these rules? Are the rules fair (explain)?

12) How are the Forestry Department rules enforced? Who enforces the rules? Are there any problems with the manner of enforcement?

13) How are violators of these rules punished? Is this fair/justified (explain)?

[Here we'll describe different ways to manage forests (state, common-property, joint) and then ask people to tell us which regime they think would work best to protect trees in the MMFR. We'll try to get people to elaborate as they are likely to have excellent suggestions, but it may take some persuading to get these suggestions out.]

PURDUE UNIVERSITY: MALAWI SURVEY ON SMALLHOLDER AGRICULTURE AND FOREST USE

Wood Use for Income-Generating Activities Questionnaire

Questions for *Masese* Brewers, *Kachasu* Distillers, and Pottery Makers

1) Who generally is involved in this activity? [*Check all that apply*]

women	[ ]
men	[ ]
aged	[ ]
young	[ ]
poorer people	[ ]
average wealth people	[ ]

2) Is this activity seasonal, or done year round?

seasonal [*Go to 5*]	[ ]
year round activity [*Go to 3*]	[ ]

3) Why is this activity seasonal rather than year round?

4) In which months of the year is this activity performed? Why these months?

5) What type of wood is used to perform this activity?

6) Where does the wood used for this activity come from?

state forest reserve	[ ]
customary land	[ ]
private land holding	[ ]

7) Has the number of people in the village performing this activity increased in the past 10 years? If yes, explain why there has been an increase.

8) Describe the process of performing this activity in detail. Specifically, (a) what are the steps in the process, (b) how long does each step take and (c) what is the time required to complete this activity from start to finish.

Appendix B – Data Preparation

Imputation of Prices and Net Hourly Returns to Labor

To impute values of maize prices and returns to labor, I used sub-sample ordinary least squares (OLS).[63] For each sector (forest, maize, wage-work, self-employment) an equation for price/returns was estimated for the sub-sample of households engaged in that sector. The OLS coefficients were then used alongside observed values for explanatory variables to predict prices/returns where the data were missing. Below I provide details of the imputation procedure for each equation.

The Maize Price Equation

Of the 99 sample households, 27 reported marketing maize in 1999/2000 at an average price of MK 3.84 per kilogram (standard deviation equals MK 1.18 per kilogram). Observed maize price variability may be associated with several factors, the key ones being season and location of sale.[64] As in other settings where markets are thin, crop prices tend to follow a seasonal pattern, reaching an annual low soon after the harvest when granaries are full and increasing to an annual high just before the next harvest (Sahn 1989). It is economically advantageous for a farmer to delay maize sales

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[63] A Heckman-Lee (HL) two-stage approach was also used (Heckman 1976; Lee 1982). I decided to use sub-sample OLS for the final imputations for the following three reasons. One, the inverse Mills ratio was not statistically significant in any of the equations which may suggest that sample selection bias is not an important issue here. Two, there is evidence from Monte Carlo experiments that sub-sample OLS performs well relative to the HL approach when the sample size is small (Zuehlke and Zeman 1991). Finally, use of the HL approach would imply the need to include four additional explanatory variables (the estimated inverse Mills ratios) in the labor supply equations.

until well after the harvest, but whether she/he can do so depends on the household's food security situation and access to storage facilities. Price differences may also arise across space as markets in rural Malawi are not well integrated (Kherallah et al. 2000).

To impute a price of maize for households that did not sell maize, I used data for the sub-sample of maize selling households (N=27) and regressed the maize price on three explanatory variables: MEALS, IRON, and VILL3 (see Table B.1 for variable definitions). The average number of meals taken by household residents per day provides an indication of the food security situation of the household and should be positively associated with the maize price. Households that possess buildings with iron sheet roofs have relatively effective storage. Thus IRON should be positively related to the price of maize. Households that reside in Village 3 may be able to obtain a higher maize price, all else being equal, because marketing conditions are relatively good in the village due to proximity to an urban center. The first column of Table B.2 presents the OLS results for this equation. The model fits the data quite well and coefficients have the expected signs, although only IRON is statistically significant. These coefficient estimates were used in conjunction with the observed values for the explanatory variables to impute values for the missing maize prices. For comparative purposes, the mean and standard deviation of observed and imputed maize prices are included at the bottom of Table B.2.

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[64] Quality differences may also be a factor as Malawians generally prefer flint to dent maize varieties.

Table B.1 Data Definitions and Descriptive Statistics, 1999/2000

	Variable Definition	Mean or Frequency (Stand. Dev.)
AGE [a]	Age of the household head by category (1=15 to 24 years; 2=25 to 34; 3=35 to 44; 4= 45 plus)	----
ETHNIC [b]	Household head belongs to one of the main ethnic groups in the village of residence (0=No, 1 =Yes)	0.77
FSIZE	Area of the household's agricultural land holding (hectares)	1.26 (1.20)
FHH	Female-headed household (0=No, 1=Yes)	0.41
FTOOL	Number of axes, handsaws, and pitsaws owned by household residents at start of survey year	0.96 (0.92)
IRON	Number of household dwelling units with an iron sheet roof	0.15 (0.46)
MEALS	Average number of meals taken by household residents (per person per day)	2.06 (0.44)
SCHOOL	Education of household head (0 = no schooling, ..., 9 = completed secondary school)	----
TREE	Number trees planted on household's land holding in the past five years	12.49 (23.90)
VILL2	Village 2 residence (0=No, 1=Yes)	0.38
VILL3	Village 3 residence (0=No, 1=Yes)	0.22

a. Age is categorical because respondents generally were not aware of their age. Our approach was to refer to a list of historical events and then estimate the age of the head based on her/his responses concerning whether she/he was alive and what she/he was doing the year of the important event.
b. The Lomwe tribe is the dominant tribe in Village 1 (62 percent of household heads) and Village 2 (89 percent of heads). In Village 3 there are three dominant tribes: the Ngoni, Lomwe and Manganja tribes (82 percent of heads).

The Equations for Net Hourly Returns

Data for net hourly returns were not collected directly.[65] For each sector (forest, wage-work, and self-employment), returns were calculated by dividing annual earnings or profits by hours worked. Annual hours worked in each sector were calculated by summing over household members the product of labor share and total hours worked in all activities.[66] In the sample, 75 households reported earnings from forest use with hourly returns of 1.83 MK/hour (standard deviation = 2.22); 59 households engaged in wage-work earning 3.01 MK/hour on average (standard deviation = 3.93); 41 households were self-employed with net hourly returns of 2.46 MK/hour (standard deviation = 2.78). Observed variability in net hourly returns is not surprising given the diversity of activities in each category. In the forest sector, for example, activities include the more remunerative activities such as charcoal marketing and sawing of planks and less lucrative activities such as sales of cooked food and pottery (fired with wood). Likewise, other wage-work includes contract agricultural jobs that command a far lower wage than permanent jobs such as school teacher or forestry officer.

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[65] Rural Malawians often do not know their hourly wage. Many forms of wage-work are on a contractual basis, the employee being paid (in cash or kind) for completion of a task, e.g. agricultural contract work. Likewise, the self-employed are paid for completion of a task or for providing a product or service; these business people generally do not know their "wage".

[66] As data are not available for total hours worked in all activities during the year, assumptions were made. I assumed girls, boys, and men worked 8 hours per day, 312 days per year. Women were assumed to work 10 hours per day, 312 days per year. An hour of girl or boy labor is valued at half an adult labor hour.

Three equations were estimated using data for the sub-samples of households engaged in the given activity. For each equation, the log of returns was assumed to be a function of individual or household characteristics and local marketing conditions.[67] Seven explanatory variables were initially included in each of the three equations. And two additional variables were included in the forest returns equation only.

Certain personal characteristics should influence returns to effort. Following other studies, I included human capital variables in the regressions (e.g. Alderman et al. 1996; Abdulai and Delgado 1999). The age of the household head (AGE), a proxy for general experience, and her/his education level (SCHOOL) may indicate potential productivity in an activity and should be positively associated with returns.

Some individuals may be *pulled* into the forest, wage-work, and self-employment sectors because their experience or education level creates opportunities for relatively high returns; other individuals may be *pushed* into the more plentiful low-return activities in these sectors. In other words, one would expect that individuals who engage in low-return activities in each sector do so out of need. To capture this, a variable measuring the food security situation of the household (MEALS) was included in each equation.

In noncompetitive labor markets, employment may be rationed on the basis of the status of the worker, with employers giving preference to those on the basis of gender, ethnicity, religion, or wealth holdings (Abdulai and Delgado 1999; Rosenzweig 1980). One could also extend this argument to noncompetitive credit markets, such as those in

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[67] Theory doesn't provide clear guidance on functional form. The log-linear specification is widely used (e.g. Abdulai and Delgado 1999; Alderman et al. 1996; Lucas 1977).

Malawi where credit is often rationed (Diagne 1999). Access to credit should in turn be associated with participation in and returns to self-employment activities, since financial capital is required to engage in a business, particularly one with relatively high returns. Men may be more likely to engage in some of the more lucrative activities in the wage-work sector (e.g. forestry officer), forest sector (e.g. plank sawyer) or self-employment sector (e.g. grocery sales) either due to hiring decisions or access to credit. To capture this, I included a dummy variable for female-headed households (FHH), which constitute 41 percent of the sampled households. Individuals belonging to one of the local dominant ethnic groups (ETHNIC) may also be more likely to be hired for well-paying work or obtain credit to start up a business. Finally, the size of the household's landholding (FARMSIZE) may factor into decisions to hire or extend credit to an individual.

Two additional variables (FTOOL and FHHAGE) were included in the forest returns equation only. Households possessing a greater number of axes, handsaws and pitsaws (FTOOL) may be more likely to engage in some of the high return forest activities, e.g. sawing of planks and charcoal production. FHHAGE is included to examine whether age has a differential association with forest returns for male- compared with female-headed households. One of the more lucrative forest income-generating activities that women engage in is traditional beer brewing (*masese*) for which it takes years to acquire a reputation as a good brewer.

Local labor market conditions should also influence hourly returns (Rosenzweig 1980). Since data are not available on local unemployment rates, population density, etc.

a village dummy variable (VILL2) is used to capture differential labor market conditions across space. Village 2 should have lower forest returns compared with the other villages since neither charcoal marketing nor sawing of planks (high return activities) are undertaken in this village. Returns to self-employment should also be lower in Village 2 relative to other villages largely because the main form of self-employment in this village is the less profitable resale of agricultural commodities. Finally, the relative distance of Village 2 from a town may mean fewer opportunities for well-paying wage-work.

Results for the three regressions are presented in Table B.2. For each sector the final estimating equation includes only those explanatory variables that are statistically significant at the 90 percent level or better. The R^2 values indicate that the models explain 37-50 percent of the observed variation in the dependent variables. Results for the AGE variable may indicate that age signals a worker's productivity for skilled wage-work (e.g. teacher), but for the high paying, but physically demanding forest-sector jobs (e.g. sawing planks) it may indicate to employers a lower marginal product of labor. Results also indicate that older individuals are less likely to engage in the more profitable self-employment activities. Education of the household head is positively related to net hourly returns in the wage-work sector, but is uncorrelated with returns in other sectors.

Results show that female-headed households in the sample have lower wages in all sectors compared with male-headed households. The hypothesis that age has a differential association with forest returns for male- compared with female-headed households is supported by the data, age being positively related to forest returns for female heads. The ETHNIC variable has an unexpected negative sign in the wage-work and the self-employment equations. A possible explanation for the case of wage-work is

that those filling the high wage, permanent jobs are transferred to the new location or move to fill the position. The FSIZE variable is not significantly different from zero at standard test levels in the wage-work and forest sectors. In the self-employment equation land holding size has a negative correlation with returns. It may be that FSIZE does not measure access to credit as posited earlier. It may be that the negative coefficient on FSIZE indicates that households with smaller land holdings have greater incentive to earn high returns in self-employment.

The food security variable (MEALS) is statistically significant in the forest equation only and has the expected negative sign. The forest tools variable has an expected positive sign in the forest use equation. The sign of the VILL2 variable conforms with prior expectations in all three equations, although it is statistically weak in the returns to wage-work equation.

Estimated coefficients from the three regressions for net returns were used in conjunction with observed values for explanatory variables to impute shadow wages where observed returns to labor were missing. The mean and standard deviation of observed and imputed returns to labor are included at the bottom of Table B.2.

Table B.2 Results for the Maize Price and Net Hourly Returns Equations

	Maize Price	Natural Log of Returns to Forest Use	Natural Log of Returns to Wage-work	Natural Log of Returns to Self-employment
Constant	*** 2.57	0.24	0.41	*** 3.94
	(0.85)	(1.00)	(0.51)	(0.93)
AGE		*** -0.65	* 0.22	** -0.36
		(0.21)	(0.12)	(0.17)
ETHNIC		----	* -0.55	** -0.99
			(0.28)	(0.45)
FHH		*** -3.49	*** -1.39	*** -1.16
		(0.99)	(0.26)	(0.34)
FHH*AGE		*** 0.87	----	----
		(0.29)		
FSIZE		----	----	** -0.71
				(0.28)
FTOOL		* 0.31	----	----
		(0.16)		
IRON	*** 1.25			
	(0.31)			
MEALS	0.39	*** 0.94	----	----
	(0.40)	(0.37)		
SCHOOL		----	** 0.21	----
			(0.09)	
VILL2		* -0.63	----	** -0.91
		(0.34)		(0.36)
VILL3	0.39			
	(0.44)			
N	27	75	59	41
Imputed	3.64	1.70	2.52	2.49
	(0.79)	(2.10)	(3.21)	(2.70)
Observed	3.84	1.83	3.01	2.46
	(1.18)	(2.22)	(3.93)	(2.78)
R^2	0.58	0.35	0.50	0.37

*, ** and *** imply significance at the 0.10, 0.05 and 0.01 probability levels.

The Household Income Accounts

Household income is the sum of cash earnings from several sources and home consumption of produced/collected farm and forest goods, expressed in September 2000 Malawi Kwacha. Quarterly data were brought to September 2000 values using the national Consumer Price Index available from the National Statistical Office (NSO), Zomba, Malawi. Below I describe the cash income and home consumption components of household income.

Cash Income Data

Data for cash income are complete for the 99 sample households. Cash income come from the following sources: forest occupations, crop sales (from own production), non forest-based wage-work, non forest-based self-employment, sales of assets (livestock and other assets), and transfers (remittances, gifts, and loans). [68] The cash income data should be of good quality for at least three reasons. First, the data were collected quarterly, reducing the period of recall. Second, comprehensive checklists of income sources were used to aid respondent memory; this is preferable to having an "other income" category. A third reason the cash income data should be of high quality relates to the use of gender-separate interviewing for the income and expenditure questionnaires which was useful for triangulation. Where responses of female and male respondents did not correspond, the research assistants and I returned to the household for clarification.

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[68] Remittances came mainly from husbands working elsewhere. Gifts came primarily from grown children living away from home. The main credit sources were informal, but some households reported credit from formal credit organizations such as FINCA.

Home Consumption

Home consumption is defined here as retained maize and collected firewood used for cooking meals. Below I describe the imputation procedures used to impute values for retained maize and collected firewood where the data are missing.

Imputation of the Value of Home Consumed Maize Production

Data for maize output for the 2000 harvest are available for a sub-sample of households (N = 68). [69] Missing observations for maize output exist where respondents either said they did not know the amount of maize harvested or gave their response in terms of how much of their granary was filled with maize. Conversion factors are available for a number of standard local measurement units (see Appendix C). However, the volume of granaries varies considerably across households and the research assistants and I did not directly measure the quantity of maize stored in individual granaries.

I imputed values for the missing 31 observations using sub-sample OLS. I estimated a per-hectare Cobb-Douglas production function of the following form:

$$ln\, y = \alpha + \sum_{i=1}^{3} \beta_i \, ln\, x_i + \delta_1 AGE + \delta_2 VILL1 + \varepsilon$$

where y is maize yield (kilograms per hectare), *AGE* is the age of the household head, *VILL1* is a binary variable indicating Village 1 residence, and i indexes agricultural inputs (x_i) – household labor (adult hours per hectare), chemical fertilizer (kilograms per

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[69] Data for retained maize are available for the 1999 harvest. I use the 2000 data because the 1999 data are only available for 34 households. Equally important is that I believe the 2000 data to be more accurate.

hectare), and hoes (number owned per hectare). [70] Regression results are presented in Table B.3. I used the estimated coefficients and observed values for explanatory variables to predict maize yield for the missing values. The observed and imputed means for maize yield are included at the bottom of Table B.3 for comparative purposes. The average maize output for the sample (imputed and observed values) is 423 kilograms (standard deviation = 481). This quantity of maize would last about six months for a family of five adults and two children consuming 2 meals per day (The Lamp 1999). The six-month maize self-sufficiency estimate is consistent with other evidence from Malawi. For example, Orr and Mwale (2001) report for their sample of southern Malawi farm households (N = 50) that, on average, household maize stocks ran out by mid-October, about six months after the harvest.

To arrive at an estimate of retained maize for the 99 sample households, I subtracted from maize output the quantity of (after-harvest) sales of maize; these data are available from the cash income accounts. The quantity of retained maize was valued using a price of MK7.42 per kilogram. This was the average retail price for maize for the southern region of Malawi during the 2000 maize harvest period, calculated using secondary data from the Government of Malawi Ministry of Agriculture and Livestock (European Food Security Network 1999, 2000).

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[70] Quantity of hybrid maize seed is not available as the available data are in units for which conversion factors are not available. I estimated the model with a binary variable indicating hybrid maize seed use; this was not statistically significant and had an unexpected negative sign.

Table B.3 Results of Maize Yield Regression, Sample Households 1999/2000

Explanatory Variable	Definition	Coefficient (Standard Error)
Constant	----	*** 4.42 (0.76)
AGE	Age of the household head by category (1=15 to 24 years; 2=25 to 34; 3=35 to 44; 4= 45 plus)	* -0.15 (0.08)
Log(CHEM)	Chemical fertilizer applied to maize (kilograms per hectare)	*** 0.15 (0.03)
Log(HOE)	Number hoes owned (hoes per hectare)	* 0.09 (0.05)
Log(LABOR)	Household labor hours in agriculture (adult hours per hectare)	** 0.18 (0.09)
VILL1	Village 1 residence (0=No, 1=Yes)	*** 0.56 (0.17)
Number of observations [a]		68
Imputed maize yield (kilograms per hectare)		530 (403)
Observed maize yield (kilograms per hectare)		561 (457)
R-squared		0.37
Adjusted R-squared		0.31

a. Sample size is 68 households due to 29 missing observations for maize output and two outliers that were dropped.

*, **, and *** imply significance at the 0.10, 0.05 and 0.01 probability levels.

Imputation of the Value of Home Consumed Collected Firewood

The value of collected firewood used for cooking was estimated using the following procedures. Data are available from the household survey for quantity of firewood used to cook meals. The data were collected through direct measurement with a sub-sample of households (N = 18). See Appendix C for results. For the sub-sample, 5.88 kilograms of firewood was used on average to cook three meals for a family of four using the traditional three-stone method of cooking. This figure is not too different from Brouwer's (1998) corresponding estimate of 6.3 kilograms. In per cooked meals terms, 0.49 kilograms of firewood was used on average by the sub-sample of households. To obtain household-specific estimates of firewood used in 1999/2000, I used data from the household survey for household population (young children were valued as half a consumption unit), number of meals cooked per day, the dominant type of cooking fuel used, and the estimated 0.49 kilograms firewood per meal. For the sub-sample of households (N = 18) for which firewood use measurements were done, I used these values rather than the average 0.49 kilograms.

All of the sample households cooked with the three-stones method and all cooked with firewood, at least part of the year. Some households reported that harvest residues or purchased wood was the dominant cooking fuel during the survey year. For these households, I assumed that collected wood was used in the first quarter (June to August) as this is the season when women have more time to collect wood, the rainy season is

over and therefore collection is easier, and harvest residues are less plentiful. [71] The direct measurements with the sub-sample of households in June 2000 found that all households but one cooked with wood in that month. For households that reported that harvest residues or purchased wood was the main cooking fuel, I assumed they used either purchased wood or harvest residues during the three seasons outside of the first quarter, and assigned values of zero for collected cooking wood in the second, third, and fourth quarters. One additional assumption, based on field observations, is that households that cooked with firewood during the rainy season (third and fourth quarter) used harvest residues for 20 percent of their fuel requirements.

The estimated quantities of wood used for cooking by sample households (see Table B.4) were multiplied by quarterly prices for firewood. A price for firewood of MK1.09 per kilogram was the average price charged by the population of women firewood sellers (N = 14) at a local market in southern Malawi in February 2000 (see Appendix C). This price was brought to current quarterly prices using the national Consumer Price Index available from the National Statistical Office, Zomba, Malawi.

Measurement Error

Two important sources of measurement error should be noted in regards to the farm income and the forest income variables. First, these variables are each underestimates of actual values. Regarding the farm income variable, the survey data only include output data for maize, Malawi's staple crop. The value of retained maize

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[71] Only households in Village 2 used harvest residues as a key source of cooking fuel, using mainly cassava and pigeon pea residues available around September or October.

should account for the bulk, though certainly not all, of retained crop output. Maize accounted for 74 percent of cropped land at the study sites. Data to value other home-consumed forest goods (e.g. building poles, thatching grass, game, fruit, mushrooms, etc.) are not available. These resource uses are typically not collected in household surveys either because they are not considered, or due to the great difficulties associated with collecting data on the large number and highly diverse forest resource uses (see Wollenberg 2000 for a discussion). At the study sites, firewood should capture a large portion of home consumption of forest goods since 95, 95, and 82 percent of sample households in Villages 1, 2, and 3 reported that firewood was the most important product derived from forests.

A second source of measurement error is unavoidably introduced with the imputation procedures described earlier. The intent of imputing values for retained maize and collected firewood used for cooking is to improve the completeness of the income data. The value of the these home consumed goods should be very important to the household economy in rural Malawi; leaving these values out of the income figures biases the income data.

It is not possible to determine the magnitude or direction of bias in the home consumption data. It should be mentioned that the mean for the value of retained maize and the value of own-consumed collected firewood agree rather well with those from highly-detailed and well-respected field research in Zimbabwe and Malawi (Cavendish 2000; Peters 1996). Peters (1996) home consumption measure includes only retained maize. The average share of retained maize in total income among her sample of southern Malawian smallholder households (N = 200) was 31 and 32 percent for 1990/91

and 1986/87 respectively. These figures agree very well with the corresponding average from my household survey – 31 percent. [72] For the present study, the sample average for the share of home consumed collected firewood in total income is 10 percent. This estimate is higher than corresponding figures (7 percent in 1993/94 and 8 percent in 1996/97) from a household survey in Zimbabwe (Cavendish 2000). Note, however that in the Cavendish (2000) sample, the poorest households derived 12 percent of total income from own-consumed collected firewood. This group may be more comparable with households in southern Malawi. In sum, though the farm income and forest income data are measured with error, the fact that on average they agree well with data from highly-detailed and well-respected African country field research, adds some level of confidence to the data.

Table B.4 Estimated Quantity of Wood Used for Cooking (in kilograms) by Village and Quarter, Sample Households 1999/2000

	Village 1	Village 2	Village 3	All Villages
Quarter 1 (June – Aug.)	559	380	496	476
Quarter 2 (Sept. – Nov.)	428	57	475	296
Quarter 3 (Dec. – Feb.)	299	49	420	230
Quarter 4 (March – May)	515	63	515	341
Average	450	137	477	336

[72] This is total income without the value of collected firewood since Peters (1996) did not include this income source in her measure of household income.

Construction of the Index of Forest Extraction

The forest extraction index was constructed by adding up the quantities (in kilograms) of wood and bamboo extracted from forests by residents of sample households for cash income generation. Only resources extracted from the state forest reserve or the commons were included; tree resources extracted from private landholdings were not included. Resident household members reported sales of firewood, sawn planks, and bamboo. And residents of some sample households engaged in plank transport and plank sawing. Respondents also reported sales of items produced with wood and/or bamboo: charcoal, bricks, *masese* beer, *kachasu* dry spirit, various cooked foods, bamboo baskets, and wood-fired clay pots. The forest extraction index is complete for all of the sample households and is available on a quarterly basis.

Firewood Marketing

Fifteen sample households reported sales of firewood during the survey year. [73] To obtain estimates for the weight of firewood extracted from forests, quarterly earnings from firewood sales were divided by a per kg price of firewood (MK1.09). Data for quarterly earnings from firewood sales come from the household survey. The price of MK1.09 per kg is the average charged by the population of women firewood sellers (N = 14) at a local market in southern Malawi in February 2000 (see Appendix C).

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[73] Ten households sold whole trees. Because the marketed trees were from private landholdings I did not include them in the calculation of the forest extraction index.

Charcoal Sales

Eight sample households reported sales of charcoal during the survey year. The household survey data includes information on charcoal earnings and the number of bags sold in each quarter. Charcoal was sold in 50 kg bags at an average of MK70 per bag during the survey year. The actual weight of 50 kg bags of charcoal has been estimated to average 29.5 kg in a study conducted with charcoal producers (N = 31) operating close to Village 3 (Makungwa 1997). The same study calculated an average charcoal conversion efficiency of 22.76 percent. To obtain the weight of charcoal sold, I multiplied the number of bags sold by 29.5 kg. To obtain household-specific estimates of the quantity of raw wood used to produce the marketed charcoal, I divided the estimated weight of charcoal by 0.2276. [74]

Sawn Planks from the MMFR

In the MMFR, planks are generally sawn from pine or *Mulanje cedar* with pine being more common (Knacck Consultants 1999). I estimated the weight of pine planks as 33 kg each using a pine density of 600 kg/m^3 and an estimate for plank size of 50 mm thick, 200 mm wide, 5,500 mm long, the most common plank size from the MMFR (Kathindwa 2002). Using a conversion factor of 45 percent for pit-sawn timber (Knacck Consultants 1999), the 33 kg per plank translates into 73.33 kg of timber per sawn plank.

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[74] Some of the sample households sold, but did not produce charcoal. These households walked to Mwanza District (about 20 kilometers away), bought charcoal from producers and then transported the charcoal back to their village for sale along the roadside. I used the same method to estimate quantity of wood removed from the forest for charcoal burning, whether or not the sample households burnt charcoal themselves.

Removal of planks from the MMFR involves several people: the plank seller who commissions the felling of timber and sawing of the planks, the pit sawyers who work in pairs, and the plank transporter who carries the sawn planks on his shoulders or head from the sawing site on the mountain down to the roadside. During the survey year, pine planks sold for about MK200 each, pit sawyer teams were paid about MK70 per plank sawn (Kathindwa 2002), and plank carriers were paid an average of MK13 per pine plank transported (Knacck Consultants 1999). To avoid double or triple counting, I assumed that plank sellers, pit sawyers, and plank transporters were each responsible for timber extraction quantities corresponding to their share of the revenues from plank sales.

Plank Sales

Residents of two Village 1 households reported sales of planks during the survey year. Lacking information on the type of wood the planks were sawn from, I assumed they were pine planks. For each household, I divided earnings from plank sales by MK200. I then multiplied the number of planks by 73.33 kg to obtain estimates for the weight of timber removed to produce the planks. Finally, I multiplied the weight of the timber extracted by 0.575 (plank sellers' revenue share) to arrive at estimated quantities of timber extracted by plank sellers.

Pit Sawing

Ten of the sample households in Village 1 reported that male household residents had earnings from employment as pit sawyers in the MMFR during the study year. The number of planks sawn was estimated by dividing earnings by MK35. The number of planks sawn was then multiplied by 73.33 kg to estimate the weight of timber extracted.

Finally, the weight of timber extracted was multiplied by 0.175 (an individual pit sawyer's revenue share) to arrive at an estimate for the amount of timber extracted by each pit sawyer among my sample households.

Plank Transport

In Village 1, five sample households reported earnings from plank transport. I divided reported earnings by MK13 to obtain estimates for the number of planks transported. I then multiplied the estimated number of planks by 73.33 kg. Finally, I multiplied the weight of timber extracted by 0.075 to obtain an estimate for the quantity of timber extracted by plank transporters.

Brick Burning

Male residents of five sample households reported earnings from brick making during the survey year. However, only in two cases were the bricks fired (with wood and bamboo). A research assistant worked with two brick burners in Village 1, weighing the quantity of wood and bamboo used and the number of bricks produced (see Appendix C for results). [75] An average of 3,246 kg of bamboo and wood was used to fire 3,950 bricks to build a large (by local standards) house. To determine the number of fired bricks produced by the two sample households, I divided earnings from brick burning by MK0.55 (the average price per brick in 1999). The number of fired bricks was then multiplied by 0.82 kg per brick, the average from the measurement exercise.

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[75] The measurements were done in August 2002 by one of the research assistants.

Bamboo Marketing

Three households in Village 2 reported sales of bamboo during the survey year; the marketed bamboo was derived from the VFA. A research assistant weighed five sample bamboos provided by the three households; the average weight of the five bamboos is 16.8 kg (see Appendix C). [76] Earnings from bamboo sales were divided by a price of MK2 per bamboo to obtain an estimate of the number of bamboos sold. The estimated number of bamboo sold were then multiplied by 16.8 kg to arrive at estimates for the weight of bamboo extracted from the forest.

Bamboo Basket Weaving

In Villages 1 and 2, seven sample households reported earnings from sales of baskets woven with bamboo obtained either from the MMFR or the village commons. Weaving is a male-specific activity at the study sites and was particularly prevalent in Village 2. From interviews with bamboo weavers I know that one to two medium-sized baskets can be produced with a single bamboo plant, depending on the size of the bamboo. In making the baskets, bamboo is cut lengthwise into four parts and the two parts that are smooth (do not have branches) are used for basket weaving; the other two parts are discarded or used for other purposes. From the bamboo measurements it was found that about 10.77 kg was needed to produce a medium-sized basket, and sample households that sold baskets charged about MK15 per basket during the study year. To arrive at estimates for the quantity of bamboo used to produce baskets, reported earnings from the sale of bamboo baskets were divided by MK15 and then multiplied by 10.77.

Wood-Fired Clay Pots

Pottery making is an activity performed only by women at the study sites, and only occurred in Villages 1 and 2 during the study year. All of the sample households that reported pottery sales (N = 8) stated that only small pots were produced, those that would be used for holding *ndiwo* or *nsima*. [77] These sold for about MK10 each in 1999/2000. The clay is found locally and wood is used to fire about 10 to 40 pots at a time. Direct measurements with women potters (N = 5) found that 1.33 kg of wood per pot was required for firing (see Appendix C). The number of pots fired was estimated by dividing reported earnings from sales of clay pots by MK10. To obtain estimates for the quantity of wood used for firing clay pots, the number of pots fired was multiplied by 1.33 kg.

Masese Beer Brewing

Throughout rural Malawi, beer brewing is a popular income-generating activity for women. For the sample households, 11 women reported sales of brewed beer during the survey year. Direct measurements of wood used by five groups of women brewers found that about 75 kilograms was used to brew an average batch (see Appendix C). [78] Data are available from the household survey for the number of batches of beer brewed by sample households in each quarter. These data are used with the figure of 75 kg per batch to obtain estimated quantities of wood used for beer brewing.

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[76] The measurements were done in August 2002 by one of the research assistants.

[77] *Ndiwo* is a generic term for any side dish that accompanies *nsima*.

Kachasu Dry Spirit Distillation

Six sample households reported sales of *kachasu* dry spirit. *Kachasu* distillation is another popular income-generating activity for rural Malawian women. It is generally more common than *masese* beer brewing (though not in the study villages) largely because costs of production are far lower for *kachasu* distillation. Direct measurements of wood used by five women *kachasu* distillers found that an average of 2.4 kilograms was used to distill 1 liter (see Appendix C). I determined the number of liters sold by dividing earnings by K40 (the average price per liter of *kachasu* in the study villages in 1999). This data is used with the figure of 2.4 kg of wood required per liter of *kachasu* to obtain estimated quantities of wood used for distillation.

Cooked Food

Women from 27 sample households reported sales of cooked food or baked goods during the survey year. Cooked foods included: cassava, maize, velvet beans, sweet potatoes, groundnuts, and coconut. For these items I used data from Brouwer (1998) for the quantity of wood used to cook four servings of cassava (1.5 kilograms). Based on field experience, I assumed a serving of cooked foods would sell for about MK2. Using these figures along with earnings data from the household survey, I was able to estimate quantities of wood used to prepare these items.

Baked goods sold by sample households were: *chikondamoyo* cakes, *mandasi* doughnuts, and *chitumbua* fried banana cakes. I assumed 2 kg of firewood was used to bake or fry a batch of a dozen cakes, based on my experiences baking with firewood

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[78] An average size batch is measured in a local basket unit – two *mseches*.

using a traditional oven. Baked goods sold for MK1 each during the survey year. Using these figures and earnings data I estimated amount of wood used to prepare baked goods.

Extractive Activities Not Included in the Index

A few forest-based income-generating activities were not included in the calculation of the forest extraction index despite the participation of sample households: traditional medicine and thatching activities. Although medicinal plants are becoming increasingly scarce due to timber harvesting, fires, and other factors, it is said that traditional doctors extract relatively small quantities of medicinal plants and therefore have little impact on these resources (Knacck Consultants 1999). While there is some evidence that thatch is increasingly scarce in the study area, it is expected to be far less of a problem than is scarcity of tree resources (Konstant 1999).

Appendix C – Results of Focus Group Discussions and Direct Measurement Exercises

Results of Focus Group Discussions

Main Uses of Wood Collected from the MMFR

In all of the 15 villages, informants agreed that wood collected from the MMFR is primarily used for cooking *nsima* and *ndiwo*. A large number of other end uses were identified including: construction materials (for dwelling unit, toilet, kitchen, granary, animal shed, fences), *masese* beer brewing, *kachasu* dry spirit distilling, basket weaving, pot firing, carpentry, brick making, baking, firewood marketing, and charcoal production.

Marketing of firewood was identified as an important income-generating activity in all villages. Both women and men participate in sales of firewood, though this is a far more common activity for women. Women participate in firewood selling primarily because it is an easy entry activity, and they are used to collecting wood. The general sentiment was that they would prefer to engage in other income-generating activities because firewood selling is laborious, risky (they have to contend with the forest guards), and earnings are low (largely because there are far more firewood sellers than buyers).

In 12 of the 15 villages, some community members burn and sell charcoal. In two of these villages the produced charcoal is used only for ironing clothes, and therefore sold locally. In the other villages, people produce charcoal for urban markets. The produced charcoal is placed into 50 kilogram bags and transported by bicycle to trading centers about 10 to 20 kilometers away where they are sold along the roadside to Blantyre. In one village, there is a school where charcoal producers sell charcoal to the teachers. Charcoal earnings are said to be highest in the winter months (June and July).

Other Items Collected from the MMFR

Key informants mentioned a number of other items collected from the MMFR: grass for thatching, medicinal plants, and wild foods. Wild foods from the state forest reserve include: a variety of fruit and vegetables, mushrooms, caterpillars, and bush meat (antelope, wild pig, hares, monkeys, mice, birds). The importance of these wild foods lies more in when they are consumed, than in the quantities consumed. The wild foods said to be most important for filling a seasonal gap were fruit and mushrooms.

People said that women and children snack on wild fruit while collecting other items from the forest. This is said to be more prevalent during the hungry season, although some types of wild fruit are available most months of the year. Mushrooms are only available a few months a year, the mushroom season coincides with the hungry period. Local people (mostly women) collect mushrooms while collecting firewood. For the very poor, mushrooms are commonly eaten with *nsima* during the hungry season.

Local Perceptions of Forest Decline

In all villages except one, key informants told us that the number of trees in the MMFR has decreased considerably over the past ten years. In one village, people said that the number of trees in the MMFR has not changed; this village is not representative of villages in the area because it is one of a limited number of villages that benefit from German Society for Technical Cooperation (GTZ) programs. The GTZ program is an afforestation program on common land; it also introduces mud stoves that require less wood than the traditional three-stone method of cooking.

Key informants expressed much concern over what they perceive as a reduction in trees on the mountain. People said they worry that life will be more difficult for their children and grandchildren because they will have a hard time finding wood to cook *nsima* and there will be fewer ways for them to earn money. People said they worry that future generations will not know the beauty of the mountain and all the varieties of trees it has. In one village, informants said that if extraction of forest products continues at current levels there will be no trees left when their grandchildren are adults.

Key informants recognize forest decline in terms of its direct impact on their daily lives (see Figure C.1). For example, when asked "How can you tell that the number of trees in the MMFR has decreased in the past 10 years?", the most common response provided by women was that, with each passing year, it takes more time to reach wood collection sites. Women also mentioned that dry wood is far less available now than in the past. In one village the elderly female village head remembers a time when she could collect wood just inside the MMFR boundaries. Today it takes her three-fourths of a day to collect wood, which she does three times per week.

Some of the men in the focus groups regularly hunt in the MMFR using dogs, traps, sling shots, and very rarely guns. These men said they recognize forest decline in terms of a reduction in the number of animals found in the forest. Traditional doctors in the groups mentioned that it has become increasingly difficult for them to find the plants used for their medications. Many informants also linked a reduction in the number of trees in the MMFR with other environmental outcomes, including reduced rainfall and increased soil erosion. They said that this was causing problems for them in that it has become harder to produce adequate maize to provide for their families.

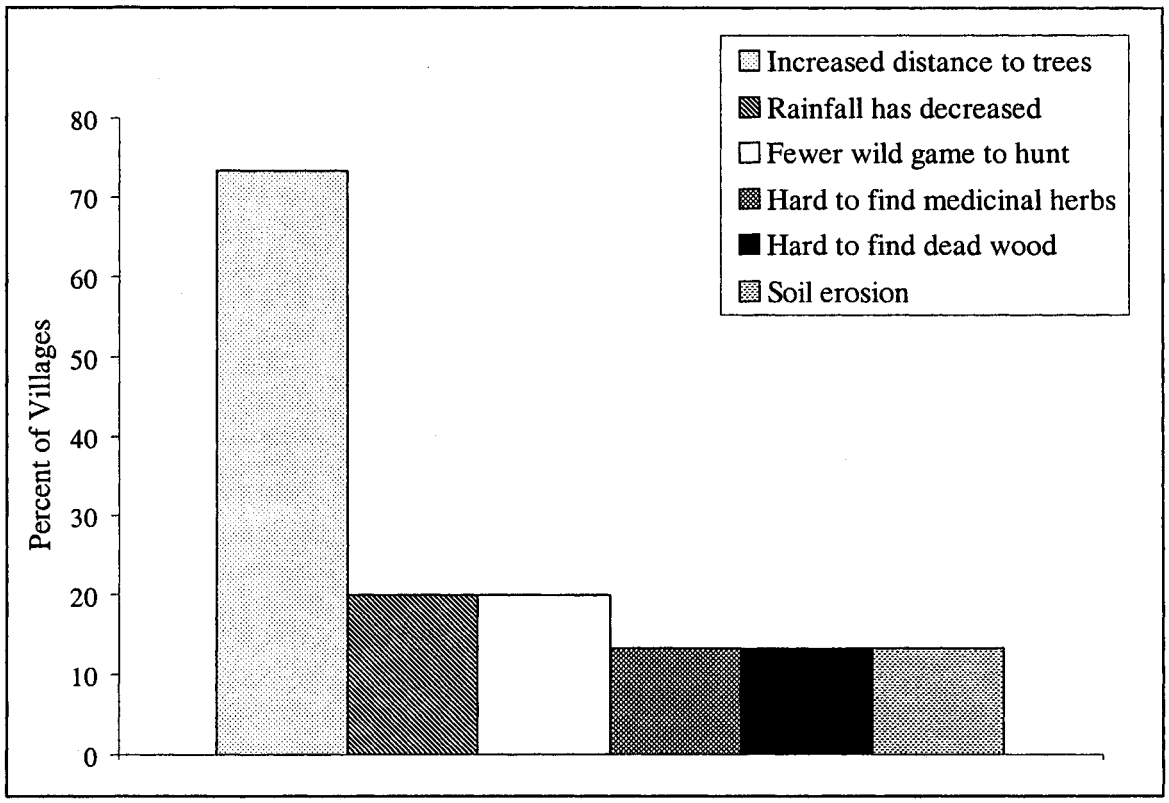

Figure C.1 Local Perceptions of Forest Resource Scarcity

As stated above, key informants in 14 villages stated that there are far fewer trees in the MMFR today than there were 10 years ago. We asked the people in these villages to tell us the main reasons for the reduction in trees over the past decade. The most common responses are shown in Figure C.2. People recognized that collectively they are playing an important role in forest decline, but the general sentiment was that individuals have little choice in this matter. The most common answer in the villages was that overpopulation is responsible for forest decline. People said that there are simply too many people and not enough trees. Some women mentioned that because so many people collect wood from the MMFR, there is not enough dead wood available, and they are forced to cut live trees. Other key informants mentioned that local people have no other choice to expand their gardens than to clear forest. Some people even build houses in the forest reserve.

Unemployment was also commonly mentioned as a reason for forest decline. Lack of employment opportunities forces people to use the forest to earn money. Key informants from two neighboring villages mentioned that at one time a tea estate was nearby. A few years ago, the tea estate removed most of the tea plants and replaced them with eucalyptus trees. This resulted in a loss of jobs for the local people. Many of the former tea estate workers from these villages now must engage in multiple activities to earn money, and one of the most common activities is selling wood. In a couple of villages, respondents said that they would stop selling wood and charcoal if there were employment opportunities in their village.

A number of key informants said that poverty is the main cause of forest decline. Because people are poor, they have no alternative other than using wood for cooking.

They are too poor to buy paraffin stoves and do not have electricity in their houses. Also because people are poor, they are willing to do low-return jobs like selling firewood. In a few villages, people said the lack of tree planting was a cause of forest decline. Respondents said that people cut trees but do not recognize the need to plant trees.

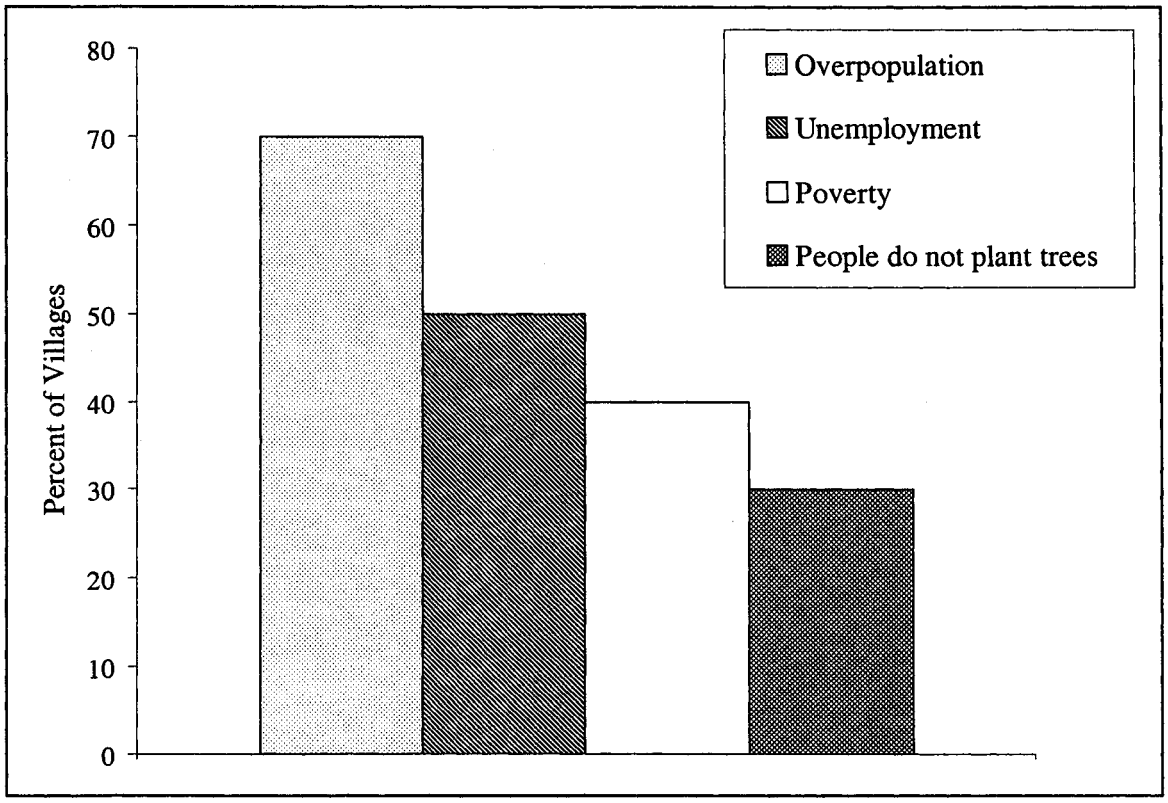

Figure C.2 Local Perceptions of the Causes of Forest Decline

In most of the villages people said that, to date, they have done nothing to conserve forest resources on the MMFR. When asked how people in their village can conserve trees in the MMFR, the overwhelming response was that they should plant trees on their private landholding (see Figure C.3). People made it very clear that they want to plant trees on their own land, not in the village commons or the MMFR. In all villages, key informants said that some people were currently planting trees, but that there was a

need for more people to be involved in tree planting. In several of the villages, people mentioned that in order to plant trees, outside assistance would be needed in the form of loans and/or seedlings. Although community members of two villages located adjacent to a tea estate key informants expressed the desire to plant trees, they said that their landholdings are too small to plant trees due to encroachment by tea estates. They also said that their landholdings are too small for them to grow enough maize to feed their families, so they really cannot think of using the land for planting trees. In other villages people were more optimistic. Many people were aware of NGOs with tree planting programs in the area and hoped that their villages would benefit from such programs in the near future. In one village, respondents said they are already planting trees but need to plant more; their goal was to plant two trees for each tree they cut down. They said that they plan to plant quickly maturing trees such as eucalyptus.

In about half of the villages, key informants mentioned that local people must stop cutting live trees and use only dead wood if tree resources in the MMFR are to be conserved. In two villages, people said that they should help the Forestry Department with its activities. People in another village said that they would assist the Forestry Department by patrolling the forest (of course this would mean they would need to be employed by the Forestry Department). In another village, people said that their village would like to monitor compliance with the Forestry Department rules within their village.

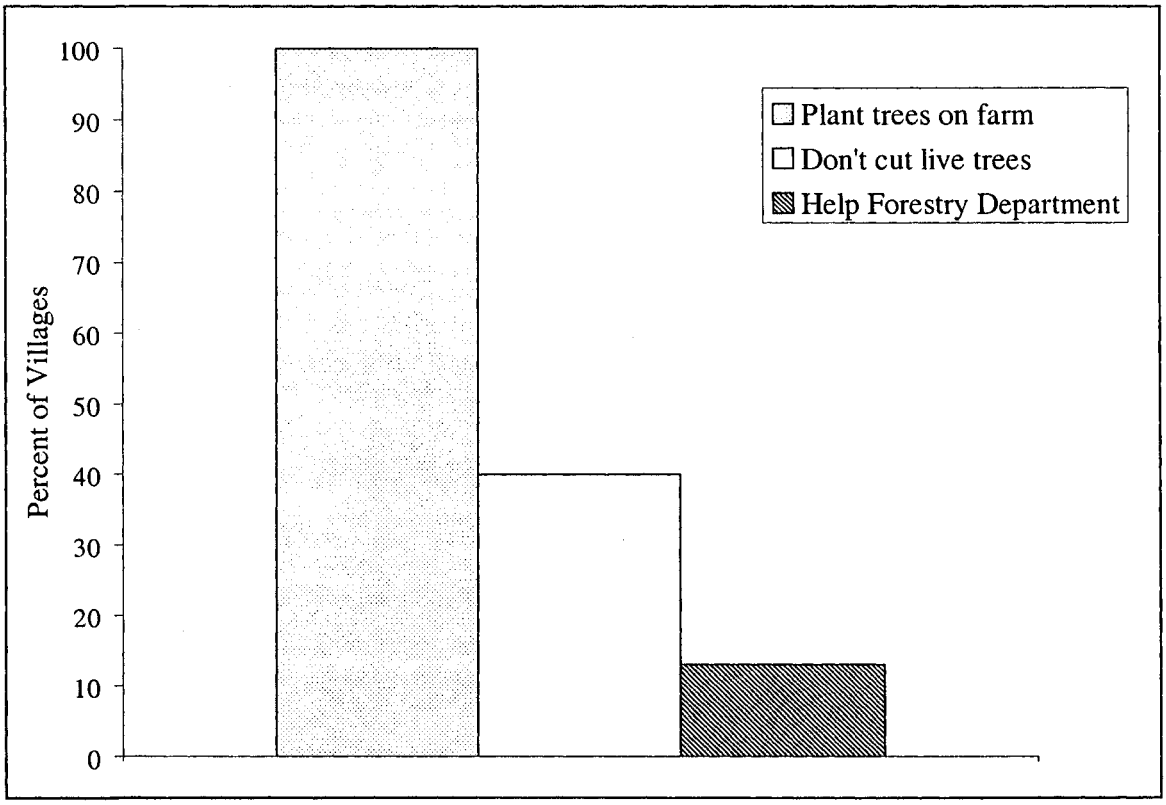

Figure C.3 Local Opinions on How to Conserve Forest Resources

Forestry Department Rules: Local Awareness and Opinions

Responses during the FGDs indicate that community members were well-aware of the Forestry Department's rules pertaining to extraction of products from the MMFR. Interestingly, how people felt about the rules was also rather uniform across villages. In most villages, a common sentiment was that the Forestry Department rules are necessary to prevent over-exploitation of forest resources. One man said that without these rules and the guards to enforce the rules, there would be no trees on Mulanje Mountain. In some villages, however, people mentioned that the Forestry Department does not have authority to set and enforce the rules, as the MMFR sits on their ancestral land. A few

people complained that as long as they can remember "outsiders" have assumed ownership of the forest. First it was the colonial government and now the Forestry Department. They questioned how the forest can be owned, since indigenous trees are gifts from God.

Although most people acknowledged the need for rules, in all villages the majority of key informants felt that the MK5 fee charged for head loads of wood is excessive and unfair. One woman noted that if people have difficulties paying MK2 for salt, then of course MK5 for dead wood is unreasonable. Other women noted that sometimes they were unable to cook for their families because they did not have MK5 and they encountered a guard on the way to collect wood. People also complained that when the fee was raised a few years back, neither they nor their village heads were consulted. In most villages, people agreed that they should set the head load fee, and that it should be far lower. Some proposed that only people who sell wood should be charged a fee. The few dissenting voices concerning the excessiveness of the fee for head loads were a couple of men in two villages. One man said the fee is completely justified because the Forestry Department needs the money to pay the forest guards. He said that without forest guards, people would cut trees without restraint. In another village, a few men went so far as to say that the fee should be raised to MK 100. This they said would result in very few people entering the forest to collect wood. People would then be forced to plant trees and to cook using harvest residues.

In most villages, people admitted that they usually only pay the fee for head loads if they meet a guard. They are so dependent on wood, and they lack money to pay the

fee, so they have no choice but to violate the rules. Many people said that if the fee were lowered to a reasonable amount, they would pay every time they collected wood.

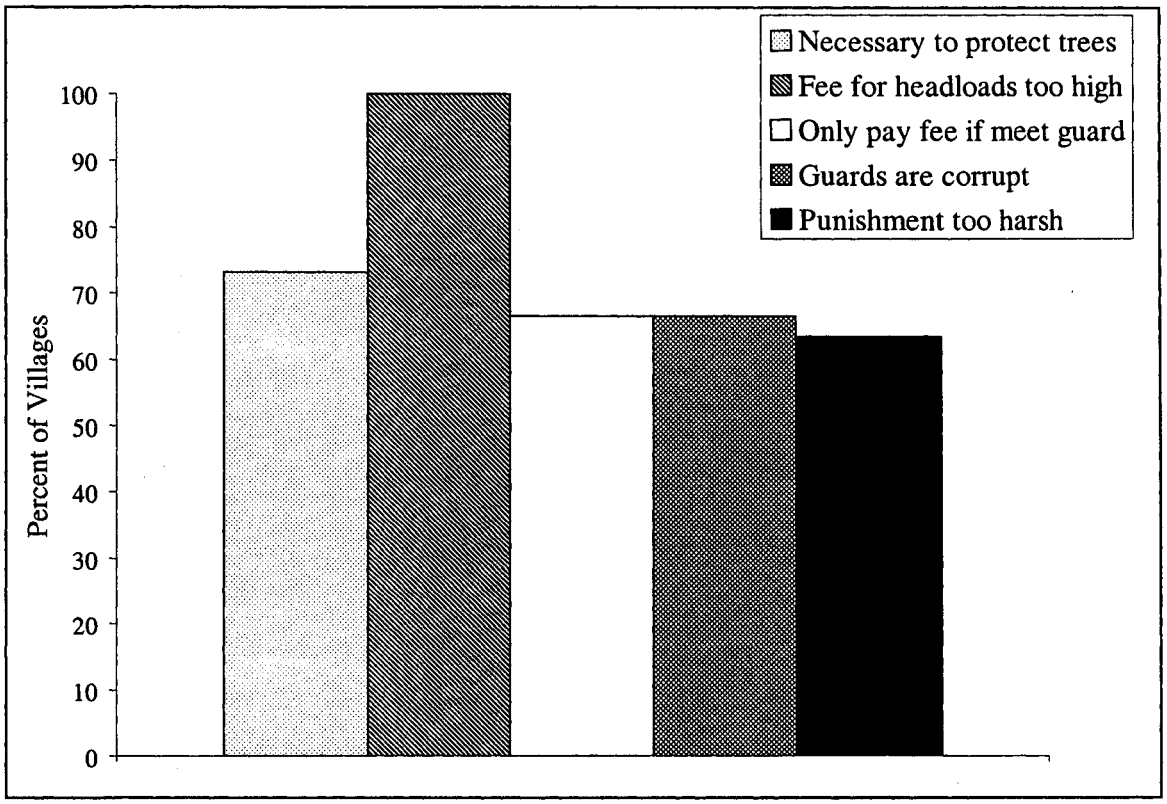

Figure C.4 Local Opinions About Forestry Department Rules and Regulations

In most villages, there were some complaints that the forest guards employed by the Forestry Department are corrupt. Many people said that the forest guards allow their friends and family to collect wood without paying a fee and cut protected trees illegally. A number of people also mentioned that the guards are easily bribed by wealthy "outsiders" who come to the MMFR to illegally extract timber. Some people mentioned that often when they pay the guard the fee for head loads he/she does not issue them a

ticket; they think that some guards are pocketing the money. There were also complaints of guards being overly harsh with women wood collectors. Some people however, said that the guards performed their job appropriately. Some women told us they had never been asked to pay a fee higher than MK5 for head loads of wood. In one village, all key informants said that they had very good relations with the forest guards.

The general punishment for violation of Forestry Department rules is confiscation of the forest product(s) and the forest tools. The tools will generally be released once the violator pays a fine at the Forestry Department office. In most villages, people said that the punishment for illegally collecting dead wood was too harsh. Many women expressed the opinion that it is very unfair for the guards to burn their head load of wood and take their *panga* knives if they are unable to pay the fee. When guards confiscate their head loads women return home without wood and cannot cook or make money selling firewood.

People generally thought that the punishment for cutting live trees (fine of MK 150 or higher and confiscation of the trees and forest tools) and for setting fire to the forest (possible imprisonment) were appropriate and should be enforced. They said that it is usually "outsiders" who violate these rules, not the local people. In some villages people complained that the problem is that the guards are very easily bribed, so "outsiders" illegally using the forest get away without punishment.

We asked key informants to give us their ideas concerning the type of management regime that would work best to conserve forest resources on Mulanje Mountain for future generations. In most instances we had to spend a fair bit of time explaining the differences between community-based management, state management,

and co-management. We only noted the response after group consensus had been reached. The answers to this question are shown in Figure C.5.

In most villages, people decided that co-management has the best chance for success. In several villages, people said that community members deserve to take part in making the rules and enforcing them, since they are the ones who use the forest on a daily basis. People were very interested in being employed as forest guards; many people complained that until now it is only "outsiders" that are hired for these jobs. Many key informants mentioned that if they have a say in rule making, the rules will better reflect their needs and interests, so there will be less illegal activity in the MMFR. Some people liked the idea of co-management; they said they would then be able to report corruption on the part of guards and hopefully these guards would be dismissed. Some said that if they had a say in decision making, then they would have better relations with the Forestry Department and more respect for rules. In one village, key informants said that the best thing about co-management is that they or their village head would finally get to meet the "bosses" of the Forestry Department and disclose to them all the problems in the MMFR such as corrupt guards and the badly maintained firebreaks that contribute to fire occurrence on the mountain.

In two villages, people did not seem to understand the concept of co-management despite our attempts to explain. They seemed to think that the only change with co-management would be that they would be informed of the rules early on and that the Forestry Department would educate them on various issues such as the importance of protecting trees. These villagers may limited experience with participation in local governance.

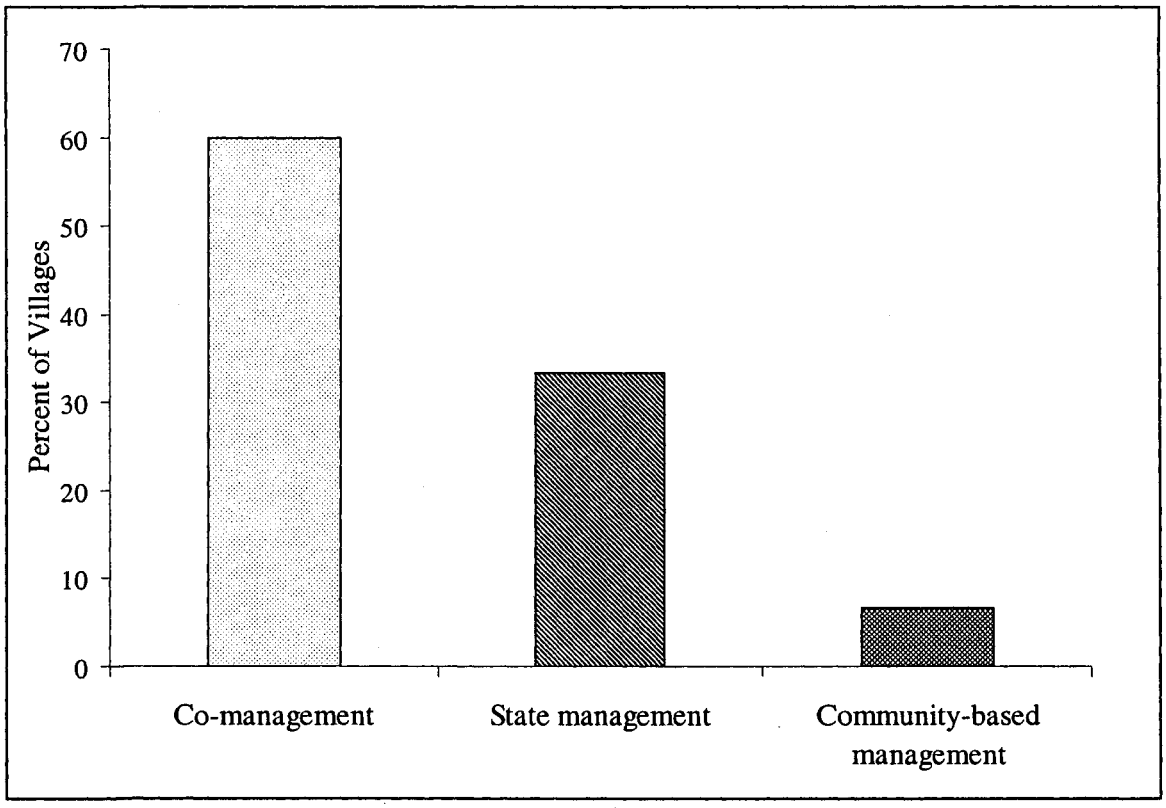

Figure C.5 Local Opinions Concerning the Preferred Management System for Conservation of Forest Resources in the MMFR

In five villages, key informants said that the current state management should remain. In one village, community members argued that the problem with co-management or community-based management is that community members would never be able to reach consensus on a fair set of rules. They believed the end result would be that everyone would just do whatever they pleased, and the trees would rapidly disappear. In another village people argued that co-management would not work because people would only be willing to participate if they are paid. Some respondents said they are satisfied with the Forestry Department's performance, so no change is needed. In the other villages, people said that only the Forestry Department knows how to manage the

forest, and the job would be too hard for community members. They said that they are all too poor and desperately need to exploit the MMFR, so they should not be involved in management.

In one village, people argued for community-based management. They said that the problem with co-management is that they would be expected to turn in their friends and neighbors, and they do not want to have to do this. Somehow they believed that this would not be an issue under community management, because they felt that everyone would agree to the rules so that there would be no violations to report.

While key informants acknowledged the importance of management, there was a common sentiment that "good" management is not enough to protect forest resources in the MMFR. People mentioned the need for jobs on tea estates, with the Forestry Department, or government-created jobs. People also said they need loans to start up businesses, such as resale of maize bought in Mozambique. People also mentioned the need for assistance to purchase seedlings so they can plant trees on their landholdings. Informants stated that at the moment they are forced to exploit the forest, but if they are provided with opportunities for employment, self-enterprise, and tree planting they would reduce their use of the MMFR.

Results of Direct Measurement Exercises

Daily Fuel and Food Consumption

Table C.1 Quantity and Type of Fuel Used for Cooking in January and June 2000, Sample Households

Household ID No.	January 2000		June 2000	
	Type fuel	Qty. fuel (kg)	Type fuel	Qty. fuel (kg)
8	firewood	8	firewood	6
9	pigeon pea stalks	7	firewood	4
15	firewood	3.5	firewood	4
22	firewood	5	firewood	5
23	firewood	6	firewood	6
25	firewood	7	firewood	6
27	firewood	7	firewood	5.5
28	firewood	4.5	firewood	4.5
30	firewood	6.5	firewood	6.5
31	firewood	4.5	firewood	4.5
34	firewood	2.5	firewood	2.5
36	firewood	5	firewood	5
54	cassava sticks	7	firewood	4
56	cassava sticks	3	cassava sticks	4
57	cassava sticks	5	firewood	5
64	cassava sticks	5	firewood	6.5
70	firewood	8	firewood	6
73	bamboo	5	firewood	3
Average		5.53		4.89

Table C.2 Number Meals Consumed per Day, Quantity Wood Used for Cooking, and Per Capita Quantity Wood Used for Cooking in January and June 2000, Sample Households

Household ID No.	Number Consumption units [a]	January 2000		June 2000		Per capita qty. wood (kg/pers/meal) [b]
		Number cooked meals (per person per day)	Qty. wood (kg)	Number cooked meals (per person per day)	Qty. wood (kg)	
8	4.5	2	8	2	6	0.78
9	5	2	0	2	4	0.20
15	3	2	3.5	3	4	0.51
22	3	2	5	2	5	0.83
23	4	2	6	2	6	0.75
25	7	2	7	3	6	0.39
27	4	2	7	2	5.5	0.78
28	6	3	4.5	3	4.5	0.25
30	3	3	6.5	3	6.5	0.72
31	6.5	2	4.5	3	4.5	0.29
34	2	1	2.5	2	2.5	0.94
36	5	2	5	3	5	0.42
54	7	2	0	3	4	0.10
56	2	1	0	2	0	0
57	3.5	2	0	3	5	0.24
64	3	3	0	3	6.5	0.36
70	5.5	3	8	3	6	0.42
73	5	2	5	3	3	0.35
Average	4.39	2.11	4.03	2.61	4.67	0.49

a. The number of consumption units is the number of household residents, where young children are valued at half a consumption unit.

b. For each sample household the column entry is the average over the two seasons of the quantity of wood divided by the product of number of consumption units and meals. The zero value for household number 56 is not included in the computation of group average.

Weight of Wood Head loads

With a sample size of 20 girls/women, the average head load weight carried was 40 kilograms, with a maximum of 67 kilograms (see Table C.3). The average weight of the women and girls themselves was 50 kilograms. Thus, on average the girls and women carried 80 percent of their body weight upon their heads, down the mountain, over a distance of several kilometers.

Table C.3 Type of Wood and Weight of Wood Head loads Carried by Girls/Women in the MMFR, February 2000

Observation Number	Type of Wood (Local name)	Head load Weight (kg)	Weight Girl/Woman (kg)	Approx. Age Girl/Woman Carrying Head load
1	Nanyole	27	47.5	20
2	Thethere & Chinine	41	47	20
3	Masuku & Thethere	42	53	21
4	Kamphoni	26	42.5	12
5	Kamphoni & Nsopa	41	48	51
6	Kamphoni	36	47	21
7	Kamphoni & Peu-Peu	39	47	26
8	Zoyera	49	52	21
9	Nsopa	27	51	16
10	Zoyera	44	57	16
11	Kamphoni	41	53	20
12	Kamphoni & Nsopa	58	60	39
13	Kamphoni	41	47	25
14	Masuku	44	56	17
15	Kamphoni	38	54.5	26
16	Kamphoni	33	39	22
17	Kamphoni	27	50	15
18	Kamphoni	67	59.5	40
19	Kamphoni	38	50	19
20	Not available	37	47	56
Average		40	50	25

Local Price of Firewood

Mwanakhu Market is held two times per week, on Monday and Thursday mornings. This is the largest market in the Likhubula area and the main market for firewood for households in Village 1. Of the people marketing wood on the day of our visit, all were women, which I was told is typical. The women told me that they are required to pay a fee of K4 per market day in order to sell wood at the market. Wood is sold in two different size bundles, the larger selling for K20 and the smaller bundle for K5. Women told me that about two K20 bundles are equivalent to a head load of wood carried down from the mountain on a single trip. The buyers of wood come primarily from the *dambo* (lowland areas) distant from the MMFR and with scarce common forest land. In Tables C.4 and C.5 findings from the measurement of bundles are presented.

Table C.4 Samples of K5 Bundles

Observation Number	Weight (kg)	Unit Price (MK/kg)	Type of Wood (Local name)
1	7	0.71	Kamphoni
2	6	0.83	Kamphoni
3	5.5	0.91	Blue gum eucalyptus
4	4.5	1.11	Blue gum eucalyptus
5	3.5	1.43	Masuku
6	4.5	1.11	Masuku
7	4.5	1.11	Masuku
8	3	1.67	Masuku
9	4	1.25	Masuku
Average	4.72	1.13	----

Table C.5 Samples of K20 Bundles

Observation Number	Weight (kg)	Unit Price (MK/kg)	Type of Wood (Local name)
1	20	1.00	Kamphoni
2	24	0.83	Nsopa & masuku mix
3	23	0.87	Nsopa & masuku mix
4	17	1.18	Nsopa & masuku mix
5	16.25	1.23	Nsopa & masuku mix
Average	20.05	1.02	----

Quantities of Wood Used for Income-Generating Activities

Masese Traditional Beer

Table C.6 Quantity Wood Used to Produce Two *Mseches* (large baskets) of *Masese*

Observation Number	Quantity of Wood (kg)
1	70
2	77.5
3	74
4	86
5	69.5

Kachasu Dry Spirit

Table C.7 Quantity Wood Used to Produce *Kachasu*

Observation Number	Quantity of Wood (kg)	Number of Liters Produced
1	10.5	7
2	28	10
3	11.8	4
4	21	9
5	14.5	6

Wood-Fired Clay Pots

Table C.8 Quantity Wood Used to Produce Clay Pots

Observation Number	Quantity of Wood (kg)	Number of Small Clay Pots Produced
1	18	9
2	19.5	13
3	28	32
4	24	19
5	16.5	16

Fired Bricks

Table C.9 Quantity Wood Used to Produce Bricks

Observation Number	Quantity of Wood (kg)	Number of Bricks Produced
1	3,398	4,000
2	3,094	3,900

Note: These measurements were made by one of the research assistants in August 2002.

Bamboo Baskets

Table C.10 Quantity Bamboo Used to Produce Baskets

Observation Number	Quantity of Wood (kg)	Number of Medium-sized Baskets Produced
1	10	1
2	16.17	1.50
3	20	2
4	14	1.25
5	23.7	2

Note: These measurements were made by one of the research assistants in August 2002.

Conversion Rates for Maize Measurement Units

Table C.11 lists the conversion rates used to convert quantities of maize from local units to kilograms. The figures are averages for about 10 samples per measurement unit.

Table C.11 Conversion Rates for Local Maize Measurement Units

Measurement Unit	Mean Weight of Shelled Maize (kg)	Mean Weight of Maize on the Cob (kg)
50 kg bag	58	34
small dengu	20	12
medium dengu	22	15
large dengu	46	31
small ntanga	29	21
medium ntanga	49	32
large ntanga	Not Available	Not Available

VITA

VITA

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