NATURAL RESOURCE DEGRADATION AND HOUSEHOLD TIME ALLOCATION AMONG RURAL ACTIVITIES: EMPIRICAL EVIDENCE FROM UGANDA

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Declaration

I, Paul Okiira Okwi, do hereby declare that the work presented in this thesis, is my own, except where acknowledged and that this thesis or any part of it, has not been submitted in the past, for the award of a degree at any university. Any errors are entirely my responsibility.

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Abstract

This thesis analyses the effects of natural resource degradation on production and well-being of rural households in Uganda. In the face of growing concerns about the environment, policy makers in Uganda are finding themselves increasingly pressured to choose between environmental degradation in the long run and the ever-growing needs of the poor populations in the short run. The effects of environmental degradation, such as loss of woody biomass, on household welfare may have been understated and less recognized. Some economists point to the development of alternative (substitute) fuels and new technology, use of fertilizers and controlled population growth as the solutions to rural environmental deterioration and subsequent improvement of rural household welfare.

The rural areas of Eastern Uganda provide a prime example of an area in which agricultural and household activities are surrounded by rapid environmental deterioration due to high deforestation. These rural areas are characterized by low agricultural output, out-migration to urban areas in search of better paying jobs, high reliance on household labour input in production, limited markets for fuel-wood products and limited use of modern agricultural technology and pressure to expand cultivated land at the expense of forestland as population grows. Forests are mostly a common property resource and rural households freely collect fuel-wood from the forests or own farms. This results in over-cutting and over-use of tree resources, with limited replacement. There is steady deforestation as a result of low natural regeneration, over-cutting and inadequate reforestation and conservation efforts. A number of studies in developing countries have shown that exploitation of fuel-wood can have disastrous effects on the environment and households, but these studies do not clearly explore the resultant effects on household activities and welfare.

In this study, the link between deforestation, household time allocation to fuel-wood collection and agriculture was analyzed. The analysis focused on the consumption of fuel-wood by a sample of rural households in Eastern Uganda, and how these households reallocate time to environmental product collection from agriculture when the products become scarce. The time required for the household to collect a unit of fuel-wood including finding, extracting, processing and transporting fuel-wood from the forest to the village is used as a proxy for deforestation. Specifically, the allocation of household time is influenced because household members are engaged in not only collecting fuel-wood, but also in farm work. According to the hypothesis, deforestation reduces household labour input to agriculture by increasing time spent in collecting fuel-wood products, thus shifting time away from agriculture. As a result, household agricultural activities may be affected. Uganda is a good location for a case study to examine this hypothesis, as a number of factors such as rapid deforestation, high economic growth amidst high poverty, forestry programs, labour shocks like the effects of Human Immune-Deficiency Virus/ Acquired Immuno-Deficiency Syndrome (HIV/AIDS) have been in place longer than in many countries in the region.

A non-separable (non-recursive) model was developed to test the participation of households in fuel-wood collection and farming activities, as a function of land use,

collection time, household demographic and economic characteristics, seasonality and location variables. Using data from rural areas of Eastern Uganda, both qualitative and quantitative analyses were done. Direct estimates of marginal productivities (shadow wages) of family labour were derived from a Cobb-Douglas agricultural production function. The estimated shadow wages were then used as regressors in models of fuel-wood demand and labour supply. Similarly, market wages were used in the regression models for household farm time allocation. Both qualitative and quantitative analyses suggest that household fuel-wood collection, consumption and farm activities are dependent on various socio-economic, seasonal and agro-ecological variables. In general, results of the quantitative analysis of collection and demand functions for fuel-wood showed that the more traditional measures of economic conditions – shadow wages and prices, labour time, demographic composition of the household, seasonality and agro-ecological differences – are important variables that affect household labour allocation decisions. In terms of the effects on household farm time inputs, the results provide no support to some of the previous studies which show that as deforestation increases and fuel-wood gets scarce, household members will divert time away from farming. Estimates of the determinants of time allocation to agricultural activities showed that deforestation does not divert household time away from farming activities. Instead, the effect of deforestation on women's farm labour input was positive in both seasons. Other important determinants of labour allocation to farming for the different gender groups include age, education, gender of the household head and household composition, agro-ecological zone, amount of time spent in water collection per trip, proportion of land under crops, ownership of livestock and hiring of labour. Given this explanation, the fact that there is no evidence of labour relocation away from agriculture to fuel-wood collection, it can be concluded that agriculture is such an extremely important activity and fuel-wood products have not become costly enough to significantly tighten household labour constraints.

Moreover, the results suggest that it is not enough to rely on reforestation efforts alone to improve the rural economy and ecology. Strategies to improve existing technologies (improved input use), a shift away from subsistence agriculture, an increase in wage incomes and off-farm employment opportunities such as food processing, the development of energy efficient cooking systems and fuel-wood substitutes, and an improved management of natural resources and their institutions need to be considered. Clearly, efforts are needed to alleviate the labour bottlenecks of subsistence farmers through agro-forestry programs, efficient use of fuel-wood and adoption of efficient cooking equipment, which will relieve environmental good collection labour burdens or reduce collection time for fuel-wood. This requires investment in research and extension. Suggestions for the improvement of future data collection and analysis to examine the linkages between natural resource degradation, household and agricultural activities, and land use are provided.

Chapter 1
Background and introduction

1.1 Introduction

This study seeks to analyse the effects of natural resource degradation on production and the well-being of rural households in Uganda. It focuses, in particular, on how various attempts to cope with adverse rural environments have affected the time allocation profiles of individual households and it emphasizes the interaction between household members. Specifically, the study examines the consumption of fuel-wood by a sample of rural Ugandan households, and how these households reallocate time to environmental product collection when the products become scarce. The analysis is based on data collected from rural households in Eastern Uganda covering a sample of 359 farming households. The study employs and modifies the framework developed by Becker (1965), Gronau (1973, 1977), Huffman (1980), Low (1986) and Singh *et al.* (1986) as the basis of a model of home production and fuel-wood collection.

Forest products are particularly important because they provide disproportionately high values of environmental services and biodiversity. However, in recent years, there has been an increasing concern about the declining quality of forests and the negative consequences on the decreased availability of forest products, climate change, soil degradation and flooding in Uganda, and the developing world generally. According to the National Biomass Study (2002), Uganda has moved into a national fuel-wood deficit as over 32 percent of the tropical high forest is now degraded, and private forests are shrinking more rapidly than forests managed by government. Most remaining forest cover is highly degraded secondary forest. The substantial decline in Uganda's forest cover has occurred in conjunction with the rapid growth in agricultural land use. Apart from the direct impact that expansion of agriculture and grazing land has had on the forest environment, deforestation has also arisen as a result of Uganda's ongoing dependency on fuel-wood to meet her energy needs (National Environment Management Authority-NEMA, 2002).

In recent works on rural areas of Latin America, Asia and Africa (Bluffstone, 2001; Kohlin, 1998; Thapa, 1996; Agarwal, 1986; Dankelman and Davidson, 1988), some studies have found that increased deforestation leads to more time spent by rural households on food production and household work activities, especially fuel-wood collection. On the other hand, some studies (Nankhuni and Findeis, 2003; Heltberg, 2000; Khumar and Hotchkiss, 1988; Soussen *et al.* 1991; Skar, 1992) have found strong evidence that deforestation is associated with increased fuel-wood collection time and a reduction in the number of hours spent on directly productive agricultural activities, and other activities like education, cooking, child care and leisure. These existing empirical findings are largely based on surveys in narrow geographic regions in which markets for labour and in some cases fuel-wood are missing, and they are not gender disaggregated. However, conditions in rural Eastern Uganda differ in important aspects from those in frontier regions in Asia, Latin America, Ethiopia and Southern Africa where similar studies have been conducted.

Poor agricultural practices and infrastructure, population pressure, policy and market failures[1], different cultures, and community networks are among the typical characteristics that may provide differences between these areas, and also lead to high rates of natural resource degradation. Besides, the differences between the two areas may also arise because, according to Mellor (1986), the situation in Asia and Latin America represents high growth agricultural zones, where labour may be surplus and there is potential for widespread adoption of labour intensive agricultural technologies and for growth in rural off-farm employment. Production in Uganda, as in the rest of rural Africa, follows a "hard-working peasant" model, in which output is a direct product of labour input. In this case, since the marginal product of labour is high, labour constraints are likely to develop and it is difficult to support additional labour demands when aggregate productivity is low. Thus, the significance of labour in agricultural production remains high, yet it is from such areas that high out migration of labour due to relatively low productivity of land is observed. Also, with increased

[1] There is no market for environmental and other "open access" public goods, for example no one pays for water flowing from forests. Also there are market imperfections, for example forest owners are not aware of the price of forest products in the market and thus they undervalue their assets. Also forest users do not pay for the negative externalities associated with their actions.

population growth, the pressure to expand cultivated area increases and this further promotes deforestation (NEMA, 2002).

In analyzing the situations that may arise from deforestation, a major hypothesis, namely that progressive deforestation is changing the production functions of rural households considerably, is assessed. These changes range from crop area cultivated and the labour time available for it, types of crops grown (selection of less labour intensive crops like cassava), number of meals cooked and types of food cooked (less fuel-wood demanding foods like green vegetables), labour time allocated to core household activities such as farming, leisure, fuel-wood and water collection, and the roles of different household members. It is therefore not clear if the results obtained from previous studies will hold in Eastern Uganda because the relationships between deforestation and household activities may be quite different from those observed elsewhere.

The idea that access to fuel-wood can be a major driver in the socio-economies of rural areas in Uganda and other developing countries is not widely recognized and needs to be stressed and investigated. Not much is known in Uganda about the behaviour of rural households regarding deforestation, energy use and its implications for agricultural production and policy. An important first step towards filling such a gap in knowledge is empirical research with a focus at the household level. This study is innovative in several ways. First, it includes analysis of the consumption of an important environmental product, fuel-wood. So far, no study in Uganda has done an economic analysis of the effects of deforestation on household fuel-wood use, collection and farm-time allocation. Secondly, since the sample covered two seasons, it was possible to assess the effect of seasonality on the consumption of environmental products and on labour allocation to agriculture. Seasonality is becoming widely recognized as an important factor in household labour decisions, yet it has not previously been analyzed in this context. Thirdly, a gender-disaggregated analysis of the effects of deforestation on rural household activities was conducted. Therefore, development policy interventions, be they poverty alleviation, safety nets, basic services, projects or agricultural extension, have a lot to learn from information that comes from time allocation.

1.2 Issues of definition and measurement

1.2.1 Deforestation or biomass degradation

The term deforestation is in most instances used to describe situations of complete long-term removal of tree cover or a process during which land is converted from forests to other uses. However, in a few cases, deforestation is used to address issues related to biomass loss, shortened fallow length and other types of forest degradation. Unlike other studies on deforestation, the focus here is not specifically on selective logging and its effects on tropical forests. Instead, it is mainly on deforestation as a consequence of loss of tree cover for purposes of fuel-wood collection and its linkages to the rest of household economic activities. The type of deforestation of concern here is therefore not based on any specific cause (that is long term or other types of degradation), but on the consequences.

To keep the study within manageable bounds, issues related to how much forest clearing is socially optimal are largely ignored. This is because the socially optimal level of deforestation is hard to determine due to difficulties in estimating the benefits of forests to different groups (Pearce, 1994). Even then, models that seek to determine the social optimum levels of deforestation often have limited practical relevance in explaining why deforestation occurs, as they assume that the objective of decision-makers is to maximize social welfare (Kaimowitz and Angelsen, 1998).

In this study, the analysis of deforestation does not include issues related to optimal rotational length and management intensity or sustainable forest management and forest cover change. Further, the factors that promote reforestation or secondary forest growth and that do not include issues related to the magnitude and location of the processes involved in deforestation and the effects of policy are also not analyzed. However, from a policy perspective this study shows that current policies in Uganda lead to inappropriate deforestation, because the people who clear the forests do not have to pay for the negative externalities associated with their actions.

1.2.2 Time-use (allocation)

The analysis of time-use is essentially an analysis of the allocation of time to various activities such as work for wages, work on the family farm or "enterprise", 'inside' chores in the households (for example childcare, cooking and washing) and 'outside' chores (for example fuel-wood and water collection). There is usually a reference period in which time allocation is studied. It can range from the last 24 hours to time spent on various activities over a year (usually measured in months or weeks). While the first studies of time use mostly concentrated on the time allocation of females in developed countries (see for example Gronau, 1973, 1977; Huffman, 1980), it is now more common for empirical work to consider time-use of the various members of the household including men, women and children (see for example Kimhi and Rapaport, 2004)

The method is more critical when it comes to time-use than in other measurement typically undertaken in economics (Juster and Stafford, 1991). There are typically two ways time-use data can be collected, and the results one obtains are sensitive to the approach taken. One method is the traditional survey method in which the respondent is asked how much time he/she has spent on an activity in the reference period (for example in the last 24 hours or last seven days). The other method is the more detailed time diary method, usually based on a 24 hour recall. Here the emphasis is on the chronology of events over the past days. Juster and Stafford (1991) provide a rich discussion of the merits and costs of each method. In this study, the traditional survey method is adopted because it is more applicable, less costly and easier to administer.

1.3 The nature of the problem

Forestry and fuel-wood scarcity have become important issues within the broader topic of rural economic development, and forest conversion by agricultural households is believed to be a leading cause of deforestation (Amacher *et al.* 1996). In Uganda, there is little information about how rural households use forest resources. Although there are many opinions about fuel-wood, there are few rigorous analyses of the relationship between household activities and deforestation. Generally, it is known

that many rural households collect fuel-wood from forests and own woodlots, although some participate in informal fuel-wood markets.

Given that many rural households in Uganda rely on self-collected fuel-wood as a source of energy for cooking, increased scarcity of these products due to deforestation is likely to increase time spent in collecting fuel-wood, leaving less time for household members to spend on their farms and other activities. This is likely to affect household agricultural activities and probably output. For example, in Uganda, in the rural Eastern region and specific areas like Mabira and Mt. Elgon forest reserves, households are faced with increasingly scarce forest products because the areas are experiencing alarming rates of deforestation (NEMA, 2002). As a result, households which are primarily fuel-wood collecting may have to reallocate some of their time from other activities to collecting fuel-wood. This kind of switch in time allocation will affect agricultural time, water collection time, leisure-time and time spent on household core activities like cooking and child-care. In addition, income from agriculture may decline due to reduced output and farm time (Kumar and Hotchkiss, 1988). If households find no alternative sources of income, food consumption will also be adversely affected. Children who are involved in collection of forest products may also experience adverse effects on their education (Nankhuni and Findeis, 2003) and health, which would ultimately influence the regions' prospects for raising the productivity of labour in the long run. In terms of classic urbanization models (Lewis, 1954 and Fei, 1961), by affecting the average marginal products of labour, scarcity of fuel-wood may also influence the rates of migration to urban areas.

In this study, some of these propositions and their policy implications with specific reference to rural areas of Eastern Uganda are assessed. In this area, households use forest fuel-wood supply to meet their energy needs and arable land to meet their food needs. The cost of time spent in collecting fuel-wood is used as a measure of the consequences of deforestation, its effects on household time allocation and agriculture. In particular, the allocation of time by households is influenced because they engage not only in collection of fuel-wood and essential forest products affected by deforestation, but also in agricultural production. This implies that if encroachment on forests is to be reduced and a sustainable agricultural economy is to be attained,

alternative sources of energy have to be developed and used, and agricultural production has to be increased by using modern technology. If this does not occur, forest resources may become increasingly scarce, further accentuating the requirement for human labour and creating further pressure on agricultural activities and output.

1.4 Objectives and rationale of the study

This study aims to examine the effects of deforestation on household time allocation and agricultural activities among rural households in Uganda. More specifically, it seeks to analyze the consumption of fuel-wood by a sample of households in the rural areas of Uganda and how these households reallocate time to the collection of environmental products when the products become scarce. In other words, it looks at the possible consequences of deforestation for household collection and agricultural activities, as a result of the competing demands for household labour. An additional goal of this study is to determine whether there are seasonal and gender differences with regard to time allocation, as is frequently thought.

In addition to the household production function aspect, it has been argued in the literature that deforestation can have adverse physical impacts on agriculture, for instance, flooding and silting cause rapid blockage of irrigation systems (NEMA, 2002 and Pender *et al.* 2001). This is quite different from the widespread ecological and environmental consequences of deforestation. Consequently, since these are externalities, the privately and socially optimal rates of deforestation differ because there has been failure to intervene to close the gap between private and social returns. Negative externalities are for instance not internalized in the market prices (for example, the costs of soil loss downstream are not included in the price of forest products and land cleared upstream). These observations obviously point towards a need for concerted efforts to slow down deforestation. If deforestation affects agricultural and other household activities, understanding the mechanisms involved would assist in efforts to improve agriculture as well as forestry. When yields are too low to sustain the growing population, there is a tradeoff between increasing cropland and using other inputs that would raise output. Inevitably however, there is pressure to expand cropland because the price of land is low relative to other inputs that would raise agricultural output, and this is often at the cost of forests. Thus, while forestland

may provide a safety net for the growing population in the short run, its depletion only promotes the cycle of declining agricultural productivity.

In this study it is argued that agricultural time would decline as a result of additional labour demand created by deforestation. High degrees of deforestation limit supply of forest products thus, the time required to collect a given amount of these products increases. The increasing time required to collect essential forest products competes with labour input in agriculture. Empirical evidence of such a labour allocation link between the natural resource bases and agriculture would highlight the serious consequences of environmental degradation for subsistence level agriculturalists, and would perhaps increase the perceived benefits of policies to improve forest resources. Therefore, unless measures to provide alternative energy and improve agricultural production are undertaken simultaneously, the push for clearing new land due to population growth will continue. It is expected that making the explicit connection between patterns of labour allocation, deforestation and agricultural production will help identify the extent to which labour constraints are a factor and hence will suggest alternative approaches for improvement.

1.5 Scope of the study and methodology

Cross-sectional survey data collected from rural households in Eastern Uganda are used. Community level data and focus group discussions are also used. Since the main consideration is the increase in workload associated with reduced accessibility to forest products, it was decided that a measure of the time spent in collection would be most appropriate. The time for collecting a standard load of fuel-wood (about 15 kilograms) was recorded for each participating household member during the survey. It is hypothesized that deforestation reduces time spent in agricultural activities (and thus agricultural output) from existing land by increasing time spent in collection activities (fuel-wood), which shifts time away from agriculture and other household activities. However, since data on other activities like leisure and cooking are not available, the focus is on labour allocations to agriculture, fuel-wood and water collection. A detailed discussion on the methodology is presented in chapter five.

From a theoretical perspective, the Becker (1965, 1981), Gronau (1973, 1977), Huffman (1980), Singh *et al.* (1986) and Low (1986) framework is used as the basis of a model of home production and time allocation. In this framework, the household is seen as a production/consumption unit, which attempts to combine market inputs with the time of its members so as to produce consumption requirements as cheaply as possible. The study uses a model of a utility maximizing household where fuel-wood collection depends on labour allocation according to household preferences. However, the local labour market adds complexity to this problem because hired labour for agriculture is available and observed in rural households in Eastern Uganda, but these households do not employ hired labour to collect fuel-wood. Household members themselves provide the labour for fuel-wood collection. The presence of such market imperfections or failures indicates the existence of non-separability – that is, the household farm cannot be viewed as separately or independently maximizing profits as a producer and utility as a consumer. Thus, any comprehensive study of the determinants of time allocation requires a detailed knowledge of household preferences, household production technology and the substitution possibilities across different types of family labour and market conditions. This makes the rural areas of Eastern Uganda an ideal setting for this study.

Given the limited information on outputs of household production processes (meals, health, childcare); this study focuses on the input side. Fuel-wood enters as an input in the home production function and can be collected as fuel-wood or purchased from the markets. The conditions under which households decide to either collect or purchase their fuel-wood are derived. A non-separable (non-recursive) fuel-wood demand and supply model is then estimated, as are production and supply functions for collected fuel-wood, labour supply for fuel-wood collection and agricultural activities. Resource depletion is measured as a decline in the efficiency of time spent in fuel-wood collection. The average time per trip for households is used as a proxy for the degree of deforestation in the area and the analysis draws on households in two different geographical and ecological zones in Eastern Uganda, namely the highlands and lowlands.

In addition to the quantitative methods used, qualitative methods using focus group discussions and interviews with key informants are used. Focus groups are group

discussions in which about five to twelve people are gathered together to discuss a topic of interest. The discussion is guided by a moderator who asks questions and tries to help the group have a natural and free conversation with each other. The group interaction of focus groups is important because it gives some understanding of how people are thinking about a topic. Focus groups can find out about people's feelings, attitudes and opinions about the topic of interest, in this case natural resource degradation in their communities and its effects on household activities.

In order to weight the degree of truthfulness from the findings of the household-based survey, focus group discussions were held with the communities and their leaders in the study area. In most cases, the group discussions explored the same variables as the household survey. The information obtained from the focus group discussions was then collated with some findings of the survey. Like any other research method, focus group discussions have both strengths and weaknesses but these are not discussed them in this study.

1.6 The structure of the study

Chapter 2 provides a general description of the Ugandan economy, the forestry, land and agricultural policy environment. The main part of this chapter describes the rural economy, land and labour issues, macroeconomic policy, energy and the agricultural sector and the role of institutions in management of natural resources in Uganda. While Uganda has registered high economic growth, the indigenous agricultural sector has not grown as much. Although some developments have occurred in terms of rural infrastructure, credit facilities and extension services, the general performance of the sector has been generally dismal even in areas with favourable agro-climatic conditions. In Eastern Uganda, indigenous agricultural communities use forests primarily to collect fuels, construction material, medicinal plants and food. Forest use for food and medicines, however has a negligible impact on the resource, largely because of its non destructive nature. Because resource destruction appears to be primarily driven by fuel-wood collection, the study focused on this. It is the conditions that exist in Uganda (land, agriculture, forestry and institutions), that subsequent chapters are primarily concerned.

Chapter 3 offers a synthesis of agricultural household modelling and it begins by reviewing the origins and applications of the household-economics theory. This theory (household economics) has been applied to the analysis of household behaviour in both developed and developing countries. Although originally seen as a tool for price policy analysis, household-farm modelling techniques have been used in a number of studies ranging from technology adoption and migration to biodiversity and deforestation. In this approach, the household is viewed as a production/consumption unit. Recently, household models have begun to be recast to reflect imperfect-market environments characterizing rural economies in developing countries. Incomplete or missing markets for inputs and outputs, including labour and capital, result from high transaction costs endemic in developing countries. The relevance of the approach (household-farm models) to indigenous farm-households in sub-Saharan Africa and other developing countries is reviewed. This chapter also provides a discussion of the theoretical and empirical relationship between fuel-wood scarcities, labour, and agricultural activities. It sets a foundation for the development of an analytical model for Uganda in chapter 4.

Chapter 4 shows an illustration of how the household economics concepts discussed in the preceding chapter are used to develop a model of farm-household production in Uganda. The household is distinguished as both a producer and consumer of a set of "production-consumption" goods; that is, goods that are both supplied and demanded by the household. According to the household-economics theory, if the farm household faces fixed and identical buying and selling prices for all production and consumption goods, it does not matter that the farm household is both a producer and a consumer. The household will maximize in a two step process that is recursive and hence separable. However, the conditions that exist in rural areas of Eastern Uganda require that household production and consumption decisions are considered non-separable because markets are imperfect. Using a non-separable framework where the opportunity cost of labour is endogenous, the issue of fuel-wood demand, its determinants and effects on agricultural activities is analysed econometrically. This chapter also derives the conditions under which the household decisions are made using a non-separable model. However, this chapter modifies the formal model of household behaviour by incorporating seasonal, gender, intra-household and agro-climatic conditions. In addition, it describes the structure of the econometric model

and presents the estimation procedure used to measure the effects of deforestation on household fuel-wood collection and agricultural activities.

A discussion of the survey design and data, and a tabular and descriptive analysis which show some indications of the effects of deforestation on household activities is presented in chapter 5, but of course this falls short of providing statistically tested measurements. The results of the focus group discussions are also presented in this chapter. In order to illustrate how the agricultural household model is applicable in Eastern Uganda, two areas with markedly different agro-climate and biophysical characteristics are studied. The areas in agro-ecological zone 1, that is, districts of Kumi and Tororo (lowlands) are generally flat and almost semi-arid while the districts Mbale and Kapchorwa (highlands) are generally mountainous well watered (agro-ecological zone 3). A diagrammatic analysis of farm household behaviour in terms of the various linkages is presented in the last part of chapter 5. This link is important in explaining the behaviour of households in rural areas of Eastern Uganda.

Chapters 6 and 7 present and discuss the results of the analyses. Specifically, Chapter 6 focuses on the effects of deforestation on fuel-wood demand activities and the determinants of household labour allocation to fuel-wood collection. Analysis is done both at the household and intra-household level using concepts of shadow wages and prices. Shadow wages and prices are used to measure the opportunity cost of labour. The degree of resource scarcity is measured by the round trip time it takes to walk to, gather and return from the forests with a bundle of fuel-wood. The importance of seasonality and the gender dimensions of labour allocation are also examined. Regression analysis mainly using the two Stage Least Squares (2SLS) and the Tobit estimation approach is used as appropriate. In Chapter 7, the analysis is extended to look at the implications of deforestation on household farm time allocation using a household model. Farm time includes ploughing, planting, weeding and harvesting. Like in the previous chapter, the analysis is done at both the household and intra-household level with a gender and seasonal emphasis. However, unlike in the case of forest fuel-wood collection and demand, in this chapter actual market wages for farm work are used to measure the opportunity cost of agricultural labour instead of shadow wages. The analytical techniques involve the use of Ordinary Least Squares (OLS) and Tobit estimation methods as appropriate.

Based on the results and the theoretical expectations, the last chapter provides a conclusion on the framework developed and applied in the context of rural Eastern Uganda. It points out the potential policy implications of the study and suggests areas for future research.

Chapter 2

The Ugandan economy: Land, forestry and agriculture

2.1 Introduction

This chapter outlines the main features of the Ugandan economy, with a specific focus on land, forestry and agriculture. It also briefly reviews the macroeconomic, agricultural and forest policy environment in Uganda.

2.2 The Ugandan economy: An overview

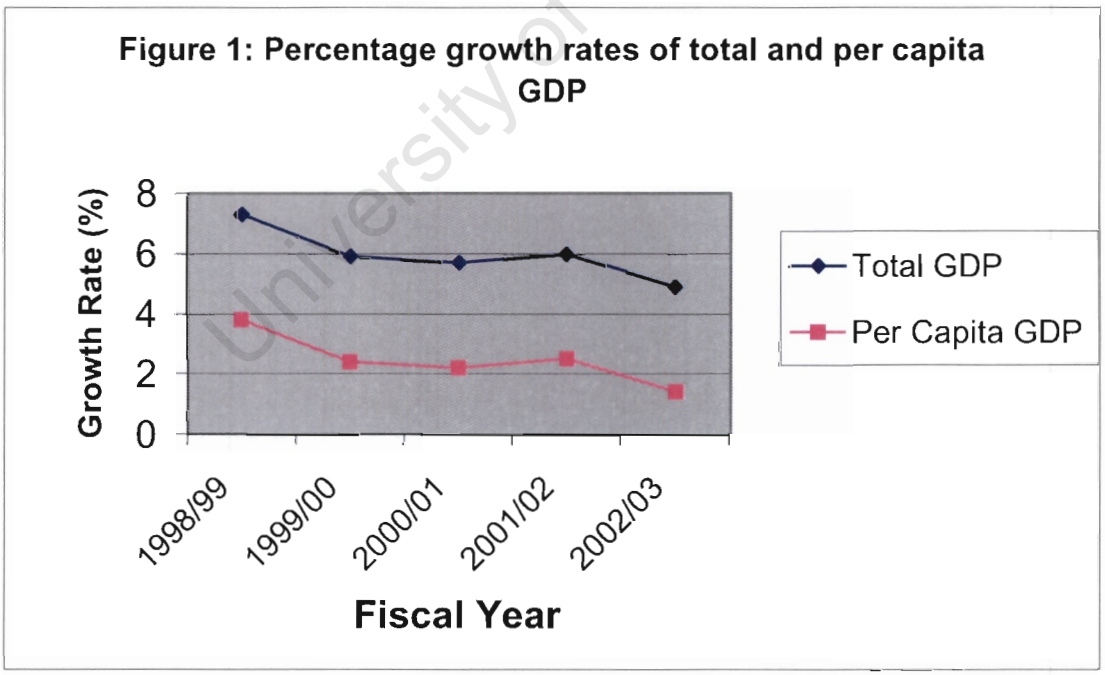
Uganda has very rich ground and water resources, which have not yet been optimally exploited. Despite this wealth, the country is faced with high levels of natural resource degradation. The economy is pre-dominantly agricultural with over 90 percent of the population dependent on subsistence farming and light agro-based industries. Agriculture makes close to half of the Gross Domestic Product (GDP), accounts for almost 90 percent of the exports and mainly depends on family labour. Earlier statistics indicated that the forest sector contributed about two percent of GDP. The major income earners are coffee, tea and cotton, although fish has recently begun to take a leading role. The major imports include petroleum, petroleum products and road vehicles (Economic Policy Research Centre-EPRC, 2003). Uganda is self-sufficient in food and hardly records any significant amounts of food imports. On the other hand, the share of the service sector has gradually grown over time while the industrial sector has been growing rapidly since 1987 although from a very low base. The share of industry in GDP has increased from about 9 percent in 1992/93 to about 13 percent in 2002/2003 (Government of Uganda-GOU, 2003).

On average between 1998-2003 (Table 1 and Figure 1), Uganda registered a GDP growth rate of 6.1 percent (Uganda Bureau of Statistics-UBOS, 2003). Previously, the country had experienced GDP growth rates of about 7.2 percent (between 1991-1997) but the slack in GDP growth started in the fiscal year 1999/2000 due to a fall in world coffee prices, droughts, civil wars and the war in the Democratic Republic of Congo (DRC), increases in pests and diseases and a rise in world prices of oil (UBOS, 2001). These shocks affected the expansion of the productive sectors and the economy's position with the rest of the world.

Table 2.1 Uganda: Key economic and social indicators

Indicator	Year	Index
Surface area ('000 of Km squared)	2002	241
Population (millions)	2002	24.7
Population (annual growth rate)	1991-2002	3.4
GNP per capita (US $)	2002	320
GDP annual growth rate (percent)	1998-2003	6.1
Agriculture (percent share in GDP)	2002	44
Agriculture (percent annual growth rate)	1998-2002	3.7
Deforestation (percentage of total area)	1990-95	0.9
Labour force (millions)	1999	11
Average annual growth of labour force (percent)	1990-99	2.6
Infant mortality (per 1,000 live births)	2000/01	88
Maternal mortality ratio (per 100,000 live births)	2001	504
Life expectancy (in years)	2002	
Male		48.1
Female		45.7
Total fertility rate	2001	6.7
HIV/AIDS prevalence (percent)	2001	6-7
Nutrition (stunting) (percent)	2001	39

Source: World Bank, World Development Report (2002) and UBOS (2003).



Source: Uganda Bureau of Statistics, 2003.

Although Uganda's per capita income had risen to US$ 320 in 2001 (UBOS, 2003), the country is still placed among the ranks of the poorest nations in the World. Its

weak economy and poor social indicators are the legacy of nearly 15 years of economic decline and political turmoil. In the 1970's, Uganda experienced negative growth in GDP. Between 1972 and 1980, GDP fell at an average rate of 2.8 percent per year, but the virtual collapse of GDP occurred at the end of the seventies, when it fell by 5.5 percent in 1978, then by a further 11 percent in 1979. This seriously affected the growth of the economy and the provision of social services such as education and health care. Economic performance in the mid-1980's was much more favourable. The country has experienced significant land degradation, mainly due to soil erosion, deforestation and bush clearing, and over cultivation (NEMA, 2002 and Pender *et al.* 2001). There have also been significant changes in landscape and land use patterns. About 50,000ha of forest cover (0.9 percent) is lost to agricultural land each year through deforestation, most of this occurs in woodlands outside protected areas (NEMA, 2002).

Despite positive reports about the continued high rates of economic growth in recent years, Uganda is still one of the most seriously affected nations in the world in terms of poor quality of health services and outcomes, with the exception of the declining but high Human Immune-Deficiency Virus/ Acquired Immuno-Deficiency Syndrome (HIV/AIDS) infection rates. Poverty, corruption, insecurity and infrastructural problems have exacerbated the effect of poor health services in Uganda. However, even with the recent economic gains in Uganda, the AIDS epidemic has continued to reverse some of the economic and social gains such as the gains in infant and child mortality, adult longevity, and general health. The relationship has been bi-directional. On one hand, many of the patterns of recent social and economic development in Uganda created conditions that have allowed the spread of diseases, including male migration, underemployment of women, civil strife, urbanization, structural adjustment and increasing poverty. On the other hand, diseases cause fundamental social and economic changes that will affect the demand for labour, availability of social services, access to health care and its demand, educational opportunities, and the rates of poverty at the household level.

Loss of labour in the public and private sector is increasingly affecting productivity and expenditure on the labour force. Results of a survey conducted by the Ministry of Public Service in 2000 on the trends and impact of HIV/AIDS on public service in the

country reflect that 15.2 percent to 27.4 percent of public officers are suspected to have died of AIDS between 1995 and 1999. The study also shows that government spent US$ 20,000 on HIV/AIDS related sicknesses and the deaths of public officers in 1995, a figure that rose to about US$3,000,000 in 1999. These figures constituted 42 percent and 56 percent of the total expenditures on staff morbidity and mortality (medical and burial expenses, pension and gratuity) in 1995 and 1999, respectively. There was also an increase in indirect costs related to loss of skills and experience, hiring of new personnel, training, and loss of man-hours. As costs increase, production is affected as well. The impact on productivity at sectoral level gradually translates into grave implications for the national economy. There is an estimated annual loss to GDP of 0.9 percent due to HIV/AIDS (Ministry of Health – MoH, 2003).

The situation is worsened by the impact of HIV/AIDS on the dependency ratio; over 80 percent of the reported HIV/AIDS cases occurred in people aged 15-45 years. Of these, the majority are adults and parents (MoH, 1999). A high proportion of women who play a significant role in the workforce are also affected. A survey in one district (Rakai) showed that 25 percent of households are cultivating reduced land areas. Of these 35 percent attributed the reduction to HIV/AIDS-related sicknesses or death. This has threatened food security for the affected families, worsened the nutritional status at household level, and led to a decline in cash-crop production. In addition, 65 percent of the household members were found to increase time input to agriculture by two-to-four hours to make up for the lost income especially in cases where the male head had died (MoH, 1999).

In Uganda, the introduction of Universal Primary Education (UPE) has reduced the availability of child labour, because of the expected large private and social benefits to be gained from school enrolment (Okwi and Kaija, 2000). About 6 million children have enrolled in primary school due to the policy of free primary education for all children that was introduced by the government in 1996. Secondly, the rapid population growth, which increased labour supply much faster than labour demand, has exerted greater pressure on land and reduced farm size per capita. The net result has been to induce labour, especially male labour, to move to urban areas. The other argument for migration was that there was underemployment in the agricultural

labour force and therefore men used to leave because they had better prospects of finding work in urban areas. These changes in the demand and supply of rural labour have resulted in shortages in agricultural labour, particularly seasonal, and women replacing men in the agricultural labour force with possibly a net increase in female labour.

The Ugandan economy is in its second decade of economic expansion, combining strong economic growth (one of the fastest in Africa) and significant declines in inflation. Inflation had declined from three digit levels to single digit levels of just under 10 percent by the end of 2001. While this period of sustained economic growth has allowed Uganda to recover from the years of economic decline in the 1970's and early 1980's, it has also been marked by persistent but declining poverty. Using expenditure based measures, the trends of poverty in Uganda show a consistent decline since 1992. Although head count poverty was estimated at 56 percent in 1992, by 1999/2000 it was 35 percent, about 21 points below the rates of 8 years earlier. The results also show that poverty in Uganda has drastically modified its composition but has largely remained rural based. While this decline is remarkable, among economists there is still doubt about the drastic fall over a period of 8 years. Moreover, evidence from qualitative studies (GoU, 2000a) suggests that poverty has increased overtime.

According to Table 2.2 below, poverty fell in both rural and urban areas during the period 1992/93 – 1999/2000. The mean living standards rose faster in rural areas: the mean rise in consumption per adult equivalent was higher in rural than urban areas (17 percent compared to 10 percent) (Appleton, 2001). However, focusing on the urban mean may be misleading and poverty statistics fell proportionately more in urban than rural areas. All regions also experienced lower poverty between 1992 and 2000, regardless of the poverty (Forster-Greer-Thorbecke, FGT) measure used. However, the magnitude of the fall varied greatly between regions. The most recent poverty statistics show that close to 40 percent of the rural households in Eastern Uganda live below the national poverty line of Uganda shillings 15,000 per month (US $ 8) (UBOS, 2003).

Table 2.2: Poverty headcount trends in Uganda, 1992/93 and 1999/2000

	1992/93	1993/94	1994/95	1995/96	1996/97	1999/2000
National	55.5	52.2	50.1	48.5	44	35.2
Rural	59.4	56.7	54	53	48.2	39.1
Urban	28.2	20.6	22.3	19.5	16.3	10.3
Central	45.5	35.6	30.5	30.1	27.7	20.3
Eastern	59.2	58.0	64.9	57.5	54.3	36.5
Northern	71.3	69.2	63.5	68.0	58.8	65.8
Western	52.8	56.0	50.4	46.7	42.0	28.1

Source: Appleton (2001) and UBOS (2002).

Uganda has also been faced with internal strife in certain parts of the country for the last 18 years. Most parts of Northern region have been under civil war since 1986 and this has severely affected social and economic development in the region. Some parts of Eastern region were faced with insurgency between 1987 and 1991. The insurgency caused social and economic hardships for the people in this area and also led to serious migration to other parts of the country.

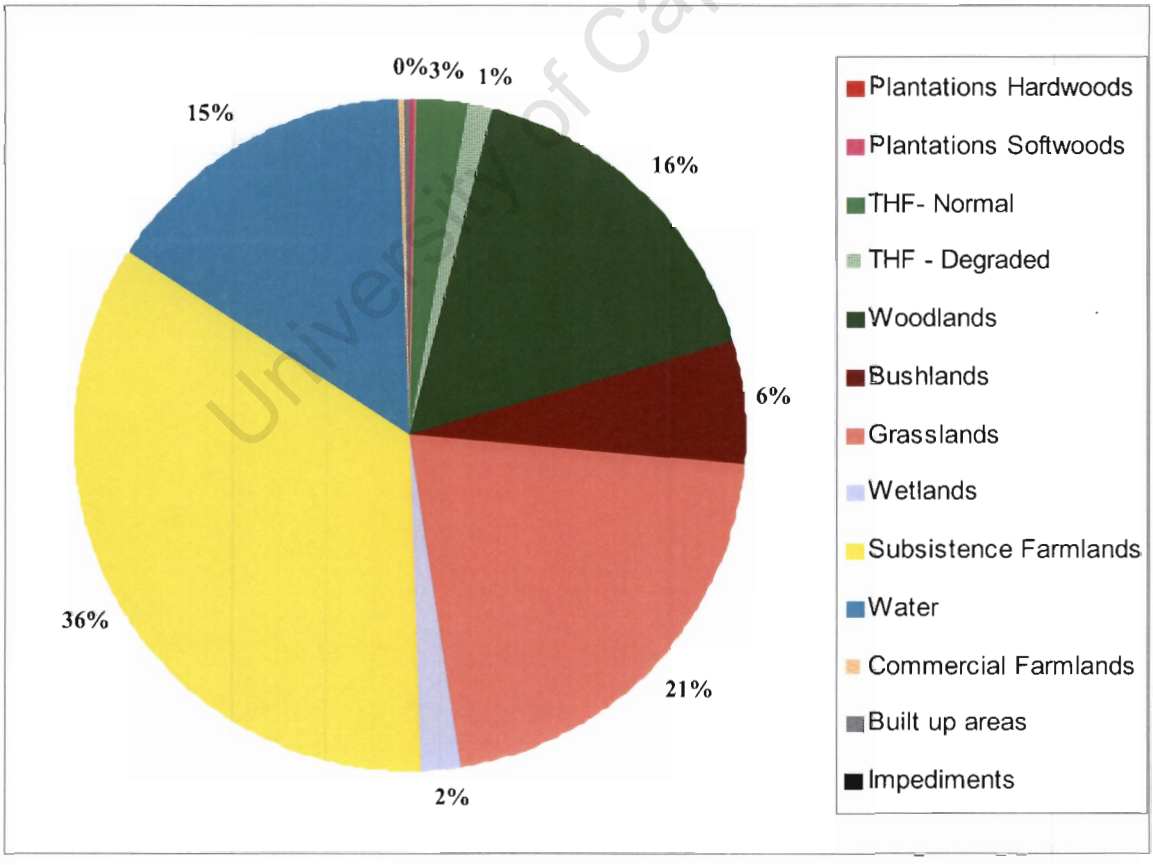
2.3 Land and population

Uganda has a total area of about 241,551 km^2, out of which, farmland forms the largest single component, followed by grasslands, woodlands, water bodies, bush lands, tropical high forest (THF- normally stocked), tropical high forest (THF-degraded) and others in that order. The land area excluding water is about 20.5 million ha, out of which 4.9 million ha (about 24 percent) is covered by forests (plantations both hard and softwoods), tropical high forests (THF) both normal and degraded, and woodlands. The rest (76 percent) is non-forested, that is, comprising other land cover types such as bush land, grasslands, wetlands, subsistence farmland, commercial farmland, built up areas and impediments.

Table 2.3: National land cover/use distribution

Stratum	Area(Ha)	Percentage[2]
Plantations Hardwoods	18,682	0%
Plantations Softwoods	16,384	0%
Tropical High Forest - Normal	650,150	3%
Tropical High Forest - Degraded	274,058	1%
Woodlands	3,974,102	16%
Bush lands	1,422,395	6%
Grasslands	5,115,266	21%
Wetlands	484,037	2%
Subsistence Farmlands	8,400,999	35%
Commercial Farmlands	68,446	0%
Built up areas	36,571	0%
Water	3,690,254	15%
Impediments	3,713	0%
Total	**24,155,058**	**100%**

Figure 2. Uganda: Relative land cover/use distribution



Source: Forestry Department, Ministry of Water, Lands and Environment. Uganda (2000)

[2] Note the zeros are due to rounding and represent values less than 1%

Apart from other uses like pasture, farmland constitutes the biggest proportion of land use in Uganda. The average landholding size in Eastern Uganda ranges from 0.4 to 3 hectares per typical household of 7 persons. This landholding size has been declining over the years due to population pressure (UBOS, 2002). Comparison with other areas shows that the farm size in the study area is smaller than that in other parts of the country. This is mainly because in the highlands of Kapchorwa and Mbale, the population growth rate has been much higher compared to other parts of the country. The lowlands of Tororo and Kumi have less dense populations and their holdings are larger.

The population of Uganda was estimated at 24.7 million in 2002 with an annual growth rate of 3.4 percent during 1991-2002 and a population density of 126 people per square kilometre (UBOS, 2002). The population is largely rural with almost 90 percent of the people living in the countryside. The settlement patterns in the rural areas vary, depending on a number of factors: areas with consistently good rains, good soils, and free from disease agents have high and rising population densities. Areas with less rain, less fertile soils, and which are not free from disease agents, have low population densities. Security is another major factor which determines settlement patterns in Uganda. For instance, the serious security problems in the northern region since the mid 1980's are one reason for its low population density.

The population and housing census of 2002 reported that the Eastern region has a population of 6,301,677 persons, constituting about a quarter of the total population of Uganda. The Eastern region is one of the few areas in Uganda whose population grew at an increasing rate over the last two decades. The area has the highest population density of 229 persons compared to 179, 126 and 65 persons per square kilometre in the Central, Western and Northern regions respectively. Of the selected districts for this study, Mbale has the highest density of 586 persons per square kilometre, while Tororo, Kumi and Kapchorwa have 346, 159 and 113 persons per square kilometre, respectively (UBOS, 2002). The majority of the people (93 percent) in the Eastern region live in rural areas. The average household size in this region is about 6.8 persons while the national average is about 7 persons.

The climate of Eastern Uganda is of the "equatorial" type. The area has two wet seasons, with intervening short dry seasons of one to three months. In focus group meetings, local communities have described a change in rainfall distribution over the past two decades. They argue that in recent times rainfall has become increasingly unreliable and erratic, increasing the difficulty and risks of farming. The vegetation is typically savannah, though there are some forests on the mountain ranges, and riparian vegetation in river valleys. There is a wide range of savannah woodland. This savannah is usually interspersed by perennial grasses. The mountains are good coffee growing areas while the lowlands provide good farming land, according to the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

2.4 Land tenure system and implications for natural resource use

The current land tenure situation in Uganda reflects a discrepancy between occurs in practice and what is legally binding. The basic land tenure legislation in the country is the 1975 Land Reform Decree Number 3, which provided for a uniform land tenure system of leasehold and public land throughout Uganda. Prior to the decree, there were varied land tenure systems of *mailo*, freehold, customary and leasehold which today, in practice, are still regarded by both the land administrators and land owners as operational. However, Government has taken steps to correct this situation by enacting the Land Act 1998 to repeal the Land reform Decree No.3 of 1975 and design a uniform land tenure system throughout Uganda with a freehold system in rural areas and leasehold in urban areas. The new Land Act of 1998 also recommends that land ownership in Uganda must be regulated through the law in order to ensure land management practices that will help sustainable use of land and its resources.

There are several land tenure systems prevalent in Uganda, namely; customary, *mailo*, private and leasehold. The customary land tenure system is the most widespread in Uganda. Under this system, two types of property holdings can be identified; first, specific permanent holdings where each family has its specific piece of land where it lives and practices agriculture. Second, the communal with non-permanent individual holdings where there is no permanence in family and land holdings as they are only retained for as long as they are in use.

In Eastern Uganda, where the customary tenure system is most widespread, clans which allocate plots of land to members traditionally govern the land. By the early 1900's, households had settled on lands and acquired strong permanent rights to specific parcels. In some areas, power shifted from clans to chiefs, following colonial intervention. But in 1966, the Uganda government formally abolished kingdoms and this led to loss of control over land by the traditional sources in some cases. A land commission was then instituted to manage these lands. However, the customary laws provide the farmer with user rights. These rights can be inherited, and only in exceptional cases do traditional authorities deny user rights to inheritors.

The *mailo* land tenure system was based on square mile sub-divisions, and it came to Uganda as part of the Buganda agreement of 1900 between the Kabaka (King of Buganda) and the Protectorate Government. Some of the *mailo* land has been sold off and transformed into lease land. On the other hand, the freehold land tenure system refers to land owned by a private individual or an organization (public or private) in perpetuity at no cost of acquisition. Private land ownership is becoming common in Eastern Uganda, especially after the enactment of the 1998 Land Act. This system has a lot of similarities to the *mailo* tenure system, the major difference being in the size of the holdings, in that the freehold is smaller than *mailo*. Under the leasehold tenure system, the method of holding land is based on an agreement (lease title) between the lessors (usually the government) and the lessee (a developer) on the other hand. Here land is only leased out for development and not merely for holding. The system is more widespread in the urban than in the rural areas.

Under the new land act, within each of these tenure systems, a rightful landholder may apply for a formal lease from the state. In doing so, the tenure over that land is transformed into the legally recognized category of leasehold. In reality, few leaseholds are taken out by occupants of customary land while leaseholds are more common among *mailo* owners and recent settlers on public land. Land ownership in Uganda tends to affect the management of natural resources and more especially the gathering of woody biomass resources. Place and Osaka (2000) show that land tenure, population pressure and market access are important factors affecting tree resource management and land use in Uganda. Specifically, they show that population pressure is the most important variable affecting the conversion of woodland and grazing land

into agricultural fields in the Eastern and Northern regions. They also show that the change in tree cover density was not linked to population pressure, and that for agricultural land it was higher under the more privatized "*mailo*" tenure system. However, the data used in this study did not provide specific information on the types of land tenure and their relationship to resource use. As already indicated, land in Uganda is not concentrated in the hands of a few landlords or government, rather Uganda is a country of many small peasant landlords.

The wood gathered for purposes of fuel comes from private and open access land, private and restricted land, customary land and some government owned land. Government owned land in Uganda is poorly managed and as a result any person may gather wood from it. Due to the heavy demand that exists, over-exploitation of wood sources occurs. However, government owned land in Uganda represents a fairly small proportion of the total land area, although exact figures have been difficult to obtain. Despite the small area involved, much of the land under forests, water and wetlands in Uganda is under the control of the state and therefore this poor control poses serious conservation problems especially in the forest reserve areas of Mabira (see Appendix 4), Budongo, Busitema and Mt. Elgon (NEMA, 2002 and National Biomass Study, 2002).

In the open access land, a large number of users have emerged and this has left property rights ill-defined. As a result, no single person can control land use, and the classic result associated with an open access occurs; lack of investment in the resource (for example tree planting and husbandry) and over exploitation of the resource. On the other hand, although customary land tenure institutions in Uganda provide strong private rights in agricultural land, they are relatively weak in collective management of other resources. Thus, communal land with poor control tends to become open access and this similarly has dire consequences for the environment. Even in the privately owned pieces of land, farmers often have very high discount rates (clearing of land for farming outweighs any benefit from investment in trees). As a consequence, even on private land, deforestation has advanced inexorably.

2.5 Recent reforms in economic policy

Since 1987, the government of Uganda has been implementing an economic reform program supported by a large number of donors like the World Bank, International Monetary Fund (IMF) and the United States Agency for International Development (USAID). This reform program aims to promote better fiscal and economic management, develop human capital through investment in education, health and other social services, reform the regulatory framework and improve incentives to the private sector. The result of this program has been realized through the macroeconomic stability now seen, and the continued growth of GDP at an average of about five percent per annum since 1987.

Some studies have found that policy reforms included in the current economic and liberalization and adjustment efforts may increase the pressure on forests (Jones and O'Neill 1995; Angelsen and Kaimowitz, 1999). For instance, Kant and Redantz, (1997), show a positive correlation between external indebtedness and deforestation. However, some of these empirical studies are based on poor quality data; the analytical models make very simplistic assumptions about government objectives and policy formulation that limit their relevance.

Uganda has also made impressive strides in human resource development. Expansion in the provision of public goods (for example education and health care) has extended the benefits of its economic growth to most of the population. As a result, its social welfare indicators have improved significantly (see Table 2.1). Uganda's economic and social performance since 1987 has been one characterized by steady movement towards stability and prosperity. This sustained economic performance is attributed to a number of factors; stable monetary and fiscal policies, an open trade regime, a tax and regulatory environment conducive for private investment, and a fairly stable political environment. These factors have allowed Uganda to find new markets in the changing global economy, thereby giving strong impetus to the process of economic innovation and diversification within the country. As a result of this enabling environment, gross domestic product per person, personal income and consumption have risen since the late 1980's. So too has private investment and export growth,

both in absolute terms and as a proportion of GDP. However, poverty, unemployment and environmental degradation remain serious challenges for the economy.

2.6 Agricultural production in Uganda

Uganda is endowed with one of the most favorable climates for agricultural production in the world. Given this climate, it is possible to grow two crops a year in most parts of the country. The soils are able to support vigorous crop growth. Because of the favorable climate and often very fertile soils, most of the country has relatively high carrying capacity for both human and animal populations. Although the contribution of agriculture to total Gross Domestic Product (GDP) has been declining over the years, the sector has continued to dominate the Ugandan economy. Contributing 39.8 percent of the total GDP in 2002/03 (valued at Uganda shillings 3,551 billion) agriculture provides approximately 80 percent of the employment and is a basis for most industries and services in the country (UBOS, 2003).

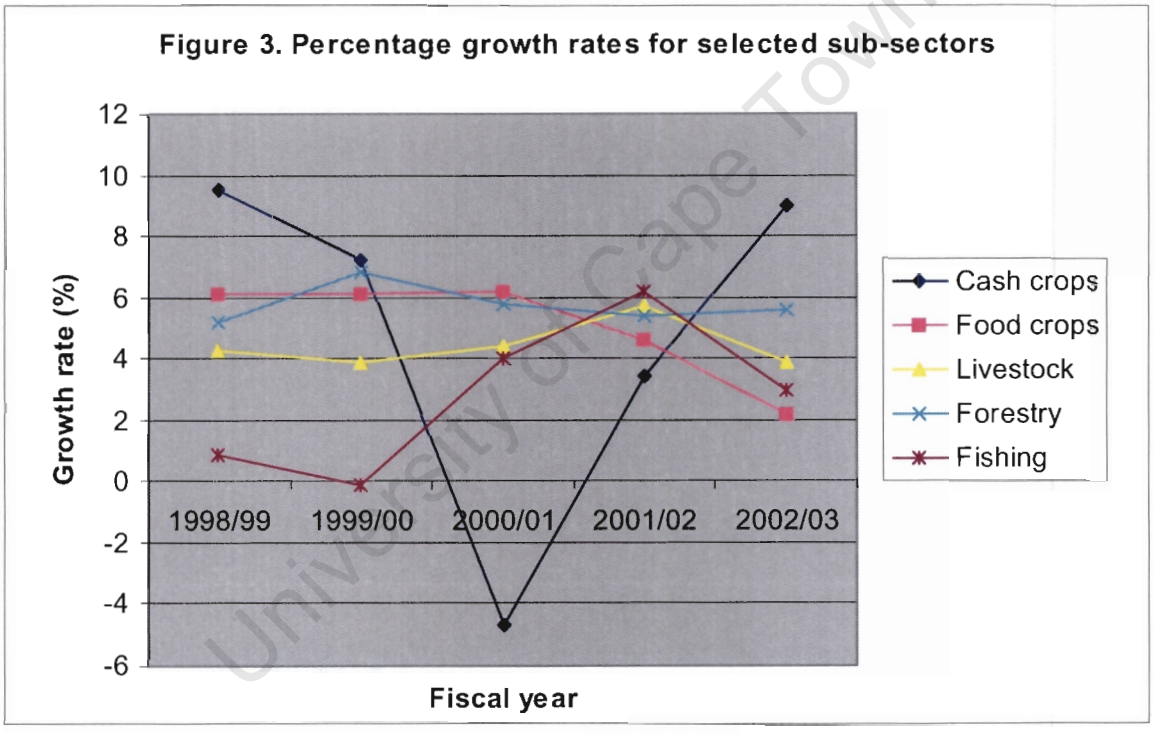
Coffee is the major cash and export crop in Uganda. Tobacco, tea and cotton are the other cash crops. Food crops vary according to region and ethnic background. Bananas are the major food crop in several Bantu speaking areas in the Eastern, Central and Western regions while grains such as millet, maize and sorghum form the major crop in the non-Bantu speaking areas of mainly Northern and some parts of the Eastern region. Food crops currently contribute 66.8 percent of the overall agricultural output in Uganda while cash crops contribute only 10.3 percent. Fishing, forestry and livestock contribute the rest. Table 2.4 and Figure 3 show the growth trends for selected sub sectors in agriculture. The rapid contraction in cash crop growth in the year 2000/2001 was mainly due to a fall in world coffee prices and increases in pests and diseases (coffee wilt disease). These shocks affected the coffee sector, which forms the export base for Uganda. The food crop sub-sector experienced a decline in 2001/02 and 2002/03 due to drought in some areas of the country. The decline and sudden rise in the fishing contribution was due to the imposition and removal of the fish ban between 1998 and 2001, while the forestry sector has remained more or less stable at about 5.5 percent. The livestock sub-sector showed some positive gains, especially after 1999/2000. These gains were attributed to the improved control of

cattle diseases such as foot and mouth and lumpy skin, which were prevalent in some districts in 1999/2000.

Table 2.4 Percent growth rates for selected sub-sectors, 1998-2002

Sub-sector	1998/99	1999/00	2000/01	2001/02	2002/03
Cash crops	9.5	7.2	-4.7	3.4	9.0
Food crops	6.1	6.1	6.2	4.6	2.2
Livestock	4.3	3.9	4.4	5.7	3.9
Forestry	5.2	6.8	5.8	5.4	5.6
Fishing	0.9	-0.1	4	6.2	3.0

Source: Ministry of Finance Planning Economic Development (MFPED) and UBOS[3]



Source: MFPED and UBOS (2003).

The structure of agricultural production and farming systems employed vary within Uganda and even within the Eastern region, reflecting differences in agro-ecological conditions and land use. World Bank (1993) shows that agricultural production in Uganda is predominantly rain fed and hence hostage to the vagaries of the weather. The structure of production is geared towards providing food for domestic consumption, and the growth in agricultural output recorded by Uganda is attributable

[3] Ministry of Finance, Planning and Economic Development (MFPED) and Uganda Bureau of Statistics (UBOS), various issues.

primarily to an expansion in the area cultivated rather than to increased productivity of existing land area in use. Also, land quality and cultivable area per capita are falling in the face of rapidly increasing population pressures. Uganda is also facing serious soil degradation problems and farming remains predominantly traditional. The rural economy in Uganda is characterized by the existence of estate and smallholder agriculture. Smallholder and subsistence farmers use labour intensive techniques and a very small proportion of modern inputs. They produce little or no surplus output for the market. At times, the smallholders' own production is below even minimum dietary requirements. However, individual peasant's households produce over 90 percent of total agricultural output in Uganda.

Land use patterns in Uganda have long been dictated by the changing consumer demand for agricultural commodities. Export agriculture occupies a large share of the country's (mostly fertile) land area. There is also an extensive cattle industry implying that pastureland and cattle ranches occupy a big land area. Land under permanent crops occupies only 8.8 percent of the total land area. Until 1983, Uganda experienced a substantial decline in agricultural output. The factors responsible for this contraction can be traced to a number of sources; the land tenure system, deterioration of world prices for agricultural products, social upheavals caused by long years of civil war and reduced availability of essential credit and inputs due to higher import prices. There is a great detail of information on how each of these has affected agricultural output but such analyses are beyond the scope of this study.

Farming systems in Uganda are largely determined by rainfall patterns (total amounts per year and the distribution). Based on the combinations of crops and the area of production, there are at least seven different farming systems in Uganda, each with its own soil degradation problems. These systems cover a wide range of activities including the production of cash and food crops and keeping of livestock. The various crops produced include perennials (coffee, bananas, tea, cotton and sugar cane) and annuals (maize, millet, potatoes, sorghum, peas and many others). Within these two broad categories of crops grown, there are a number of variations in the combinations of crops based largely on food preferences and the resources available.

The cultivation system used in the Eastern region is popularly known as the Northern and Eastern cereal-cotton and cattle system. The soils are light sandy loam with low to medium fertility and are suitable for cultivation with ox-drawn implements. The main crops are millet, cotton, cassava, groundnuts, sesame (*simsim)* and sweet potatoes. Cash crops include coffee, cotton and rice. Cotton is grown in pure stands, which provide little vegetation cover, leading to widespread rill and sheet erosion, especially in Tororo district. Cattle are traditionally an integral part of the system, providing draught power. The average cropping intensity of land is about 150 percent, indicating that half of the land is cropped twice a year (NEMA, 1998). A comparison with the national average shows that the cropping intensity in this region is probably higher, which is partly because of the effective population pressure on arable land.

The major animals kept are cattle, sheep and goats. Livestock is an essential component of agricultural production in Eastern Uganda and they are considered a form of insurance for households. With increasing intensification of livestock rearing, the absolute requirements for pasture increases, and the timely availability of pasture for livestock becomes more important in maintaining animal stocks. There is a wide variation in the distribution of livestock populations in Eastern Uganda. Although data for the region as a whole are not available, it is believed that the sector is beginning to grow. Livestock and its products contribute a small proportion (less than 10 percent) of household cash income in the study area (UBOS 2003). At the same time, livestock contribute essential labour and products for agriculture; their upkeep entails the use of grassland resources for the provision of leaf fodder, grass and other feed inputs.

2.7 The forestry sector

Uganda still has considerable forest and biomass resources. However this resource is being heavily 'mined' through rapid expansion of agricultural land. Official estimates of land being cleared in 1994 ranged from as low as 70,000 hectares (GoU, 2000b; World Bank, 2,000) to 200,000 hectares (Ministry of Finance and Economic Planning, 2002). Agricultural expansion will continue to be a major source of woody biomass derived energy, that is, fuel-wood, although deficits can be expected for other forest products like timber. However, since the extent of land cover distribution was not accurately known, nor was there any analysis of future scenarios affecting most of

the remaining bush lands, grasslands and woodlands, the National Biomass Study was initiated to address these aspects.

Official statistics have so far seriously under-estimated the contribution of the forestry sector to the national economy. For example, in the mid-1990's the forestry sector was estimated to have contributed only 2 percent to the GDP (GoU, 1998). This is partially due to insufficient empirical data on forestry products and services (monetary and non-monetary). However studies conducted by the Forestry Department and Department of Energy revealed that the contribution of the Forest Sector to GDP is about 6% while FAO (1998) estimated it to be about 23 percent.

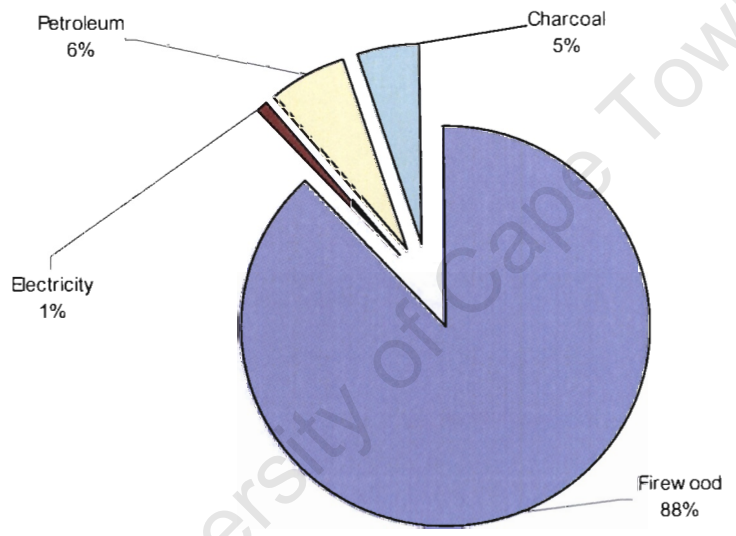
A political and cultural bias towards 'modern' forms of energy like electricity and petroleum make them appear important energy sources, but compared to charcoal and fuel-wood, these forms of energy are less important for economic growth and public welfare (Department of Forestry, 2001). For example, the Public Investment Plan (PIP) 1995/96 - 1997/98 showed a high disparity between public investments in electricity production and forestry sector. For instance, the Government of Uganda (GoU) in 1995/96, spent almost Uganda shillings 214 billion in generating and distributing electricity yet only 11 billion was spent on the forestry sector.

Fuel-wood is an important source of energy for the Ugandan population both in the rural and commercial (urban) sectors. About 93 percent of the Ugandan population relies on fuel-wood energy (fuel-wood and charcoal) for heating and cooking. Traditional fuels, mostly fuel-wood, supply about 88 percent of all total energy consumption in Uganda (UBOS, 2002). Electricity contributes the least (see Figure 4 below). Although Uganda produces electricity for its own consumption and for export to Kenya, Tanzania and Rwanda, the cost of electricity to households remains high and unaffordable to most rural households. According to recent estimates (UBOS 2003), despite the extension of the Owen falls dam at Jinja, less than 4 percent of rural households in Uganda have electricity. However, currently the Government of Uganda is exploring other parts of the river Nile, for potential hydro-electricity generation to meet the ever growing domestic demand. This situation is not unique to Uganda because in The Gambia, for instance, total energy consumed was estimated at 262,710 tonnes of oil (total oil equivalent-toe) of which, 61 percent was from

traditional energy sources. Similarly, in Burkina Faso, traditional energy contributed 91 percent of the national energy requirement.

Within the household sector, rural households are the major consumers of fuel-wood in Uganda. There are two primary sources of rural household fuel-wood supply; agricultural clearing and primary gathering efforts. However, there is no clear picture as to which factor plays a greater role in Uganda's deforestation. Both are significant: the dominance probably depends on the region and its characteristics.

Fig.4. Composition of energy consumption in Uganda, 1997



Source: Developed from UBOS (2002)

Ugandan fuel-wood is mainly gathered from areas close to where it is consumed. Wood for charcoal production is gathered outside the urban areas. However, today, deforestation has advanced to the point where trees are felled at the extremities of the country to supply charcoal to the city (NEMA, 1998). Charcoal is the most important commercial fuel in the urban areas of Uganda. In 1992, fuel-wood consumption by households was 68.6 percent; commercial 9.8 percent; industrial 4.9 percent and 16.7 percent for charcoal production. In Uganda as a whole, fuel-wood production increased by 3 percent during the 1996/97 period (for total household, commercial and industrial categories). Fuel-wood for charcoal accounted for about 16 percent of total round wood produced during this period.

Energy requirements in Eastern Uganda are overwhelmingly based on fuel-wood. Fuel-wood is the sole cooking and heating fuel in the rural areas. In the urban centers, charcoal is the main source of energy. Charcoal demand in urban centers has also resulted in the depletion of trees in surrounding areas. Apart from cooking requirements, trees are cut for brewing purposes. The brewing and distilling industries are flourishing and consume quite large amounts of fuel-wood. For example, large tracts of land have been rendered bare of trees and bushes around towns in Kapchorwa, Kumi and Tororo mainly for cooking and brewing purposes[4]. Therefore, forest products (fuel-wood) provide incomes through employment or sale of several products in which it is used as an input in production.

Other uses of fuel-wood include building materials and curing of bricks, especially in the semi-urban areas and many rural areas. With the high growth rates of the construction industry, the demand for bricks has increased, causing a correspondingly increased demand for fuel-wood. After 15 years of civil war and very little construction activity, there has been a building boom between 1985 and 2003, during which period alone, the sector experienced annual growth rates of 10-20 percent. The construction sector is one of the fastest growing sectors in Uganda (UBOS, 2003) today, and is well spread throughout the country, except in parts of the North where there has been persistent insecurity. It is therefore very common to find brick-making centers in most of the areas surrounding Kampala and other major towns. Some local sources suggest that the amount of fuel-wood used for brick making is equal to that used for cooking in rural areas[5].

Another sector which will affect the biomass resource is the urban sector. It is projected that by the year 2006, more than 20 percent of the Ugandan population will be urbanised (GoU, 2002). This combined with higher household incomes will mean a transition from using fuel-wood to charcoal. In addition, people will have more hot meals per day, better housing and more furniture per household. All these indicate that the use of forest products in general and woody biomass derived energy in particular will grow faster than the growth in population and/or growth in the economy for many years. This is as long as the resource base allows it.

[4] Own observations from field work
[5] Personal discussions with district environment officials of Kampala and Wakiso districts.

Within agriculture, fuel-wood is used in income generating activities such as curing tobacco and tea. Good examples of areas that are faced with high deforestation due to tobacco curing are Arua and Bunyoro where trees near farms have been cleared to provide fuel-wood for tobacco curing. In Malawi, for example, tobacco estates account for 21 percent of the national fuel-wood consumption and contribute nearly 47 percent of deforestation caused by woody biomass for fuel (Tietema *et al.* 1991). Similar data for Uganda are not available. The fishing industry is another major consumer of fuel-wood. Areas near water basins and lakes depend on fish processing (drying) as a source of income. Smoked fish is consumed in many areas that are far from the lake and cannot easily obtain fresh fish. Trees along the water bodies have been cut primarily for this purpose.

Another extensive use of wood biomass is fencing of homes and kraals, using mostly dead wood. In the North-Eastern region, a typically pastoralist region, trees and shrubs are cut to provide wood for fencing homes and kraals to keep out invaders and protect the livestock from wild animals. In such areas, it may not be surprising to find that fencing consumes more wood than is used for cooking by households. In Botswana, Tietema *et al.* (1991) found that fencing of fields to keep out livestock, consumes one and half times more wood than is used for cooking by households. Other products gathered by households from forests and woody biomass include medicinal herbs for treatment of various diseases, fruits, and cultural and spiritual values[6]. Forests provide safety nets against shortages of food and ill-health. These wild leaves and roots or *"famine foods"* are in many cases used during the difficult times like drought seasons. The other benefits of forests to farmers include maintenance of water quality and slowing runoff.

Being a country heavily reliant on its natural resource base, with experiences of market and policy failures, Uganda provides an interesting case of a country experiencing widespread natural resource degradation. There is increasing concern about the deteriorating state of forestry in the country. The area of land under permanent crops has increased from 8 percent in 1980 to 8.8 percent in 1997 and the annual rate of deforestation was 592 square kilometers during 1990-95 (World Bank,

[6] Forests and natural diversity holds special significance for many communities, providing the basis for many religious beliefs and much traditional knowledge.

2000). Today Uganda has a fragile agro-ecological environment and with a growing population pressure, natural resources are being over-exploited. Poor land management practices are already evident in areas such as Tororo, Kapchorwa and Mt. Elgon where forests are being cut and cleared to increase production in the near term, despite the effect loss of forests can have in reducing both agricultural productivity in the long run and generally retarding the welfare of the rural population.

Although agriculture has been a dominant sector in terms of output, employment and export earning, production has been far from sufficient. Deforestation and land degradation stand out among the major contributors to this problem (NEMA, 2002). Rural areas in Uganda are a prime example of areas in which low productivity in agriculture and food shortages are surrounded by rapid environmental degradation as a result of deforestation. For instance, as population pressure intensifies, land clearance for farming, fuel-wood use, and construction increases. This has been a major cause of deforestation in the Mabira forest reserve (see for example appendix 4). Another well-documented example is the desertification in large parts of North Eastern Uganda by pastoralists, and the encroachment on forest reserves in Western Uganda (NEMA, 1998). As pressure on the existing land mounts, more marginal lands are being brought under cultivation. The next section discusses the role of institutions in the conservation of the environment.

2.8 The role of institutions

There are two major players in the use and conservation of natural resources; the individuals/households and government institutions. In Uganda as in other developing countries, the government has more powers than the individuals/households in the conservation and use of natural resources. Governments play two main roles in the management of natural resources. They often own them and influence their allocation by setting the legal framework through policies that affect incentives to which other resource users respond.

In many developing countries, governments manage economically and environmentally significant natural resources. In Uganda, forests are managed by the

National Forest Authority (formerly Department of Forestry) in conjunction with the National Environment Management Authority (NEMA). Tropical forests are almost invariably publicly owned, and the infrastructure of water resources, as well, is often developed and owned by the public sector. It is important to note that property rights are often unclear to the communities around them. The reason for the management of natural resources by government is that government is best placed to pursue multiple objectives - environmental protection, economic growth, regional development, and support of indigenous people and cultural heritage. Government ownership and management in pursuit of such public objectives need to be effective if they are to overcome the incentives for private gain. In Uganda, government stewardship of resources has shown a mixed record of successes and failures.

The failures are basically bureaucratic. The institutions are often inefficient and overstaffed with unqualified personnel. In Uganda, job insecurity, turn over and personal benefits remove the incentive to adopt new management techniques. The other related problem is that under-priced natural resources put additional pressure on resource management agencies. By creating opportunities for corruption and personal gain, under-pricing makes the agencies vulnerable to influence from the politically powerful. For instance, forestry departments come under pressure to provide low-cost materials to industries and allow encroachment to gazetted areas so as to serve politically important areas and people. Meanwhile, essential tasks with little political appeal, such as maintenance and regeneration, are overlooked.

In many cases, because of poor management by the state, the control of these natural resources requires devolution of responsibility for investment and implementation from central agencies to individuals, communities and fiscally autonomous agencies. The Government of Uganda has responded by formulating the National Environment Management Authority (NEMA) and the National Forest Authority[7] (2002). NEMA is given the responsibility of research, protecting property rights and resolving conflicts related to environmental matters while the National Forest Policy is specifically to create a favorable policy environment to ensure the protection and sustainable use of forest resources. Previous forest policies did not provide any incentive for

[7] The Uganda National Forest Policy, 2002. Ministry of Water, Lands and Environment.

conservation. However, despite the formation of NEMA and the National Forest Policy, political influence still overrides the performance of this institution and policy. There is a need for a thorough review of laws and regulations governing the use of natural resources to ensure consistency. There is also a need to ensure that legal frameworks and economic incentives that will avoid deterring responsible private investment and also preserve the rights of local people and forest dwellers are in place. However, economic incentives that foster environmentally destructive practices need to be removed and stable policies that aim at long-term gains should be instituted.

2.9 Conclusion

In this chapter, a review the Ugandan economy with a specific focus on agriculture, land and forestry has been done. It is evident that the high rates of economic growth realized since 1987, have been accompanied by natural resource degradation. There is general concern about the decline in forest cover and ecological services as Uganda relies on forest products for most of its energy requirements. Major contributors to deforestation include households who need agricultural land for growing crops, energy for cooking, building materials and food products from the forests. The various land tenure systems also provide different forms of access to fuel-wood resources and therefore different magnitudes of deforestation. Poor management and institutional weaknesses seem to have further affected the forest sector and therefore, there is a need for a thorough review of laws and regulations governing the use of natural resources to ensure consistency. It is the issues and concerns raised in this chapter that form the background for subsequent chapters. In the next chapter, the household-economics concepts are reviewed in order to develop an analytical farm-household model for Eastern Uganda.

Chapter 3

Agricultural household models: Evolution, applications and relevance

3.1 Introduction

This chapter provides a synthesis of agricultural household models, their evolution and uses, and summarizes the diversity of their applications and relevance. Agricultural household models are a core of microeconomic research on developing country rural economies. Although originally seen as a tool for price policy analysis, household farm-modeling techniques have been used in a number of studies ranging from biodiversity and deforestation to migration and technology adoption. Emerging empirical evidence and microeconomic theory strongly suggest that, in many developing country settings, farm-household production and consumption decisions are "non-separable" - that is, the farm household cannot be viewed as independently or separately maximizing profits as a producer and utility as a consumer. The existence of such non-separability indicates the presence of market imperfections or failures that may have important policy implications. These market failures took the form of missing or incomplete markets for inputs or outputs, including labour and capital, arising out of the high transaction costs that are endemic to developing economies. Household-farm models have been developed to provide tools to study household decision-making in such settings. The chapter focuses on the significance of human labour in traditional household production and intra-household time-use in developing countries and reviews recent advances in the empirical literature on the role that households and families play in the use of human and natural resources. As such, it serves as a basis for the empirical household model that is developed in the subsequent chapter to analyze the behaviour of rural farm-households in Eastern Uganda.

3.2 The household economy and agricultural household models

The New Home Economics theory originated from the works of Becker (1965) and Muth (1966), and it emphasizes the productive role of households. According to

Becker, market goods and services can only generate utility if they are combined with consumer's time. This theory has been modified and applied to both developed and developing countries. In developing countries the theory has been applied to the analysis of farm-household behaviour. For example in Malawi, Low (1986) shows that the household economics approach is relevant to the analysis of indigenous farm-household behaviour in southern Africa and by extension the rest of sub Saharan Africa. The theory of the new household economics therefore forms the basis of the analytical approach used in subsequent chapters of this study.

Agricultural household farm models were first introduced among other things, to explain the behaviour of farm households in the rural sectors of both developing and developed countries. The search for an explanation led to a model in which production and consumption decisions are linked because the deciding entity is both a producer, choosing the allocation of labour and other inputs to crop-production and other work activities, and a consumer, choosing the allocation of income from farm profits and labour sales to the consumption of commodities and services. In this case, farm profits included profits from goods produced and consumed by the same household, and consumption included both purchased and self produced goods. In theory, if the farm household faces fixed and identical buying and selling prices for all production-consumption goods, it does not matter that the farm household is both a producer and consumer. By consuming all or part of its own output, which would alternatively be sold at a given market price, the household implicitly purchases goods from itself. By demanding leisure or allocating its time to household production activities, it implicitly buys time, valued at the market wage from itself (Taylor and Adelman, 2003). This process applies to all but agribusiness-operated commercial farms, which consume a small share, if any, of their own output and supply few, if any, of their own inputs.

Agricultural household models provide a framework for analyzing household behaviour that integrates joint decisions over consumption, production and work (labour) allocation in developing countries. The solution to a household-farm model yields a set of core equations for outputs, input demands, consumption demands, and either prices (for household non-tradables) or marketed surplus (for household tradables). For the case of produced goods, market surplus refers to output less

household consumption. In the case of labour, it refers to the household's labour demand minus its labour supply, or net wage-labour supply. The solution to the farm household model represents all dependent or endogenous variables as functions of exogenous variables (prices of tradables, farm assets, household time constraint and other household characteristics) usually including some that may be influenced by policy. The form of this solution, especially the interactions between production and consumption that are a trademark of household farm models, are sensitive to specific assumptions about the extent to which households are integrated into the product and factor markets (Taylor and Adelman, 2003).

The concepts embodied in the reformulation of the household economics theory have been criticized by several economists including Nerlove (1974) who identifies four basic elements of this framework. These elements include a household production technology; an external labour market environment providing the means for transforming household resources into market commodities; a utility function with arguments that are not physical commodities, but home produced bundles of more basic commodities or attributes; and a set of resource constraints – most notably the time of household members. Most agricultural household models are static (exceptions include Huffman, 2001 and Finkelshtain and Chalfant, 1991) and assume that prospects are certain or, equivalently, that households are risk neutral (changing 'expected utility' to simply 'utility'). Among the constraints typically faced by the household are cash income, family time and endowment of fixed productive assets, and production technologies, all of which may be combined into a single 'full income constraint' and prices of inputs, outputs, and non-produced consumption goods. The price related constraints either fix prices exogenously, with complete markets supplying all relevant information, or, in the case of missing markets, specify an internal "shadow price" determination condition. A fundamental trait of the complete perfect markets model is that it is "separable" or "recursive". That is, production decisions are independent of consumption decisions (although consumption clearly depends on production, via the budget constraint). When one or more markets are missing, production and consumption decisions are simultaneous, rather than recursive; the model is non-separable.

Lofgren and Robinson (1999) explain that separability depends on whether or not there is a difference between market prices of production-consumption goods and the value of those goods within the household – their shadow prices. In the case of separability, all markets exist for the household and all prices are fixed exogenously in those markets. There are no unobserved 'shadow prices', because market prices represent the opportunity cost of food and time in both production and consumption activities. Household production and consumption decisions are non-separable whenever the household shadow price of at least one production-consumption good is not given exogenously by the market but instead is determined endogenously by the interaction between household demand and supply. In a developing country context this is usually due to market failures. Markets fail when the cost of transaction through market exchange would create disutility greater than the utility gain that it produces, such that no market transaction occurs. Non-existence of a market is an extreme case of a market failure, but more commonly, a market exists, but some households will not participate because the gains are less than the costs. It should be noted that market failure is usually household specific and not commodity specific.

Non-separability may arise under a wide range of circumstances (Jacoby, 1993; Skoufias, 1994). It may be present whenever the market for at least one production-consumption good is "imperfect" that is when the household in at least one market: (a) is not a price-taker; (b) views the good sold in or purchased from the market as an imperfect substitute to the good that is produced and used on the farm; and or (c) faces gaps between purchase and sales prices (due to transaction costs). In some cases of market imperfections, non-separability follows invariably. Typical examples include a situation in which the market price of a good is endogenous whenever trade takes place (a type (a) imperfection) or if the household labour on- and off-farm are distinct arguments in the household utility function (a type (b) imperfection). Similarly, non-separability follows when no household labour works off-farm (in spite of the option of doing so) in a setting where family and hired labour are separate arguments in the household production function. Other sources of non-separability include situations of thin markets where there are not a lot of buyers and sellers and where there is risk and risk aversion. As will be detailed in subsequent chapters, in Uganda a situation of imperfect markets requires the use of a non-separable model.

The farm-household is an important decision-making unit in many settings and the main form of economic organization in rural areas of Eastern Uganda. A distinguishing feature of these farm-households is that they are both producers and consumers of a set of 'production-consumption' goods; that is, goods that are both supplied and demanded by the household. In Uganda, family time (in the form of labour or leisure) and food products are common examples of such goods. In other words, for this study, household production is the production of goods and services by the members of a household, for their own consumption and for the markets, using their own capital and their own unpaid labour. It should be noted that agricultural production in Uganda comes primarily from family farms, with the family (children included) providing most of the labour. In general, each hour devoted to a home production activity by each family member competes with alternative activities such as work in the labour market, leisure or schooling. Furthermore, production at home is characterized by a division of labour based on gender and age. This is also the case in many other developing countries (Kimhi and Rapaport, 2004 and Jacoby, 1992). In addition to home production activities, many rural households in Eastern Uganda also provide labour for the labour markets. Some households face both choices, and either choose to work on their own farms or off-farm for a wage according to their valuations of the opportunity costs of their own labour.

In this study consumption is viewed as a process which involves spending the money and time of household members. For instance, household members' time may be spent in market production (for example wage employment) or in the non-market production of consumption goods within the household. The non-market production processes may involve the use of varying proportions of purchased inputs and time (Low 1986).

Agricultural household models also show the explicit linkage of production and consumption, a relationship ignored in standard models. A fundamental difference between an agricultural household model and a pure consumer model is that, in the latter, the household budget is generally assumed to be fixed, whereas in the household-farm models it is endogenous and depends on production decisions that contribute to income through farm profits. Thus, because of their numerous

advantages agricultural household models are used under different situations in different countries.

There are some advantages of agricultural household models. A key empirical advantage of agricultural household models is that they account for the profit effect. This affects demands for all sorts of commodities (including non-agricultural ones) and labour supply via cross price effects. Agricultural household analysis is also important for policy design and analysis, based on comparative statics with theoretical and parameterized models. Analytically, these models resolve the apparent paradox of a positive own-price elasticity of demand for food in farm households, as well as where profit effects are greatest, that is, when profits are a large share of total income or for commodities having relatively large income elasticities (Taylor and Adelman, 2003).

In the next parts of this chapter, the literature is placed in historical context. The work of Gary Becker, the 1992 Nobel laureate, and others on the economic model of the household has been critical in bringing a series of fundamental issues into the domain of household economic research. Insights from these models are discussed very briefly. Armed with both a modeling framework and an abundance of data from developing countries, some studies have set about attempting to explain household behaviour and estimate relationships between welfare, human and natural resources. Many of the studies have followed in the footsteps of the empirical labour and consumer demand literature which underwent a similar progression of integrating economic and micro econometric theory with empirical evidence. Indeed, today all of these literatures have much in common, especially in terms of their empirical and theoretical methodologies. This chapter follows this trend and discusses the body of evidence that has accumulated on a number of household economics issues but pays special attention to identifying results that seem to be more robust, problems that seem to be more serious and approaches that seem to work better.

3.3 Applications of agricultural household models

There is a rich literature that focuses on the use of household models in both developing and developed countries. Despite an early emphasis on price policy, the

uses of farm-household models included applications to such diverse topics as off-farm labour supply, nutrition policy, technology policy, labour supply, migration and savings. Huffman (1980, 1991) used an agricultural household model to examine off-farm labour supply, production, and consumption decisions by U.S farmers. Alan Low (1982) applied household models to study peasant households in Southern Africa (Swaziland) where off-farm employment opportunities allow decisions on the allocation of household time given the opportunity cost of time, and in the presence of a life-cycle treatment of the household itself. Low uses this general framework to show that household members with low wage employment prospects will often be used to produce subsistence food crops in preference to non-food cash crops because they can produce more food than could be purchased with the proceeds of the cash crops they might otherwise grow. According to Low (1986), labour force participation in indigenous farm households in Africa may be explained in terms of a comparative advantage analysis which is based on the household economics approach.

Nieuwoudt and Vink (1989) applied a similar analytical approach to study intra-household effects of increased real income from agriculture in Southern Africa. Their study shows that increased real income may affect household decisions in various ways such as through the income effect, the liquidity effect or the opportunity cost of leisure. Other studies that have used household models include Singh and Janakiram (1986) who studied the impact of government input and output policies on modern input use by Korean farmers. The analyses presented in the above studies provide some insights into household behaviour and how the household model can be applied to a developing country like Uganda. It is evident from these studies that access to land and other natural resources results in specialization taking place within, rather than between, households. This applies to areas in Eastern Uganda where wage employment and other forms of non-farm production opportunities exist and some household members participate in non-farm or wage employment, while others who remain on the farm have other household activities such as water and fuel-wood collection besides farming.

In Israel, Kimhi and Rapaport (2004) used the standard model of time allocation in farm households and found that the demographic composition of the household affected labour supply, namely, the existence of adult children and siblings of the

farm couple tends to decrease farm labour supply and increase off-farm labour supply. Strauss (1984) investigated the determinants of food consumption and calorie intake by rural households in Sierra Leone, using a household farm model where he found that the effects of price policies on calorie intake are especially pronounced for low-income, semi-subsistence farmers. Barnum and Squire (1979) used a household model to estimate the opportunity cost of migration. Their estimates indicated that the true opportunity cost is about half of the marginal product of labour on the farm when allowances are made for the increase in supply of family labour remaining on the farm in response to reductions in household size, along with the effects of migration on market wages. Other applications of agricultural household models in developing country settings include Rosenzweig (1980), Jacoby (1993), and Abdulai and Delgado (1999). Most of these studies used "whole" household models, in which they estimate both the consumption and production sides of the model. The model used in this study draws on this literature provided by exploring factors related to labour supply decisions in agricultural households and extends the existing research by incorporating fuel-wood as an input in household production and consumption.

Empirical application has provided a weight of evidence in support of household models that are non-separable because of issues related to labour and demographics. Inspired by the work of Lopez (1984) using a Canadian data set, recursiveness is rejected as a result of imperfect substitutability between on- and off-farm work. Benjamin (1992) found that, for Java, demographic variables influence the production decision, a link that is incompatible with a recursive model. Jacoby (1993) and Skoufias (1994) have rejected the hypothesis that the household shadow wage equals the market wage, for Indian and Peruvian households, respectively, an outcome that requires a non-separable model. Taylor (1987) adds the rural income-effect of remittances from the migrants to the effects on which migration is conditioned. Based on this study, on average, estimated remittances from migrants are about three times the expected contribution to household income of the same individuals had they stayed on the farm. Sadoulet *et al.* (1998) in a study of Mexican households disaggregated according to labour regime, rejected recursiveness for households self-sufficient in labour but not for sellers and buyers of labour, a finding that implies a non-separable model with transaction costs for labour.

From a different perspective, farmers in many parts of the world face significant transaction costs for production-consumption commodities. Rozelle *et al.* (1999) and de Brauw *et al.* (2002) design and estimate a non-separable or simultaneous agricultural household model with data from Chinese households to test the proposition of the new economics of labour migration that migrant remittances loosen various market constraints on rural households. They find significant negative effects of families' loss of labour to migration on farm production, incomes, and crop yields, but also significant positive effects of remittances on all of these variables. These findings contradict the assumptions of perfect markets and are evidence that rural Chinese households face imperfections in labour and credit markets.

In other studies, analyses have generated non-separability of household decisions due to household self-sufficiency in labour (Chayanov, 1925), a positive relationship between the interest rate and the amount borrowed (Iqbal, 1986), and *ex ante* classification of production-consumption goods traded and non-traded in combination with a credit constraint. The latter formulation appears in de Janvry *et al.* (1991) and Sadoulet *et al.* (1998). An agricultural household perspective is implicit in a number of models of access to, and terms of, credit (Kochar, 1997). This work builds upon seminal work by Feder *et al.* (1990). It informs empirical and applied-theoretical studies of household strategies to overcome constraints in credit, labour and product markets (Strauss, 1986; *de* Janvry *et al.* 1991) and risk (Finkelshtain and Chalfant, 1991). Therefore, increasingly the starting point for microeconomic research on rural economies, theoretical or applied, is an agricultural household theoretical framework.

Agricultural household models have also been used to analyze critical environmental issues (Adhikari *et al.* 2004; Nankhuni and Findeis, 2003; Fisher *et al.* 2002; Herltberg *et al.* 2000; Cooke, 1998a and 1998b; Kohlin 1998). It is generally held in international literature (see for example Cooke, 1998b, Mekonnen, 1998 and Kumar and Hotchkiss, 1988) that deforestation leads to fuel-wood scarcity and increasing marginal costs of fuel-wood. The outcomes of deforestation and fuel-wood scarcities may include increased time in fuel-wood collection which varies according to density, distance and accessibility to local forest resources, loss of agricultural production, desertification, climate change, migration, loss of bio-diversity and some social impacts. In Malawi, Nankhuni and Findeis (2003) find that children are significantly

involved in resource collection work and their probability of attending school decreases with increases in hours spent in this work. Kumar and Hotchkiss (1988) and Soussan *et al.* (1991), carried out localized studies of regions characterized by fairly dense forest cover and limited fuel-wood and labour markets in Nepal. They used an *hours per kilogram* approach. Serious measurement errors arise when this approach is used, affecting both the dependent and independent variables. This usually happens if the respondents have difficulty recalling information on time use.

In a related study in Nepal, Ilahi and Jaffarey (1998) used round-trip community distance to source of wood and found that there is an inverse relationship between productivity and distance. Their empirical results indicate that women in households that are close to sources of fuel-wood might allocate more time to wood collection as their collection productivity declines. However, for those who live in regions far away from fuel-wood sources, productivity decline may lead to a decrease in collection time either due to substitution of purchased fuel-wood from the market for collected fuel-woods or due to substitution away from wood as a fuel. These results shed more light on the findings of Kumar and Hotchkiss (1988). Cooke (1998b) finds that as environmental goods such as fuel-wood become scarce, rural households in developing countries spend more time in their collection and as a result may reallocate labour from own farm production. However, when random effects estimation is used, the time for fuel-wood collection is instead reallocated from other activities to leisure. On the other hand Heltberg *et al.* (2000) find the magnitude of response to fuel-wood scarcity (by substituting fuels from own plantations) to be insufficient to prevent current fuel-wood collection from causing serious deforestation.

As explained above, a combination of economic theory and empirical evidence suggests that, increasingly, the starting point for microeconomic research on small-farm economies, theoretical and applied, is an agricultural model. More generally, with the increasing diversity of rural economies, a household or firm theoretical framework is required.

3.4 Relevance to Uganda and other developing countries

The applications of household models discussed in the previous sub-section show that a household economics approach can be used to understand the behaviour of households in developing countries with very different socio-economic and biophysical environments from those that exist in the developed world. Such differences in behaviour may be attributed to the socio-economic environments within which households operate, which may imply differences in the opportunity and costs of producing consumption goods (Low, 1986). For example, the demand for family and hired labour in Uganda is being affected by several factors. First, as land becomes increasingly scarce and degraded, additional labour is required to maintain if not increase original yields. Secondly, the rapid population growth of 3.4 percent per annum (UBOS, 2002) and urbanization characterizing most areas of Uganda has raised the demand for food in general and hence for agricultural labour. Thirdly, increased urbanization has shifted the composition of food consumption away from foods such as millet and sorghum to less labour intensive products such as maize and beans. Fourthly, the introduction of such high yielding varieties and technologies as hybrid maize and beans, early planting and clean weeding, call for a higher labour input per acre, in total and in peak times; moreover, additional labour is also needed to harvest and process the increased crop yields. On the supply side, availability of labour is a crucial constraint, and the contribution of all possible members of the household is often necessary for them to survive in the short-run (Townsend, 1993). In the long run, households can increase their labour supply by having more children, anticipating their future contribution on the farm.

As farming becomes a more difficult and unrewarding enterprise, households are being drawn into low paying casual agricultural labour or off-farm labour as a necessity. This is done to compensate for the low and unpredictable incomes from agriculture. In Kenya, for example, one third of casual agricultural workers are women, a much higher proportion than that among regular workers, and most of them are poor and landless (Monsted and Riunge, 1987). Due to migration of labour to urban areas and HIV/AIDS, shortages of agricultural labour, especially seasonal shortages, are now common in Uganda, and by extension, probably in many parts of Africa. In Swaziland, Low (1986) shows that those members of the household with

the highest wage-earning potentials will leave the farm for better paying jobs while those with lower earning potentials will remain in rural areas. The shortage of labour raises another issue, which is the cost of hired labour. Hiring labour especially to alleviate the seasonal bottlenecks depends on the availability of both financial resources and the right kind of labour to meet the needs. However, hiring labour, especially male labour, usually tends to be costly. This is because male labour usually finds better paying jobs in urban areas and therefore it is relatively scarce. For example, serious farm labour shortages and high wage rates were found in South-Western Nigeria because of the availability of better paying jobs in cities. As a result, the cost of hiring labour was beyond the reach of most farmers, forcing about 70 percent of female producers to reduce the size of their farms (Adeyemo, 1984). In Uganda, households often adjust their cropping patterns and farming systems to fit labour availability as was observed in the study area.

Given this background, there seems to be an apparent contradiction; rural labour shortages exist in a labour surplus economy. The marked seasonality of demand for agricultural labour and the low average level of agricultural productivity explain the rural shortage. It is clear that in Uganda, the demand for agricultural labour is highly seasonal. In addition, different farming systems, crops, obligated and own-account activities, together with other on- and off-farm responsibilities, compete for this labour. This implies that labour use at the seasonal peak is highly productive. Thus, the marginal product of labour at these times is comparatively high. It also implies that the productivity of labour diminishes rapidly if it is comparatively idle for the rest of the year. Thus, the average product of labour over the entire cropping season is comparatively low (World Bank, 1993). In some parts of the country, casual urban workers return to rural areas during the peak seasons (mainly ploughing, weeding and harvesting) to provide additional labour on the farms. During this time, households also tend to receive more remittances from relatives living in urban areas to finance the agricultural activities.

Rural labour markets exist in Uganda, with the highest amount of labour being hired to meet peak period requirements such as weeding and harvesting. Most of the rural labour is paid for in cash and in kind, although in some parts of the country, labour sharing arrangements are common. Available data (World Bank, 1993) reveals

significant differences in the casual and permanent labour wage rates across regions and agricultural systems. Higher rates are realized in areas which produce mainly cash crops such as coffee, tobacco and tea, reflecting the need for permanent labour, and regional growing seasons, which differ in timing across the country. Agricultural labour in Uganda is usually paid a daily wage.

Agricultural households are so important to Ugandan agriculture and by extension other developing countries, that any initiatives to raise the sector's productivity should not ignore them. These households engage in production for both market and domestic consumption. That is to say, most households in agricultural areas produce partly for sale and partly for their own consumption. These households also purchase some of their inputs (seeds and fertilizers, for example) and provide some (such as labour) from their own sources. Moreover, overall agricultural labour productivity in Uganda is low. With low marginal returns to permanent labour and limited seasonal labour availability, households adjust their cropping patterns and farming systems to fit the situation. They do this by limiting the area cultivated, the amount of weeding or fertilizer applied, or by growing less labour intensive crops such as maize and thus reducing labour value added.

Human labour input is required both for the production of crops and the provision of non-farm energy supply that comes primarily from the forests for the household, providing essential fuel-wood and animal feed products. As long as both crop and non-crop energy supplies for human consumption remain heavily dependent on human labour, there is a high likelihood that labour will be diverted from farming to fuel-wood collection if fuel-wood becomes scarce, thus lowering the apparent agricultural yield of labour (Kumar and Hotchkiss, 1988). Improving agricultural performance therefore requires choosing an appropriate mix of inputs and technologies. Hence it is expeditious to examine the characteristics of producer households and to identify their relevant constraints.

In sum, the conditions in the rural areas of Eastern Uganda exhibit many of the features that are central concerns of the agricultural household model literature. The next section addresses issues that are central in this study: intra-household labour allocation and specifically, the gender dimensions. These issues are used not only

highlight some of the controversies in the literature but also to illustrate, in some depth, many of the difficulties that arise in empirical research on household models.

3.5 Household economics and intra-household arrangements

3.5.1 The gender dimension

The economic theory of the family by Ashenfelter and Heckman, (1974) and household time allocation (Becker 1965 and Gronau 1973, 1977), proposes that family members specialize in activities in which they have a comparative advantage so as to maximize family welfare. Comparative advantage is in part determined by the opportunity cost of time of each member and in part by the relative efficiency in household production of each member. For example, if males and females produce commodities inside the household efficiently but male wages are higher, then males tend to work outside the household for wages and females work at home. Changes in the value of time of a family member relative to that of other family members will induce an allocation of time of that family member toward the activity with the highest reward (Low 1986).

Becker (1965) and Gronau (1977) extended the conventional labour supply model of consumption and leisure by incorporating home production as yet another activity that requires human labour. They argue that women's work at home can be valued in a way similar to market work, and that this work will respond to economic incentives such as changes in market wages, unearned income and productivity of work at home. While this extension was insightful, it had a few shortcomings. It paid too little attention to the norms governing male behaviour both inside and outside the household. It was also a model with an empirical focus on developed countries where women's production is less dominated by incomplete markets market failures (Ilahi, 2000). For example, there was little application to developing countries where women's time in home production can be constrained by failure or absence of markets for basic services such as water and fuel-wood.

The typical farm household in Uganda, as in other sub-Saharan African (SSA) countries, is a complex institution. This complexity stems from distinct production units within the household; some managed by men, some by women and some jointly.

Adding to the complexity, the separate own-accounts of men and women frequently have more than one line of production. This is especially true for women, who may tend family plots, their household garden or their own plots, and may engage in petty trade in the informal sector or in other economic activities. Thus, in contrast to other parts of the world where households customarily function more like a single economic unit with common goals, resources and benefits, the practice in the African household is that family members have separate and sometimes competing own account activities. Thus, sometimes the individual rather than the household may constitute the basic unit of production in sub- Saharan Africa (Saito *et al.* 1994).

That said, changes are occurring in agricultural production patterns in sub-Saharan Africa. The gender division of labour by tasks is breaking down and farm women are increasingly undertaking tasks previously done by men. In Kenya, for example, a higher proportion of women than men are engaged in most phases of the production cycle on food as well as cash crops and livestock, in addition to their work of preparing food, caring for the children, collecting water and fuel-wood and in varied income generating activities (Saito *et al.* 1994). Male labour has been drawn more into off-farm activities in the urban areas. But, when men work away from the home, women may have to take additional responsibilities on family farms. This therefore reduces men's labour input on the family farm, leaving wives to take on greater farm responsibilities. However, if a household derives a significant part of family income from off-farm activities, such as wage labour or remittances, there may be less need for that household to farm its own land and hence less need for women to be involved in agricultural activities on their own farms. Even then, the traditional gender division of intra-household rights and activities is also weakening.

In many communities in Eastern Uganda for example, men and women traditionally farmed separate fields (gender specific) and performed separate as well as joint tasks (gender sequential). In the gender specific tasks, women for instance worked on their own plots of land, separate from those of men. For example, women could plant vegetables, and would carry out all activities from sowing to harvesting and marketing. In the gender sequential system, women and men would work on the same land but there was a seasonal or task specific division of labour in which, for example, men were responsible for clearing and ploughing land, helping women plant and

harvest and building food stores like granaries while women were responsible for preparing the soil, planting and weeding, harvesting and transporting the produce home from the gardens (Ellis, 1988). Women also kept poultry and collected wild plants (like mushrooms), nuts and fruits and the men also contributed through hunting, fishing and herding livestock. The men marketed any surplus from the agricultural output. In this case, the contribution of women was more likely to go unrewarded. However, today, political, demographic as well as social changes have significantly affected this pattern. With migration and improved educational systems, women contribute more to agricultural production than men. Low (1986) asserts that increasing wage opportunities, which encourage labour-extensive methods of farm production (implying lower productivity), combined with a residual work force of women and children, lead directly to reduced productivity per hectare and per worker, This reverses the generally accepted direction of causation and provides a direct link between migration and low farm productivity at the micro-level.

These changes in intra-household arrangements have exerted a profound impact on the role of women in agriculture. Specifically, women now constitute the majority of smallholder farmers, provide most of the labour, and manage many firms on a daily basis. Not only do women outnumber men in the agricultural labour force, but they also work more hours in agriculture than men (Table 3.1). This phenomenon is common in most sub Saharan countries. EPRC (2004) report on the status of women in Eastern Africa places rural women, appropriately, at the "centre of agriculture."

Table 3.1. Average daily hours in agricultural and non-agricultural economic activities by gender.

	Burkina Faso		Kenya		Nigeria		Zambia	
	Men	Women	Men	Women	Men	Women	Men	Women
Agriculture	7	8.3	4.3	6.2	7	9	6.4	7.6
Non- agriculture	1.7	6	3.8	6.1	1.5	5	0.8	4.6
Total	8.7	14.3	8.1	12.3	8.5	14	7.2	12.2

Source: Saito *et al.* 1992

In Kenya, a country with similar social and agricultural characteristics to Eastern Uganda, women spent an average of 6.2 hours per day in agriculture compared to 4.3 hours for men. If the time that women spent on farms is added to their other responsibilities, women's workdays become even longer. Interestingly, this situation

is similar in Zambia, Nigeria, Burkina Faso and by extension other sub-Saharan African countries.

Though there is a marked seasonal pattern to the type of work performed, women's labour input consistently exceeds men's in both the rainy and dry seasons. In Burkina Faso, for example, during the rainy season, farming activities are compressed into a few, extremely busy months. However, during the dry season, women trade and process produce for the market and cook food as well, a job many men don't usually do. In addition they collect water and spend more time collecting additional wood needed for agricultural processing activities and stockpiling fuel-wood for the busy agricultural season. Irrespective of the differences in seasonal activity, women's labour input exceeds men's at all times of the year (Awudu and Delgado, 1999; Saito *et al.* 1994; Collier, 1989). A similar pattern applies to the rural areas of Eastern Uganda. The many hours worked by women on farming tasks are in addition to the time spent on other activities. Women farmers for example, devote their time to other activities like childcare, household management tasks (including water and fuel-wood collection), agro-processing and marketing. Households and more especially women face a complex allocation problem; if real income is to be maximized, they must equate the marginal revenue product of their labour in several competing activities, some of which generate no financial reward.

Haddad *et al.* (1997) present an excellent overview and synthesis of intra-household allocation of resources in developing countries, but they say little about intra-household time allocation. Their approach to the issue is one of setting their review in the context of labour supply (and completely ignoring the intra-household allocation of housework and leisure). They evaluate the traditional unitary model using available evidence of labour supply. The unitary model hypotheses that the cross effects of an income compensated increase in the wife's wages on her husband's labour supply must be symmetrical to the effect of the changes in the husband's wage on the wife's labour supply. Their review of the literature argues for the rejection of the unitary hypothesis. They also find from existing literature (see for example Jones, 1983) that labour pooling (the basis for the unitary model) does not hold in empirical testing. However, notably absent from this literature is the issue of housework. Ilahi (2000) explains how housework is an important aspect of household time allocation and

intra-household labour supply. Several studies of household labour use differentiated by age, task and sex provide different information about the role of men, women and children in time allocation between farm and off-farm activities (see for example Kimhi and Rapaport, 2004; Cooke, 1998b; Kumar and Hotchkiss, 1988).

The range of tasks on- and off-farm that households are required to perform is very broad, and calls for an application of time and energy that tests human endurance. Given the already large and growing contribution subsistence households are making to agricultural production in general, policy makers must recognize that any strategy to improve agricultural production that increases the demand for labour (especially female labour), must take the consequent opportunity costs fully into account.

3.5.2 Fuel-wood scarcity and intra-household time allocation

There is considerable debate in the literature regarding the distribution of tasks like fuel-wood collection in the household (see for example Kimhi and Rapaport, 2004; Nankhuni and Findeis, 2003; Fisher *et al.* 2002; Cooke, 2000, 1998a; Mekonnen, 1998). Although women are the most important collectors of fuel-wood in countries such as Nepal and Ethiopia, collection is not universally the domain of women alone. Mekonnen (1998) finds that on some occasions, men are the primary collectors in Ethiopia. In India, men collect fuel-wood in the off-peak seasons for agricultural labour and women increase their collection in seasons when they spend more time away from the household itself and in the fields closer to the trees (Kohlin, 1998). Youths increase their collection when adults, especially women, are otherwise occupied with peak agricultural activities. In Malawi, Fisher *et al.* (2002) find that older children (11 years and above) are more likely to do resource collection work and girls are more likely than boys to do this kind of work. Girls also spend longer hours on resource work in Malawi (Nankhuni and Findeis, 2003). In Java, children under the age of 15 provided nearly 70 percent of all the labour required for fuel-wood collection, while in Nepal, they provided only 30 percent of the total labour required (Nag *et al.*, 1978). Collection is therefore not the domain of women alone, whether in Java, Ethiopia, Nepal or Uganda. On some occasions men are the primary collectors.

Rural households and especially the women in them are directly affected by fuel-wood depletion. Women as the main gatherers, transporters and users of fuel-wood, must walk even further to collect fuel-wood. In Kenya, for example, the time needed to fetch fuel-wood more than doubled between 1973 and 1988 (GOK, 1988). In the Central Plateau of Burkina Faso, where population density is high and the demand for fuel-wood has exceeded the supply for many years, women spend 32-35 hours per week collecting fuel-wood (Saito *et al.*, 1994). Thus, fuel-wood shortages also limit household income earning activities such as beer brewing[8], pottery and fish smoking, all of which require fuel-wood. In parts of Burkina Faso, for example, despite the importance of beer brewing to household income, time spent collecting wood is making it increasingly difficult for it to continue (Saito *et al.*, 1994).

Deforestation makes it more difficult and time consuming for rural household members especially women to collect fuel-wood and other forest products; carrying loads of up to 35 kilograms, they are forced to travel ever longer distances to collect the bare minimum of fuel-wood needed for survival, sometimes up to 10 kilometers (World Resources Institute, 1995). Two decades ago, it took no more than two hours to gather fuel-wood and fodder in the foothills of the Himalayas. But now it takes a full day of walking through mountainous terrain (World Resources Institute, 2001). Over a ten-year period, the time it took to collect fuel-wood in the Sudan increased more than fourfold. In rural Bangladesh, women spend three to five hours per day searching for fuel-wood and in other countries such as India and Ethiopia, when fuel-wood is not available, women shift to alternative and sometimes inferior fuel, for instance, animal dung and crop residue (see Cooke, 1998a and Mekonnen, 1998). These fuels not only take longer to burn; they also produce hazardous fumes. The use of dung deprives the soil of nutrients needed for agricultural production.

[8] In some parts of Uganda, fuel-wood is used to prepare hot water which is mixed in the local beer (*ajon*)

Table 3.2. Time spent gathering fuel-wood, early 1980's

Country	Average hours per day	Explanation of work
Southern India (6 villages)	1.7	Women contribute 0.7 hours
Gujarat, India	3	In family of 5, 1 member spends all day collecting wood
Nepal	1.0 to 5	Often 1 adult and 1-2 children gather wood
Tanzania	8	Traditional women's work
Senegal	4.0 to 5	Often is carried about 4.5 km
Niger	4.0 to 6	Women sometimes walk 2.5 km
Kenya	3.5	Women do 75 percent of fuel gathering
Ghana	3.5 to 4	1 full days search provides fuel-wood for 3 days
Peru	2.5	Women gather and cut fuel-wood.

Source: World Resources Institute, World Resources Report 1994-95, pp 47

Apart from its effects on household time allocation, lack of fuel-wood sometimes forces households to reduce the number of meals their families receive. Khumar and Hotchkiss, (1988) and Skar (1992) show that deforestation may reduce time for cooking, childcare and leisure. In other works in rural areas of Asia and Africa, investigators have found that increasing deforestation leads rural women to spend more time in food production and household work activities, especially fuel-wood collection (Mekonnen, 1998; Agarwal, 1986; Bilsborrow and Thapa, 1995). These studies may be useful for a country like Uganda, but as already mentioned in previous sections, the conditions in these areas differ in important respects from those in Uganda especially in terms of infrastructure, services and markets, and communication networks. The relationships between natural resources and household activities may thus be quite different from those observed in more densely populated, established rural areas of Asia. This study thus offers an empirical study of a topic which has so far received very little attention in Uganda.

The issues surrounding labour use (time-allocation) and fuel-wood scarcity are far more complex than most analyses would suggest. Labour constraints to fuel-wood collection are labour constraints to the farm. Where farm labour is scarce, fuel-wood collection may be costly. Where farm labour is abundant, fuel-wood collection may involve very low costs (Dewees, 1989). However, the issue here is opportunity cost. If the marginal product of agricultural labour is low or zero, then time spent collecting

fuel-wood is apparently not imposing a cost. Without comparing labour use for fuel-wood collection with labour use on the farm as a whole, it is inaccurate to imply that increased use of time for fuel-wood collection necessarily reflects fuel-wood scarcities. For instance, if marginal productivity of labour is low (or labour is abundant), how much of a problem is it, really, if the household is spending three times as much labour in fuel-wood collection than it otherwise would? On the other hand, if labour is scarce, the impacts of that scarcity are felt in all household/farming activities including leisure. The question therefore becomes whether or not increasing a household's access to fuel-wood requires reducing its labour allocation to other farming activities. Cooke (1996, 1998b) provide thorough inquiries into the questions of labour allocation.

Clearly levels of fuel-wood consumption depend on the labour available to collect it. As competing demands are placed on the household's available labour supply, fuel-wood consumption can decline. These constraints become more binding as fuel-wood becomes more scarce because greater distances have to be traveled to collect it. The problems become even more serious when fuel-wood gathering can no longer be combined with other work (such as collection of medicinal herbs, or as an additional activity on returning from the fields), but instead has to be the object of a separate trip (Cecelski, 1987). A further issue is that time allocation to various activities is not constant over the cycle of the year, especially in rural areas. In the hilly areas of Nepal, for instance, there is a large seasonal variation (Cooke, 1998a; Khumar and Hotchkiss, 1988). In the April-June dry season, women spend less time in agricultural work and more time in collection of fuel-wood and water. Similar patterns are reported in Pakistan by Alderman and Christi (1991), while Fafchamps and Quisumbing (1988) find that the labour shares of Pakistani men and women vary substantially by season. In the dry season, men work in farm activities and women do the housework. This is similar to the situation in Eastern Uganda where according to the field observations, in the wet (rainy) season, women increase their contribution to their own and other's farms but men reduce their contribution to housework. In the dry season, men prepare gardens for the coming planting season and help in some outside chores such as fetching water and fuel-wood, while the women concentrate on housework.

In a subsistence world where the price of commodities is measured in domestic labour time, the price of fuel-wood depends on two factors; its proximity and the opportunity cost of labour, that is, the question may not be one of fuel-wood availability alone, but also one of labour availability. This is because, even if fuel-wood is available in abundance, if there are constraints on the households' supply of labour, the cost of using fuel-wood can be high and as a result consumption can be quite low. On the other hand, if the supply of labour is abundant, the time spent on fuel-wood collection and the level of consumption of fuel-wood can be quite high. A good example is the case of Zimbabwe, where du Toit *et al.* (1984) show that the frequency of fuel-wood collection, as well as the time spent for collection, increases during the dry season mainly because households are freed from agricultural labouring. During the planting season, households spend around three hours a week in fuel-wood collection and during times of lowest labour demand, they spend around ten hours a week. Therefore, increased use of time for fuel-wood gathering may not necessarily reflect fuel-wood scarcities, especially in cases where labour is abundant. For instance, festivities usually characterize the dry season in Eastern Uganda and therefore people use more fuel-wood for cooking food and brewing alcohol. Table 3.3 below provides a summary of results obtained from various studies relating environmental goods scarcity to labour allocation.

Table 3.3. Production response: Labour inputs

Study	Location	Product	Labour inputs and effects
Cooke (1996)	Nepal Hills	Fuel-wood Forage and Fodder	Labour allocation between agriculture and gathering: Increases in resource scarcity will result in increases forest collection time and increases in forest product collection do not decrease time for agricultural labour
Cooke (1998a)	Nepal Hills	Fuel-wood Forage and Fodder	Male and youth collection time is small, women's' collection time is large and women absorb the increase in collection time due to increasing resource scarcity. Seasonal differences in collection time: men increase collection time in off peak agricultural season, women increase collection time(as joint product) when in fields for agricultural activities; the youth increase collection time when women are otherwise busy.
Amacher *et al.* (1993)	Nepal Hills	Fuel-wood	If fuel-wood is in plentiful supply then women collect, men do not and children are negative collectors. If wood is in limited supply then both men and women collect, but men collect more
Shyamsundar, Kramer (1996)	Madagascar	Fuel-wood Palm leaves	Increased collection with more accessibility. The men collect more fuel-wood and palm leaves
Mekonnen, (1998)	Ethiopia	Fuel-wood Dung	Accessibility of resource is important. On common lands, girls are significant collectors. Children contribute negatively on common lands. Women are significant collectors.
Kohlin, (1998)	India	Fuel-wood	Women collect more from natural forest. Some reduction in pressure on natural forest due to introduction of village woodlots.

In areas where on-farm labour is scarce and households are facing fuel-wood scarcities, farmers may have an incentive to plant trees. For example, in Machakos district of Kenya, small-holdings headed by very young or very old women face serious labour constraints (Rochaluea, 1994). These households resorted to planting

trees around their farms so that the fuel-wood resources are more accessible to the household. In other areas such as Kisii district, in Kenya, where there are high agricultural labour demands, fuel-wood collection requires a relatively small proportion of the households' time, because fuel-wood supplies are obtained from trees planted and managed on the farms. Similar types of tree management strategies have been widely reported elsewhere. Dewees (1989) in a study conducted in Kenya finds that woodlot growing households have both labour and capital constraints. They have an older age structure and consequently have fewer children living at home. From a policy perspective, it is critically important that efforts to introduce tree-planting innovations are put into a context, which more accurately reflects the farmer's ability and knowledge. Further, this ability and knowledge must be understood within a historical and cultural setting. However, in cases where households have planted their own woodlots, there are very few cases where they have failed to manage the environment.

3.6 Theoretical issues: Determinants of household labour allocation

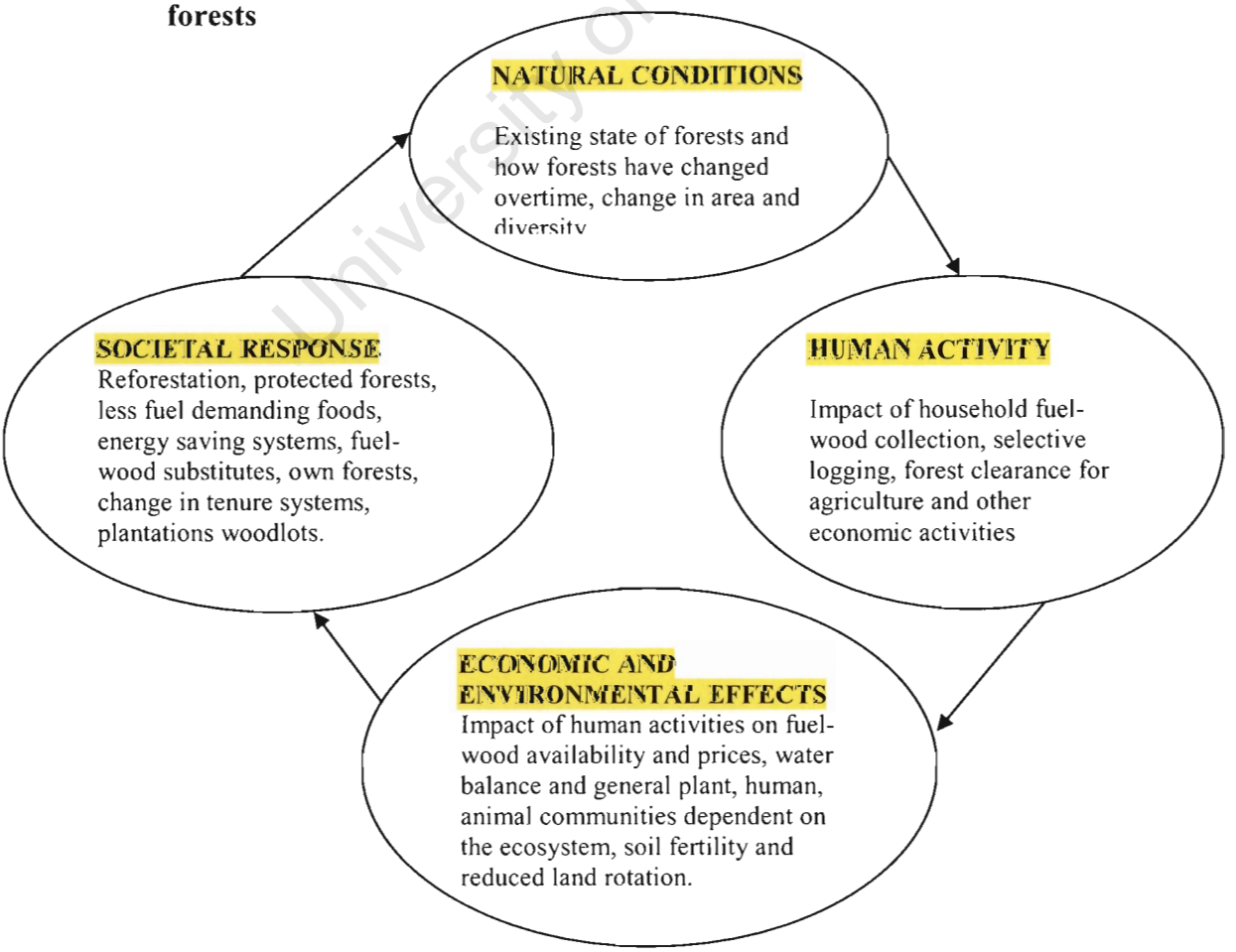
While household-economics theory has been applied to a wide range of activities and countries including some developing countries like Ethiopia, Swaziland and Malawi, it has been hardly applied at all in Uganda. Moreover, its potential for the analysis of household activities in Uganda is probably greater than in the developed countries, since households in Uganda perform substantially larger economic roles than they do in the developed countries. However, it is important to note that the issues presented at the beginning of this chapter depend on several factors like the specific environment under consideration and other location specific factors. For example, these relations may vary if households in typically highland areas are contrasted with those in lowland and purely urban settings.

In order to illustrate how agricultural household models can contribute to a better understanding of agricultural development in the region, two areas in Eastern Uganda with markedly different agro-climatic and topographic characteristics are presented in this study. While Kumi and Tororo districts are flat, almost semi-arid and poorly rainfed, Mbale and Kapchorwa districts are mountainous and well watered with high average annual rainfall. Despite such marked agro-climatic and topographic

differences, the development of agriculture and the natural environment has followed more or less a similar pattern which has been influenced by economic, social and cultural factors. This study attempts to understand what happens in these environments and the effects of their deterioration on household economic activities on and off the farm.

Figure 5 below represents the main links in the relationships between natural conditions, human activities, economic and environmental effects and societal responses. The 'natural conditions' refer to the existing state of Uganda's forests and their changes over time. 'Human activity' accounts for such things as the impact of fuel-wood collection, forest clearance for agricultural land and other economic activities. The 'environmental effects' refer to the impact of human activities on the forest ecosystem, water balance and on the plant, animal and human communities dependent on that ecosystem. 'Societal response' refers to the efforts made by society to eliminate or ameliorate the stresses caused by human activity.

Figure 5. The main links to understanding the effects of human activities on forests



Household members are involved in ongoing agricultural activities, although with varying contributions. The size and composition of families are more directly related to household production (Kimhi, 1996; Kimhi and Rapaport, 2004; Low, 1986; Ellis, 1988). Children become contributors to household survival in such activities as grazing animals, fuel-wood gathering and even on-farm labour while women, for instance, perform reproductive, productive and community activities. However, due to problems like lack of credit, insufficient access to social services and infrastructure and limited access to mechanical agricultural inputs, these households are exposed to a high degree of risk and uncertainty. Thus, the availability of labour becomes a crucial constraint and the contribution of able household members becomes necessary for these households to survive in the medium term. In the long run, therefore, these households may respond by having more children to offset labour shortage problems. This situation is suggested in Eastern Uganda where the household size has expanded significantly over the years. Therefore, the life cycle can be expected to affect household production behaviour not only in terms of changes in the value of human time of household members over time, but also in terms of the numbers of members in a household and their potential to contribute to production (MaCurdy, 1981). If the households cannot afford hired labour due to lack of cash or just its unavailability, the households usually tend to provide most of the required labour on-and off the farms.

Household composition is critical in farm production. The availability of more men in the family can substitute for women's labour in production, but its effect is indeterminate *a priori*, because the presence of more adults also increases consumption needs thereby increasing demand, including that for female labour. Women's involvement (likewise for men) in agricultural activities is likely to free up men's (women's) time, enabling them to undertake other activities such as forest clearing or gathering fuel-wood. If a household for instance, is largely constituted of children, then this could have some negative effects on members' participation, especially women, on their farm activities. But more children may also increase women's participation; the higher consumption needs imply a need for more production and therefore an additional burden on her time. While older children (youths) may often help to care for younger children, thus releasing women to work more in agriculture and other activities, (see also Nankhuni and Findeis, 2003 and Fisher *et al.* 2002), this effect may be attenuated by school attendance. The situation

in Eastern Uganda is such that household size has significantly grown due to the extended family system caused by mainly war and HIV/AIDS (The United Nations Children's Fund-UNICEF, 2002). HIV/AIDS may have had a major effect on the life expectancy in Uganda (about 42 years, World Bank, 2002) and this has had implications on the existing households that have had to integrate AIDS orphans (who constitute the largest proportion of orphans in Uganda) into their families. This has not necessarily led to fewer but larger households because population growth is still very high (3.4 percent), resulting in both more and larger households. Also improved health conditions, largely due to the massive nationwide immunization programmes, have led to lower mortality rates among the children. This puts extra pressure on household demand in terms of consumption and time needs. It is expected that larger families will produce more food and consume more fuel-wood.

Individual characteristics of household members also affect their participation in on- and off-farm activities (Goodwin and Featherstone, 2003). In Uganda, as in many parts of sub Saharan Africa, participation in farm activities is usually of lower status than in off-farm activities. It is therefore very likely that heads of households with more educated members will not work in farm activities due to the low status accorded to them and also due to their low remuneration (low prices for agricultural products) relative to alternative employment possibilities. However, it is difficult to distinguish precisely whether educated household members do not work on farms due to status after controlling for economic rewards. It is also common that households with more educated members tend to locate themselves in urban areas where better paying and more skilled jobs are found.

Another important aspect relating to individual characteristics is age. Many models have supported the hypothesis of a life cycle (Low, 1986; Huffman, 1980; Sumner, 1982), which contends that individuals will increase their work effort in earlier years in order to accumulate assets to draw on later in life. Young farm operators may also want to work more hours to add to their stock of human capital (Mishra and Goodwin, 1998). Low (1986) using evidence from Swaziland shows that the domestic development cycle explains a large part of the economic differentiation found in indigenous rural sectors of Southern Africa. The elderly in Uganda are usually accorded higher status in society and the household, and therefore are less likely to

work on the farm or gathering activities for many hours because they have children to substitute for them. Also, because the elderly are less physically able to participate in activities that are quite demanding, they tend to work fewer hours. However, this may depend on the composition of the household, as some households with fewer children may still require the contribution of the elderly. The stage at which an elderly person can be exempted also depends on other factors such as health status of the member or very advanced age, or even the economic status of the household. Again, it is difficult to identify the basis on which the elderly in Uganda are exempted from household work.

Land availability and use is also a crucial factor in determining labour use for on-farm and off-farm activities. To reduce risk, peasant households in Eastern Uganda allocate their land to different uses, including cash and food crops, and pasture. Households with more land under cultivation (especially mixed crops) may need more labour input and may therefore utilize all family labour and even hire some. Likewise, households with more land under labour-intensive crops such as rice and finger millet will tend to require more labour than those under perennial crops or pasture. Therefore, a large area under crops is likely to demand more labour.

Relating to wages, households in Eastern Uganda allocate their labour to on-farm and off-farm activities depending on the prevailing wage rate. If on-farm and off-farm labour are assumed to be imperfect substitutes in the household utility function and that family and hired labour are also imperfect substitutes in the farm production function, then at a given market farm wage rate, it is unlikely that the supply of household on-farm labour will equal demand for household on-farm labour. Hired and family labour are considered imperfect substitutes because hired labour incurs an extra supervisory cost and is paid according to hours or area worked which is not the case with family labour. On-farm and off-farm labour are not perfect substitutes because of obvious productivity (wage) differences. If households equate the two at the margin, they will act as if they faced a virtual farm wage different from the market wage. The virtual wage is derived implicitly from equating household on-farm household labour supply and demand. It will be a function of both consumption related and production related variables and is endogenous to the household. On the other hand, if interior solutions are assumed, off-farm labour supply decisions will

respond to the market off-farm wage, and hired in farm labour demand will respond to the market farm wage. Hence the virtual wage will be a function of both market-farm and off-farm wages.

The implications of household income on labour allocation are varied and also difficult to distinguish. It is expected that households with higher incomes will tend to hire more labour and also purchase some goods like fuel-wood from the market. However, this may not hold if a large proportion of income is derived from farm activities, such as rice cultivation, because the households' demand for their own labour will increase since they may have to work on their own farms probably in addition to hiring labour. On the other hand, if most income is derived from off-farm activities such as remittances or work outside the home farm, households may not need to work on their own farms hence the demand for their own labour is low. Such households tend to use their income to purchase food and non-food items such as fuel-wood from the market. The decision to allocate household labour to off-farm activities may be viewed as part of a household "survival strategy" to diversify sources of income as a method of coping with uncertainties of production in the peasant household. But when one member works away from home, the others may take on additional responsibilities on the family farm. For instance, in rural south India, to diversify sources of income and reduce risks and uncertainties, husbands work for wages away from the farm whenever possible. This reduces their labour input on the family farm, leaving wives to take on greater farm responsibilities (Desai and Jain, 1994).

These arguments lead us to propose that in rural Eastern Uganda, the participation of households in fuel-wood and farm activities will depend on: household consumption need, family size and composition; individual characteristics of household members (gender, age and education); availability of other household labour on the farm (hired and family labour); household on- and off-farm income (wage); the size of the landholding and its use; and seasonality and agro-climatic factors.

3.7 Conclusion

The purpose of this chapter is to review of the household-economics approach with particular emphasis on the agricultural household models and their applicability to developing countries including Uganda. Many researchers have studied this issue by modeling and estimating household farm decisions regarding the allocation of time between farm and off-farm work but so far, no such study has been done in Uganda. This study draws upon the theory of the farm household and empirical studies of household labour allocation in developing countries like Madagascar, Ethiopia, Nepal, Swaziland and Malawi. These models explicitly account for the fact that farm households 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 the consumption and production decisions in the model are assumed to be made jointly in response to changes in input and output prices.

In this chapter, it has been suggested that agricultural household models provide a useful tool for understanding the behaviour of rural farm households in developing countries. It is important to consider the extent to which the approach and analysis presented in various studies are specific to the particular circumstances of Eastern Uganda, and to what extent, and with what caveats, the approach may be applicable to the study of farm households in Uganda. It is also shown that the circumstances in which rural farmers in Uganda find themselves are not unique and that in respect to allocation of household time, household models provide a consistent interpretation of behaviour over a wide range of circumstances. Given the conditions that exist in rural areas of Eastern Uganda (imperfect markets for fuel-wood, labour and other home produced goods), the literature agrees that a non-separable household model is more applicable and relevant. Generally, this chapter has argued that the adoption of a non-separable farm household model can contribute to the understanding of the nature of socioeconomic characteristics that make farming in Eastern Uganda and Africa in general. Intra-household allocation of labour under various conditions was reviewed and the potential determinants of household participation in fuel-wood and farm activities were discussed. In the next chapter, a farm household model for the rural areas of Eastern Uganda is developed.

Chapter 4

Resource degradation and rural farm-household activities: A model of rural Eastern Uganda

4.1 Introduction

In this chapter a farm-household model tailored to the socioeconomic conditions existing in rural areas of Eastern Uganda is developed. The basis of this model is the theory of household economics reviewed in the previous chapter. Traditionally, the economic theory of consumer demand has taken the individual as a unit of analysis. From a viewpoint of economic policy, it is the well-being of individuals - rather than the average well-being of individuals within a household - that is the ultimate object of concern. Yet, empirical work on demand systems is usually based on data that takes the household as the unit for data collection (Kooreman and Wunderink, 1997). This study follows international studies, adopting the conventional approach with the household as the unit of analysis (see also Adhikari *et al.* 2004; Kimhi and Rapaport, 2004; Nankhuni and Findeis, 2003; Huffman, 1991 and 2001; Mekonnen, 1998; Khumar, 2002; Low, 1986; Cooke, 1998a and 1998b). This is mainly because in the rural areas of Eastern Uganda, farming systems tend to be household-based. Given the review in the previous chapter that a non-separable model is relevant and intra-household issues may be substantial, the importance of studying household time allocation among rural activities in Eastern Uganda can hardly be overestimated. A theoretical model of farm household behaviour with a graphical and analytical application is presented. This forms the basis for the development of a farm-household model that is appropriate for rural areas in Eastern Uganda. The basic equations of the theoretical model are presented in mathematical form and conditions under which the model performs are derived. In addition, the expected effects of various variables on household labour allocation to fuel-wood collection activities and farm work are explained. Finally an empirical model of household behaviour in Eastern Uganda is presented and discussed.

4.2 A theoretical model of household behaviour

In this section a brief discussion of several versions of the models of consumer behaviour is presented. All of them are static models. The first, is the simplest neo-classical model of consumer behaviour, followed by the introduction of labour supply (time). The Chayanov (1925) equilibrium theory of the household and the farm-household theory are all compared with the "new economics model" by Becker (1965). This serves as a foundation to the household model that will be developed to describe household behaviour in rural areas of Eastern Uganda.

The assumptions underlying the neo-classical model of economic choice are quite restrictive, and indeed there are many examples where the model has failed to pass empirical testing. The evolution of household decision models has involved a number of adjustments to this model. In the context of this thesis, three issues are worthy of special attention. First, the model describes the behaviour of one person yet households often consist of more than one person and the question arises, who is 'the consumer'? Second, human beings are consumers, but consumption is not the only 'utility creating' item, thus time use should be incorporated in the models (Kooreman and Wunderink, 1997). Therefore, by concentrating on consumption alone, the role of time use is neglected in the model. The role of time use need not be restricted to labour and leisure only because the consumer has all kinds of productive activities within the household that cannot be considered as pure leisure. Third, the neo-classical model of consumer behaviour assumes full information on income and prices (in the present and future). However, in reality, the consumer is faced with uncertainty about his or her future income and about current and future prices. But to get an idea about certain variables such as prices, wages and income, the consumer needs information. This information has a price either in terms of money and/or time.

In agricultural societies, households are now considered as production and consumption units. In the neo-classical model, two functions of the household can be recognized: households supply labour and households consume products supplied by the market. However, in reality, the production role of households, although not visible in the neo-classical model, is still important. The new home economics theory (household-economics approach) introduced by Becker (1965) emphasizes the

productive role of households. According this theory, market goods and services can only generate utility if they are combined with consumer's time. For example, having money for food does not generate utility. One needs time to buy, prepare and consume the food. Only this combination of food and the consumer's time generates utility.

The household economics approach developed by Becker (1965) has several similarities with the equilibrium theory of peasant economies put forward by Chayanov in the 1920's. Low (1986) presents a rich version of their similarities and differences. As summarized by Low, both the Chayanov and household economics view the household as a single production/consumption unit engaged in non-market as well as market activities. Both stress the paramount importance of family labour effort, but household economics goes further and recognizes that different household members have different relative time values in market and non-market activities. Both also recognize the influence of household structure on production and consumption. While Chayanov concentrates on how the structure of a household affects its capacity to supply a household's consumption requirements, household economics emphasizes changes in the value over time of household members` time and the effect that this has on the pattern of demand for time-intensive versus goods-intensive commodities.

In attempt to derive a model of the indigenous farm-household in southern Africa, Low (1986) reviews the farm-household theories developed mainly by Nakajima (1970) and Barnum and Squire (1979). According to Low (1986), the model developed by Nakajima is of limited applicability to developing countries mainly because it analyses production and consumption purely in monetary terms and represents commercial farmers. This is certainly true of Eastern Uganda and many parts of rural sub Saharan Africa where production is mainly for subsistence. Another shortcoming of this model is that it assumes land area is fixed at the farm-household level and that this results in declining returns as more labour is applied on the family farm. In Uganda, as explained in the previous chapters, land is not fixed as the land tenure system allows it to vary with say household size. There is also evidence of expansion of land by clearing forest for agricultural land (NEMA, 2002). The third limitation of the model advanced by Nakajima is that it assumes as household size increases, farm production surplus above consumption requirements decrease yet, in

most African settings, larger households tend to produce greater crop surpluses (Low, 1986).

Given the shortcomings of the neo-classical model, the Chayanov model and the farm-household theory, the household-economics approach of Becker (1965) who presented a theory of the allocation of time between different activities with the basic assumption that households are producers as well as consumers is adopted and modified in the work of this dissertation. This framework was modified by Gronau (1973, 1977) and used in several studies (see for example Kimhi and Rapaport, 2004; Adhikari *et al.* 2004; Heltberg *et al.* 2000; Cooke, 2000, 1998a; Ilahi and Grimard, 2000; Mekonnen, 1998; Low, 1986) as the basis of a model of home production and consumption.

4.3 Household-farm models: A graphical and analytical application

The primary motivation for constructing agricultural household models is to understand the impacts of policies and other exogenous shocks on household-farm behaviour. In its dual role as producer and consumer, the household makes production, labour allocation and consumption decisions that may be interdependent upon one another. In its most general conceivable form, the household's objective is to maximize a discounted future stream of expected utility from a list of consumption goods including home produced, purchased goods, and leisure, subject to a set of constraints. In practical applications, available data usually lead to significant simplifications to both the objective function and the constraints. Most agricultural models are static and assume that households are risk neutral. Household constraints typically include cash income, family time and endowments of fixed productive assets, and production technologies (these constraints are usually combined into a single full income constraint) and prices of inputs, outputs and non-produced consumption goods. Price related constraints either fix prices exogenously (the case of perfect markets) or, in the case of imperfect or missing markets, specify an internal "shadow price" determination condition, that is, that the household's demand for a good equals its output (Sadoulet *et al.* 1998).

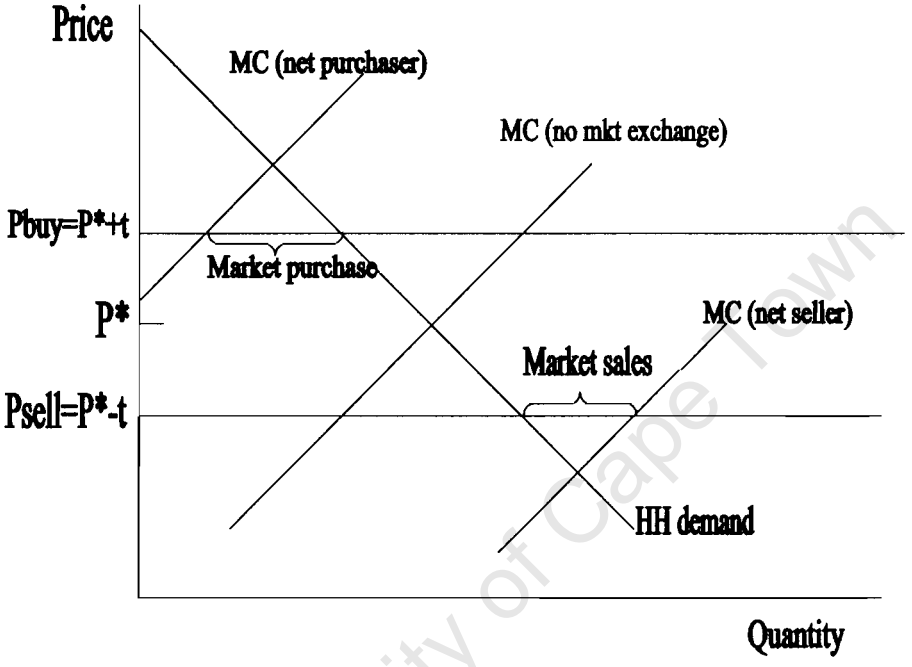
Therefore, the household's objective is to maximize utility subject to its budget constraint. The budget constraint, however, assumes different forms according to the market environment in which the household finds itself. There are three typical market scenarios, the extreme case of no markets, the case of complete or perfect markets (separability) and the case of missing or imperfect or mixed markets (non-separability). In this context, separability (or recursion) or its absence is related to whether or not production decisions depend on consumption decisions. With separability, only production decisions are assumed to influence consumption decisions. For the separable model to hold, the markets for all products and factors, including food and labour are required to be perfect (see also Squire *et al.* 1986 and Sadoulet *et al.* 1998) and all prices are determined exogenously in those markets. There is no need to derive unobserved "shadow prices" because the market prices reveal the opportunity cost of food and time in both production and consumption activities. This means that labour in production is no longer influenced by the household's time endowment; workers can now be hired from a local labour market to produce food. It also means that there is no longer a trade-off between work and leisure; the household can produce food at any point along the production possibility frontier (PPF) while demanding any amount of leisure (up to its total time endowment).

However, having perfect markets for all products and factors is unreasonable for a developing country like Uganda. This is mainly because of transaction costs (like distance to the market, high transport costs, excessive marketing margins for traders with monopoly power) and thin markets for products in areas that are isolated or remote and there are not a lot of buyers and sellers of products. These costs including missing markets cause market failure, and when markets fail, a more appropriate type of model is the non-separable agricultural household model (see also de Janvry *et al.* 1991). This model is different from the perfect markets model in that production decisions are assumed to depend on consumption ones.

In Eastern Uganda, households may face missing markets for some goods like fuel-wood and not for others. In general, a market is missing if the costs of participating in it (transaction costs) are so high that self-sufficiency is the household's optimal strategy. Transaction costs subtract from the sales price of producers while adding to

the purchase price of consumers. This creates a wedge between the (high) consumer price and the (low) producer price, or a "price band" (de Janvry *et al.* 1991).

Figure 6. The price band picture in a non-separable model

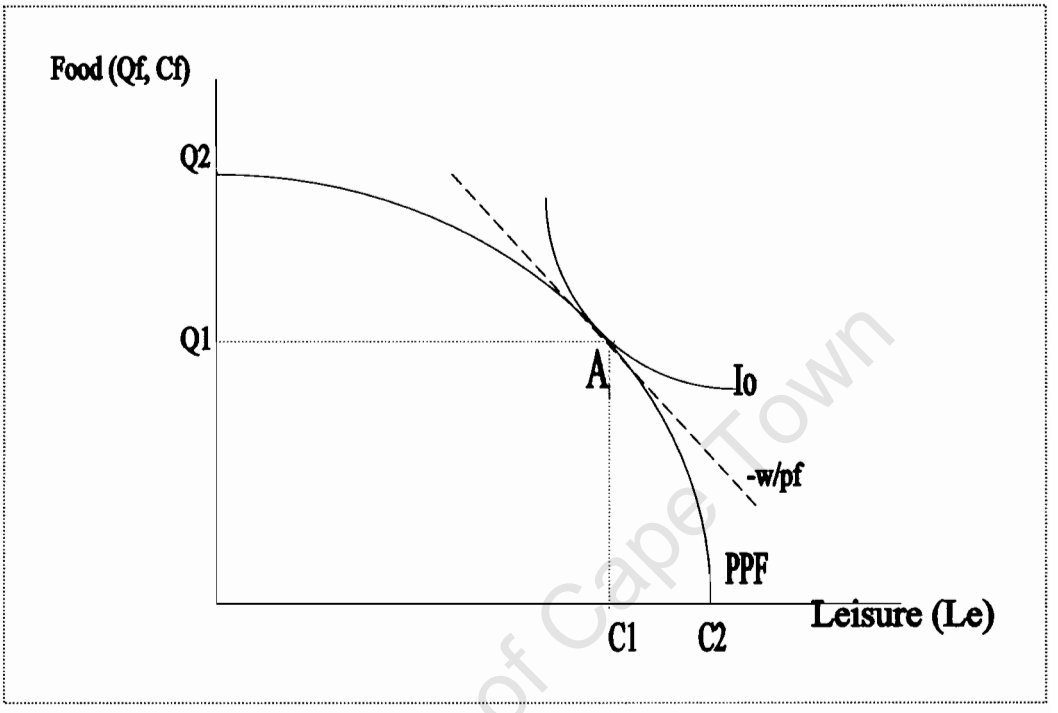


If the household shadow price that would obtain in the absence of a market lies between the producer (P_{SELL}) and consumer (P_{BUY}) prices (within the price band), the household's optimal choice is to withdraw from the market and be self-sufficient or "autarkic" (Figure 6). That is because, as a producer, the shadow price, or subjective valuation of the good, is higher than the market price minus the transaction costs and the household is better off supplying itself rather than the market. As a consumer, the shadow price is lower than the market price and the household is better off "purchasing" the good from itself. This situation is close to the one that exists in the fuel-wood market in Uganda as will be explained later. If the household marginal cost (supply) curve crosses its demand curve above the price band, then the household is a net purchaser of the good. On the other hand, if the household marginal cost supply curve crosses its demand curve below the price band, then the household is a net supplier of the good.

The width of the price band explained above depends on transport costs, opportunity costs of time involved and risks associated with uncertain prices/availability of goods. In many cases the price band widens with poorer infrastructure, less competitive marketing systems, poorer information flows and greater price risks. Given these conditions, many missing market scenarios are possible and the circumstances in Uganda determine which are most applicable. For example, a labour market might exist, but the cost (time, information gathering, and transportation) of selling fuel-wood or buying fuel-wood for consumption at the nearest market center may discourage households from participating in fuel-wood markets. The other alternative is that, markets for fuel-wood (and other consumption products) may exist, with market determined prices, but the labour market may not, as high labour transaction costs (for example, costs of monitoring workers' collection effort) discourage hired labour use.

Figure 7 below, focusing a production possibility frontier defined at the household level, is a compact way of illustrating the agricultural household model under alternative market scenarios. If a simple 2-goods scenario is assumed, a missing labour market would force the household back to the subsistence point A. On the other hand, lacking a second market good, the household would have no rationale for producing excess of its consumption demands. Households obtain utility by consuming food (C_f) and leisure (C_l), given by a utility function of the form $U(C_f, C_l; Z_h)$, where Z_h represents household characteristics influencing the marginal utilities of food and leisure consumption, and the utility function is assumed to be well-behaved. Food is produced by combining labour (L_f) with capital (K_f) later assumed to be fixed in this static model. The production technology is described by the production function: $Q_f = Q_f(L_f, \overline{K})$, assumed to exhibit usual properties: increasing marginal product of labour but at a decreasing rate, given the fixed-capital constraint. In this case, leisure is 'produced' simply by not allocating household time to production or (when there is a labour market) to wage work. The simplification of this model to only two goods is more restrictive than the usual representation of farm household models (see for example de Janvry *et al.* 1991; Singh *et al.* 1986; Low, 1986), but it greatly facilitates a graphical analysis and can easily be extended to include more than 2 goods as well as variable inputs besides labour.

Figure 7. Agricultural household with missing markets



Where:

Q1 represents $Q_f^c = C_f^c$

Q2 represents $Q_f^{max} = Q_f(\overline{T}, \overline{K})$

C1 represents C_1^c

C2 represents $C_1^{max} = \overline{T}$

$L_f^c = C_1^{max} - C_1^c$

Lacking access to a labour market, the household must supply its own labour to production, as may be the case of fuel-wood. The superscript "c" denotes constrained market. If the household produces no food, it can allocate all its time to leisure at point C2 ($C_1^{max} = \overline{T}$). By allocating all its time to production, it can achieve maximum food output at point Q2 representing $Q_f^{max} = Q_f(\overline{T}, \overline{K})$. This extreme missing market scenario depicts a Chayanovian world in which households face severe labour-leisure tradeoffs.

The result in this simple case would precisely be the same if the household had access to labour but not to a market for fuel-wood or food (see also Taylor and Adelman,

2003). The household's objective is to maximize utility subject to its budget constraint, which also depends on food production. The solution to this utility maximization problem is for the household to always situate itself on the highest indifference curve attainable, subject to the market constraint.

The graphical and analytical presentation outlined above can be extended to the consideration of other Z goods which are produced by the application of time and market inputs on the family farm that are directly consumed by the household. In most of Eastern Uganda, some of the Z goods which are obtained and retained in the home include water for washing and drinking, grazing for livestock and wood for building. The model can also be extended to analyze situations where there are three or more goods (say, staples, a cash crop, other market goods, and leisure). A missing labour market may either dampen or stimulate the production of specific goods. In a labour abundant household, a missing labour market effectively traps family labour on the family farm by preventing it from engaging in wage work. In such a case, lack of access to a labour market depresses the household "shadow wage" stimulating production and/or leisure demand. Through its production activities, the household can transform its labour into a high value product, for example, a cash crop. Other missing market scenarios are possible, most with ambiguous impacts on household production and consumption. However, these situations are not analyzed in this study. An insightful application of the missing markets model is by Sadoulet *et al.* (1998), who use a programming model of a hypothetical household farm to explore the effects of a change in price of a cash crop under four different market scenarios. In the next section, an illustration of a farm-household model constructed for Uganda is presented.

4.4 A labour allocation model of the rural areas of Eastern Uganda

An important piece of work that reviews the adoption of the household economics approach to the farming household behaviour in southern African and by extension sub Saharan Africa is that of Low (1986). As discussed above, Low applies the Becker (1965) theory to a subsistence farm production approach by examining the decision-making process in the production of Z goods. An analysis is done to consider situations where the farm household has opportunities for wage employment and it is

possible to purchase subsistence requirements as well as grow them. As Low summarizes it: "the time of household members with the greatest comparative disadvantage in wage employment will be allocated to subsistence production first, followed by members with increasing comparative advantage in wage employment until, either the household's requirement for the subsistence *Z* good is satisfied, or the next members' wage becomes greater than his opportunity cost of purchase, in which case the balance of requirements will be purchased". The analysis is extended to include other *Z* goods like water, fuel-wood and grass for thatching. Interestingly, the model is extended to include a cash-cropping farm household with more than two people. Conditions under which households will decide to produce for own consumption and sale in the market are derived. The questions of how risk can be excluded from the analysis are considered in the Low model.

There are key considerations about the basic model developed by Low (1986) worth mentioning and reviewing if the model is to be applied to Uganda. First, the model does not assume constant returns to household members in wage employment nor diminishing returns to labour on the family farm. Second, market and non-market activities are included within the same framework; that is, wants such as a staple food, may be obtained using time-intensive technology on the farm or purchased in the marketplace using market input-intensive technology. Third, the point at which a changeover between non-market and market activity takes place, in relation to subsistence crop production depends on household members' wage rates in relation to the purchase price of food as well as the structure of the household (consumer/worker ratio).

Even though the factors highlighted above make the model relevant to the situation in southern Africa, extensions on its applicability are very important and necessary. First, the model does not give explicit treatment to the allocation of time within households which is a critical issue in this study. Even though the model analyzes the allocation of time between market and non-market activities, it is still important to know the utility function of the farm-households. Analysis of the utility functions of households enables the inclusion of more variables in the analysis than the geometric model developed by Low. For instance, no account is taken of seasonal variations in labour requirements in farming. Agro-ecological and topographic factors (highlands

versus lowlands), sociological factors such as individual characteristics of household members including education have been ignored. Other issues such as remittances from family members and family wealth are equally not given adequate treatment in the model. As Low indicates, although there are advantages of keeping the model and analysis at a more general level, quantification of the geometric model would enable more variables to be considered but also pose difficulties. The analytical model developed in the next section therefore builds on previous work on household-farm models. It uses quantitative techniques to analyze farm-household behaviour in rural Eastern Uganda. Issues such as seasonality, gender, household composition and agro-ecological and topographic conditions are included in the model. Before developing the model in relation to the farm household situation in Eastern Uganda, the general situation of fuel-wood production and consumption in Uganda is presented.

In rural areas of Eastern Uganda, since fuel-wood collection is subject to the same labour, land and natural resource constraints as other household activities including agricultural production, it cannot be analyzed in isolation. The production functions assumed are based on the new home economics theory. Essentially, they represent versions of agricultural household models with a focus on fuel-wood collection as an activity distinct from market work and housework. In the case presented here, fuel-wood enters as an input into the home production function and its collection is associated with a potentially large opportunity cost in terms of collection time, which varies according to the density, distance and accessibility of local forest resources.

The non-separable model is adopted because of the following conditions that were observed in rural areas of Uganda: First, it is known in general that most rural households both collect and consume their fuel-wood, even if some of them (about 6 percent) participate in the local (informal and underdeveloped) fuel-wood markets. Although all households are faced with the choice of either collecting or purchasing their fuel-wood, they determine this based on their valuations of their own labour opportunities. A case where households prefer their own labour for fuel-wood collection to hired labour is examined. This may be due to limited off-farm labour opportunities or household preferences for farm work or proprietary labour. In this formulation, conditions under which households collect all their fuel-wood or purchase it are derived. All households in the sample consume fuel-wood. Those

households that do not collect fuel-wood purchase their fuel-wood in informal markets (6 percent). In the presence of imperfect markets for fuel-wood and labour for their collection, it is relevant to compute price elasticities using some measure of virtual[9] (shadow) prices and wages instead of market prices.

Secondly, agricultural production in Uganda is known to rely heavily on the input of human labour. Labour market opportunities at existing wages are assumed to exist for both men and women. However, the local labour market in Uganda adds complexity to the labour problem because imperfections in the rural labour markets – both gender and seasonal – make household labour supply and demand non-separable. Households can hire labour to work on the farms but do not hire labour for fuel-wood collection. The willingness to collect fuel-wood depends on each household's valuations of time and its preferences regarding the leisure-labour trade-off. Further, it is assumed that hired and family labour on the farm are not perfect substitutes because hired labour incurs an extra supervisory cost and is paid according to hours worked or area worked, which does not apply to family labour. Also, family labour includes children and aged people whose input is expected to be less than that of adults hired in as units of labour; they cannot therefore be perfect substitutes. They may be active as volunteers, or in home production, but not usually in the labour market.

Incomplete or missing markets for key goods and services like labour (Fafchamps, 1993), food (de Janvry *et al.* 1991; Omamo, 1998) and fuel-wood (Mekonnen, 1998) can exert considerable pressure on agricultural households. Using a non-separable framework where the opportunity cost of labour is endogenous, the issue of fuel-wood demand and its determinants has been analyzed econometrically by Amacher *et al.* (1996, 1999) and Heltberg *et al.* (2000). Similarly, this study looks at resource use in rural areas of Uganda and extends the analyses to include farm time allocation. Variables related to seasonality, gender, agro-ecological zones are incorporated into a formal model of household behaviour. The specification is broadly in line with the work on agricultural household models, but includes fuel-wood as an input in household production and consumption.

[9] The concepts of virtual fuel-wood prices and wages are used to take account of non-market activities in fuel collection and consumption, which are common in rural Eastern Uganda.

The assumption of non-separability implies that household resource allocation, including energy supply and demand, farm and off-farm labour supply is decided simultaneously, rather than recursively[10]. It also means that a utility maximizing household would determine energy production and consumption subject to a "virtual" or "shadow" price of energy which is unobserved and unknown, except to the household itself, and which varies between households depending on household and village characteristics (Sadoulet *et al.* 1998).

4.5 The representative farm-household in Eastern Uganda

This section presents a model of a representative household in Eastern Uganda and it captures the essential features of short-term substitution possibilities. From field observations, rural households collect fuel-wood from the commons and own farms or buy from local informal markets. However, all households face both choices, and can therefore choose to collect, to rely on market purchase or to both collect and purchase, according to their valuations of their own labour opportunities. As mentioned earlier, these households employ hired labour on farms, but choose not to hire labour for fuel-wood collection.

This study tests the *a priori* hypothesis that households with easy access to fuel-wood are likely to respond to a marginal decrease in productivity by increasing time spent in collection, especially if the opportunity cost of that time is low. On the other hand, households facing fuel-wood scarcity and/or a high opportunity cost of time are likely to decrease collection activity and switch to other tasks. The model begins with a representative household assumed to maximize utility in each season. Here each season is considered separately, but to reduce clutter, seasonal subscripts are suppressed for discussion of the model.

According to Becker (1965), households produce commodities, Z goods, by combining inputs of goods and time according to cost minimization rules of the traditional theory of the firm. The Z goods are not marketable and enter directly into

[10] The recursive model would require that hired and family labour on the farm be perfect substitutes, and that there exist perfect markets for agricultural and fuel-wood products.

the utility functions of the households. Commodities are produced in quantities determined by maximizing a utility function involving a set of commodities subject to prices and a constraint on resources. The solution to this utility maximization problem is always for the household to situate itself on the highest indifference curve attainable, subject to its budget constraint (see figure 7). The budget constraint, however, assumes different forms, according to the market environment in which the household finds itself.

In this study, the theoretical model assumes a representative household that maximizes its utility function subject to a set of production, budget and time constraints. The study assumes a utility function:

$$U = U(X, E^C, T\text{-}L_s; A, Z) \qquad (1)$$

Where X represents the consumption of other market goods by the household, E^C is the quantity of fuel-wood consumed by the household, $T\text{-}L_s$ is leisure by household members where T is total household time available and L_s is total household labour supply which is the sum of household labour to different activities including collection of fuel-wood. A refers to the state of the environment or resource endowment and Z is a vector of household characteristics such as wealth, family size and composition and educational level of household members which may affect preferences. At a later stage, a distinction is made between adult male and female labour and girls and boys because of the gender segregation of labour in rural areas. For instance, from the field observations, women face extra tasks in household activities such as cooking and caring for children, which men do not.

The household faces the following constraints to their utility maximization:

$$E^C - E^G \geq 0 \qquad (2)$$

The energy (fuel-wood) consumption E^C may be purchased on the market or gathered from the forest or woodland, E^G. Collected and purchased fuel-wood are perfect substitutes in consumption. Equation (2) is a market environment constraint for

quantities of fuel-wood collected and consumed (Thornton and Eakin, 1992). It refers to households that are either buyers of fuel-wood (when the strict inequality holds) or those whose collections are sufficient to meet their needs (when the equality holds). Households are assumed to produce and consume their own products but can also purchase from the market. During the time of the survey, no households in the sample reported having collected surplus fuel-wood for sale on the market. Household's in the study area predominantly produced and consumed their own fuel-wood[11] because they considered it time consuming (costly) to collect fuel-wood both for their own use and for the market. All types of fuel-wood are measured in bundles and later converted to kilograms. There may be some controversy in the determination of what the appropriate size of the bundle is, but in this study an approximate standard bundle weighing about 15 kilograms is used.

The labour supply for fuel-wood collection constraint is:

$$L_{de} - L_{se} \geq 0 \qquad (3)$$

Where L_{de} is the labour demand for fuel-wood collection and L_{se} is the labour supply for fuel-wood collection. This equation refers to households self-sufficient in labour for fuel-wood collection when equality holds and those that hire labour when it does not hold. However, this is a simplifying assumption given that it is already known that households do not hire labour for fuel-wood collection; in principle, sellers of fuel-wood or labour for fuel-wood collection could also be accommodated in the model without changing basic results. This equation is the market environment constraint for labour (demand and supply) for fuel-wood collection (Thornton and Eakin, 1992).

The production function for fuel-wood gathering (E^G) is given by the function;

$$E^G = E^G(L_{de}, A, Z^v) \qquad (4)$$

Where E^G denotes quantity of fuel-wood produced (collected). Production of this type of environmental good depends on L_{de}, A and Z^v a vector of characteristics describing

[11] Personal communication with village opinion leaders and local council officials.

the state of the environment and access conditions such as topography and agro-climatic factors. L_{de} includes boys, girls and adult males and females. For example, some households contain people who work more energetically or are better suited to environmental good collection (middle aged women can collect more fuel-wood than can the aged and young girls). The more degraded the environment, the longer it will take to gather a unit of fuel-wood. Households in rural Eastern Uganda face different states of the environment and have differing household characteristics, and this may contribute to the variation of marginal products across households.

The household is involved in agricultural production using boys and girls, and adult male and female labour which may be hired or own labour. The household produces agricultural goods, Q_a, that it can also opt to purchase at price, P_a. If the household consumes less of its output than it produces, it may sell some of its surplus output at the same price, P_a. The household's agricultural production function is given by:

$$Q_a = Q_a(L_a^m, L_a^f, L_a^b, L_a^g, inp; Z^h) \tag{5}$$

This production function depends on adult male farm labour, L_a^m, adult female labour, L_a^f, boys, L_a^b and girls, L_a^g. In this formulation, as already explained in earlier sections, hired labour inputs and own household labour inputs are assumed to be imperfectly substitutable, although household male, female, boys and girls labour in agriculture may be substitutable. Production also depends on inputs in production, *inp*, such as livestock feed and manure. The stock of livestock owned by the household is taken as exogenous in this model. Livestock are considered as part of household wealth in this analysis. Finally, Z^h is a vector of household endowments pertaining to farming (land, trees and family workforce).

A non-negativity assumption for non fuel-wood consumption, leisure and for labour demand and supply, and fuel-wood consumption is made. Thus,

$$X \geq 0;\ T\text{-}L_s \geq 0;\ L_a^{m,f,b,g} \geq 0;\ L_s \geq 0;\ L_{de} \geq 0;\ L_{se} \geq 0;\ E^C \geq 0; \tag{6}$$

The amount of agricultural, environmental and other market goods that a household buys is constrained by the sum of income earned from the sale of agricultural goods, environmental goods, exogenous income plus wage income and non-wage income. The budget constraint is given by:

$$P_x X + P_e E^C = W_e L_{se} + (P_e E^G - W_e L_{de}) + P_a(Q_a - Q_h) + W_L + V \qquad (7)$$

The variables P_a, P_e and P_x refer to prices of agricultural products, fuel-wood and other goods respectively. W_e is the wage rate (opportunity cost) for labour collecting fuel-wood; the term $(Q_a - Q_h)$ denotes a household's marketable surplus of agricultural goods, which may be negative indicating that a household is a net buyer of agricultural products; W_L accumulates all wage income from labour they provide to both farm and non-farm activities outside the household and V is the amount of non-wage income (measured by remittances) to the household. The expression $(P_e E^G - W_e L_{de})$ represents non-labour income from fuel-wood collection. In this expression, the value of leisure from both sides of equation (7) and variables for men, women, boys and girls are left out for clarity of exposition.

One of the short-term substitution possibilities omitted in this framework is the possibility of collecting other fuel types such as dung and crop residues. In the course of this survey, such energy choices were seldom observed; thus, in order to keep the analysis simple, the study neglects this possibility and focuses on substitution through market purchases. The empirical grounds for this modeling choice are that, as stated before, purchases of fuel-wood not only represent a commonly available alternative to collected fuel-wood but also, insofar as such purchases can be funded through market work, they can be modeled as an integral part of the time allocation decision. As previously noted, the main alternative to collected fuel-wood appears to be purchased fuel-wood.

Substituting the production functions for environmental and agricultural goods into the budget constraint, (7), the household's Lagrange function for the problem may be written as:

$$Max\ £ = U(X, E^C, T - L_x; A, Z) + \lambda\{W_e L_{se} + (P_e E^G(L_{de}, A, Z^v) - W_e L_{de}) + P_a(Q_a - Q_h) + W_L + V - P_x X - P_e E^C\} + \phi(E^C - E^G) + \eta(L_{de} - L_{se}) \quad (8)$$

where ϕ, η and λ, are Langragian multipliers attached to the constraints (2), (3) and (7) respectively.

Assuming interior solutions, the first order conditions for the household choice can be derived subject to the revised budget constraint and non-negativity conditions. These conditions are:

$$\frac{\partial £}{\partial X} = \frac{\partial U}{\partial X} - \lambda P_x = 0 \quad (10a)$$

$$\frac{\partial £}{\partial E^C} = \lambda(P_e - \frac{\phi}{\lambda}) = 0 \quad (10b)$$

$$\frac{\partial £}{\partial L_{se}} = \lambda(W_e - \frac{\eta}{\lambda}) = 0 \quad (10c)$$

$$\frac{\partial £}{\partial L_{de}} = \lambda(P_e \frac{\partial E^G}{\partial L_{de}} - W_e) + \eta = 0 \quad (10d)$$

or

$$P_e \frac{\partial E^G}{\partial L_{de}} = W_e - \frac{\eta}{\lambda} \quad (10e)$$

along with the non-negativity equations and constraints (2), (3) and (7)[12]. These conditions provide the information necessary to determine the consumption demands for fuel-wood and other goods; the supply of labour for fuel-wood collection (supply of collected fuel-wood), agricultural work and employment. The results from these first order conditions are standard for household labour allocation models of this type. The general rule is that in equilibrium the ratios of the marginal products of various activities are equalized with the relevant price ratios. Because so many activities are

[12] Lopez (1988) assumes X is the composite commodity (numeraire) and its price, P_x is set equal to 1.

devoted to home production, in many cases the price of on-farm activities is the opportunity cost wage that could have been earned off-farm.

If P_e and P_x are interpreted as market prices, from the first order conditions and if the market environment constraints (2) and (3) are binding, the relevant prices for decision making by the household concerning fuel-wood are equations (10b) and (10c)[13] and not simply the market prices. From equation (10e), the value of marginal product of labour (left hand side of equation 10e) is not the same as the market wage rate, W_e, for collecting environmental goods. This implies that the value of the marginal product of labour can be used as a shadow wage.

The prices in parenthesis in equations (10b) and (10c) are referred to in the international literature as shadow or virtual prices. These prices are important in that they reflect the relevant opportunity costs and benefits a household faces in making utility maximizing choices. Households would therefore respond directly to shadow prices rather than market prices (Thornton and Eakin, 1992; de Janvry *et al.* 1991). The relevant shadow wages would be larger or smaller than the market prices of fuel-wood or wages for fuel-wood collection, depending on the signs of $\frac{\phi}{\lambda}$ and $\frac{\eta}{\lambda}$. In their study Sadoulet *et al.* (1998) show that there would be different shadow prices and wages depending on the level of household sufficiency in fuel-wood or labour supply. It would also depend on whether the household is a net seller or buyer of labour or a fuel type. The reasons for the differences in prices and wages would arise due to transaction costs in buying or selling fuel-wood or labour, and cultural values. Also, household preferences for family labour for efficiency reasons or due to limited employment opportunities could be the other reasons for the existence of different wage rates for a particular activity. Going by these assumptions, in this study, the market constraints in equation (2) and (3), would provide the shadow wages (prices), when equality holds. These shadow wages (prices) would be those that equate household demand to household supply. In this formulation, the multipliers λ, ϕ and η, which are directly determined by the solution to the constrained maximization problem, determine shadow prices and thus the shadow prices (wages) are considered

endogenous variables. In addition, if a commodity, in this case fuel-wood, is both produced and consumed by the household, shadow prices will be a function of both preferences and technology (Sadoulet *et al.* 1998).

In this formulation, because equations (2) and (3) are added, the budget constraint becomes non-linear. However, the budget constraint may be linearised at the optimum values of relevant prices if a convex budget constraint is assumed (Jacoby, 1993). Due to the absence of relevant market prices for hired labour for fuel-wood, this budget constraint will include shadow prices instead of market prices. If this is done, then the constraint to the maximization problem would be:

$$P_x X + P_e{}^* E^C = W_e{}^* L_{se} + (P_e{}^* E^G - W_e{}^* L_{de}) + P_a(Q_a - Q_h) + W_L + V \qquad (11)$$

Where $P_e{}^*$ and $W_e{}^*$ are the shadow price and wage for fuel-wood and fuel-wood collection, respectively.

If the above conditions are assumed to hold, and that second order conditions for utility maximization are satisfied, the relevant demand and supply functions from the first order conditions of equation (1) subject to the new constraint (11) can be derived. These functions for fuel-wood collection would therefore take the form:

$$E^C = E^C(P_e{}^*, W_e{}^*, V, A, Z) \qquad (12)$$

Generally, the model shows that fuel-wood collection and participation in household agricultural tasks is determined by the opportunity cost of time. This is the kind of situation that usually prevails in rural areas of Eastern Uganda given the nature of the family system. These equations form the basis of the empirical models presented in the next sections.

[13] Equation 10c also implies the transformation of leisure into labour supply for fuel-wood collection, and that is why L_{se} (labour for fuel-wood collection) is used instead of leisure.

4.6 Empirical strategy

The empirical model used in this study is derived from the theoretical framework presented in the previous section. The model focuses on the allocation of labour and its implementation gives rise to a number of issues which are presented in this section. From the theoretical discussion, each household maximizes utility subject to a production function, time and budget constraint and household or forest endowments. Ideally, as indicated in the theoretical analysis, households are considered as producers and consumers at the same time.

The discussion in the previous section highlights three objectives which form the basis of the empirical analysis. First, fuel-wood demand and supply is determined. Secondly, the effect of household and community level characteristics on decisions to collect fuel-wood or work on the farm is determined, and thirdly, a shadow value for household labour and fuel-wood prices is estimated. Clearly, what is important in attaining these objectives is knowledge of unobserved shadow wages/prices each household imputes for the time it spends collecting fuel-wood or on the farm. Several studies (de Janvry *et al.* 1991; Sadoulet *et al.* 1998; Singh *et al.* 1986; Thornton, 1994; Jacoby, 1993) suggest approaches for the determination of the shadow wage. These studies show how the shadow wage is determined within the household as a function of household preferences, technology and all other fixed inputs and market prices affecting household choices. They estimate the shadow wage from a production function.

The above approach based on these three objectives which was also used by Skoufias (1994) is adopted in order to estimate the shadow wage using a production function approach. This consists of more or less the same three main stages. First, a production function for fuel-wood with family labour and a series of household and community level characteristics as inputs is estimated. Second, based on the estimated parameters of the production function, the corresponding marginal products or shadow wages for family labour are derived, along with an estimate of shadow prices for fuel-wood. Third, the derived marginal revenue product of labour or shadow wage is then subsequently used in estimation of determinants of time spent by the household on

fuel-wood collection. In the case of labour allocation to the farm, actual market wages rather than shadow wages are used.

4.6.1 Estimation of fuel-wood production (collection) functions and shadow wages (prices)

The first task in going from a theoretical to an empirical model is to specify forms for the production and demand functions in order to obtain estimates of the marginal product of labour that are specific to the household. In the model presented below, production technologies are specified based on theoretical equation (4) in the previous section of this chapter. More complicated functional forms are possible and can be incorporated into the model, data permitting. In this approach estimable equations for the opportunity costs of labour and for household fuel-wood collection can be developed (see Amacher *et al.* 1996). This approach also provides a useful empirical framework for distinguishing between the determinants of labour allocation in a non-separable model of the farm household.

In the estimation of the total production/collection functions, the factors influencing the amount of fuel-wood collected by the household are determined. The Cobb-Douglas production function is specified as:

$$\ln Y_h = \ln P_h \beta_h + H\ \alpha_h + D_h \delta_h + \varepsilon_h \qquad (13)$$

where $ln\, Y_h$ denotes the total output of fuel-wood produced (consumed) by household h, the vector P_h denotes the quantities of inputs used by household h suggested by the theoretical model, D_h represents household demographics, that is, household composition effects on fuel-wood collection such as the number of adults and youth separated into males, females, girls, children and boys; H is a dummy variable used to explain differences that may arise from factors other than the availability of fuel-wood such as agro-ecological factors or location, that is, the quality of the environment; β_h, δ_h and α_h are parameter vectors and ε_f is the error term summarizing the influence of all other variables not specified here.

The production (collection) function estimated in equation 13 above is then used in the determination of the marginal products of labour, which are treated as shadow wages. In practice, an estimate of the shadow wage rate can be obtained from the marginal productivity of family labour in the production of a commodity. Following the approach used by Jacoby (1993), Skoufias (1994) and Mekonnen (1998), the marginal product of labour is computed as the product of labour input elasticities and the ratio of predicted quantity produced to time spent. This is specified as follows:

$$MP_h = \beta_h * \left(\hat{F}_h / L_h \right) \qquad (14)$$

where MP_h is the marginal product of fuel-wood collected by household h, L_h is the labour time household h spends to collect fuel-wood, β_h is the parameter estimate for the variable L_h, and $\hat{F}_h$ is the predicted quantity of fuel-wood collected by household h.

Once the shadow wages have been estimated, they are matched with time allocation data, household demographic variables and other variables in the theoretical model in order to estimate the fuel-wood demand functions. The estimated shadow wages are household specific because it is expected that in the absence of hired labour, the shadow wage rate would be a result of the household's attempt to equate supply and demand for its own labour and this depends on household characteristics and resource endowments.

However, before estimating the demand function for fuel-wood, further explanation is needed on two issues that may arise. First, an important parameter from the theoretical model is the market price of fuel-wood. As indicated earlier, fuel-wood in the study area was collected almost exclusively for own consumption and even then, the existing fuel-wood markets in the study area are "thin" and highly localized. This implies that market prices for fuel-wood may not accurately reflect the extent of fuel-wood scarcity faced by the household, especially for those not involved in the fuel-wood market. Moreover, even though there is some trading of fuel-wood at the closest trading centres, a majority of households in the study area are not involved in the

market. However, saying that market prices may not reflect scarcity of fuel-wood for households should not mean that fuel-wood is not economically scarce. It simply means that alternative measures (shadow price) which are more specific to the household, should be used. Theoretically, this means that for a majority of households, the shadow price will not equal the actual market price.

Given this shortcoming, an alternative measure of this price that is specific to each household; that is, a shadow price[14] must be found. The shadow price is derived by using a combination of the time it takes to collect a unit of fuel-wood and the shadow wage. The justification for this selection is that time is a main resource that households have and its availability is the main variable that they use in their decision to collect or not. Therefore, the time they spend per trip should be a good indicator of how difficult it is for the household to get fuel-wood and hence it is an essential component in the computation of the shadow price for fuel-wood (Dasgupta and Maler, 1995). The shadow wage is then multiplied by the time per trip in order to measure the relative costliness of environmental goods to a household (shadow price). Collection difficulty and the time per unit of fuel-wood collected are assumed to increase with environmental degradation. This implies that when other factors are held constant, the longer it takes to collect a unit of fuel-wood or the higher the opportunity cost of labour used, then the higher the cost of collecting fuel-wood. None of the households in the sample used alternative fuels for cooking thus there is no need to account for prices of substitute energy sources.

The second issue is that in the sample, some households reported non-collection of fuel-wood and therefore do not have measures of shadow prices that are comparable to the ones used for the collectors. Approximately 6 percent of the households did not collect fuel-wood in the sample. For missing shadow prices for non-collectors, average shadow prices of fuel-wood are used on the basis that if those prices are missing, it is much safer to take on average values in their absence. With respect to missing values for the shadow wages of households that do not collect fuel-wood, it is expected that the non-collecting households have an opportunity cost of labour higher

[14] Note that the measure of shadow prices and wages is household specific since differences are expected across households in terms of shadow wages and time per trip for various reasons, including household composition and resource endowment.

than that of collectors. For this reason, the maximum shadow wages for the collectors is used as a measure of shadow wages for the non-collectors (see Mekonnen, 1998). This expectation is based on the argument that they would have collected it if it had not been so and that these households have almost similar characteristics (see Chapter 5).

After determination of shadow wages and prices, structural forms were estimated using a Two Stage Least Squares (2SLS) approach with all the labour categories being included as independent variables in the regressions of the other labour supply variables. This approach helps to control for endogeneity of the shadow wages (prices) and fuel-wood demands for the wet and dry season were estimated.

There are several advantages of using time-use methodology in economic analysis (Skoufias, 1994). First, it can provide a window into actual lifestyles, thereby permitting a rich, objective and replicable basis for empirical judgments. Secondly, this methodology can generate invaluable information for understanding human behaviour problems and be used to guide planning and policy development. However, a major disadvantage is that there are serious recall problems experienced in data collection.

Similarly, there are several advantages of measuring collection productivity using time. In related studies, Adhikari *et al.* (2004), Ilahi and Jaffery, 1998, Cooke (1998a) and Mekonnen (1998) used the time needed to collect a standard head load (measured in kilograms) of wood as a proxy for scarcity. They found this a better indicator of opportunity cost than measures which show amounts of deforestation using area specific indicators such as degradation per square kilometer or some exogenous measure of the stock of forest resources. Besides, good and reliable measures of forest area and quality are not available in Uganda, making it practically difficult to use area instead of time or distance.

Instead of using collection time, Ilahi and Jaffery (1998) use an alternative approach, the round trip community distance to the source of fuel-wood is used as a proxy for productivity. In this approach, they assume that cluster distance avoids both the respondent error problem and the censoring problem associated with the hours per

kilogram variable. However, the authors recognize that this approach is also prone to some drawbacks. First, there is a possible problem of endogeneity; that is, the household may have located itself based on proximity to sources of fuel-wood. Secondly, because the study covers a variety of geographical areas (high and low altitude) the distance measure could be compromised by the heterogeneity of the terrain. For example, a kilometer traveled to fetch fuel-wood in a hilly terrain may represent significantly greater time costs than the same distance traveled in the plains. The latter problem could turn out to be more severe in the highland districts of Mbale and Kapchorwa, meaning that the distance measure may be greatly compromised.

At the onset, it should be realized that it may not be easily possible to use distance as a proxy because the estimation of distance is more prone to errors than estimation of time. Therefore, the preferred option is to use the return trip time as a proxy for deforestation. The time required for the household to collect a unit of fuel-wood including finding, extracting, processing and transporting fuel-wood from the forest to the village is used. In these areas, it is expected that growing of private trees is too limited to have a significant effect on collection activities from the commons, although households are likely to shift to private trees as deforestation becomes more severe. At the household level, the use of time per unit of fuel-wood collected is likely to be a better indicator of the opportunity cost (and one that will increase as deforestation increases, given the stable pattern of habitation) than an area-specific measure of forested land.

4.6.2 Estimation of labour allocation to fuel-wood collection and farming activities

To explain the determinants of household labour allocation to fuel-wood collection, the production (collection) function for fuel-wood should include both collectors and non-collectors. Since men, women, boys and girls are involved in collection activities, time spent by each of them is recorded separately. The estimation of the collection function was done using household level data but disaggregated for the different categories. This is because it is assumed fuel-wood is consumed at the household level and so the individual observations from the questionnaire were aggregated by gender and age group at the household level (see section 3 in the questionnaire). Due

to the limited number of observations, time spent by boys and girls was aggregated for the regression analysis (see also Adhikari *et al.* 2004). The theoretical model discussed earlier in this chapter suggests the inclusion of among others, shadow wages and shadow prices as endogenous variables in the labour model for fuel-wood collection and these are household specific (see also equation 12). Other variables included are labour income and non-labour income. For real non-labour (unearned) income, annual remittances from children and relatives working away from home are used. For labour (wage) income, daily wage rates earned by household members when they work outside the farm are used. This distinction may reflect differences in labour availability and returns to labour not related to fuel-wood collection. The econometric model to be estimated for fuel-wood collection activities therefore takes the following form:

$$E_{fi}^{t,w,m,y} = a_1 W_e^* + a_2 D_i + a_3 V_i + a_4 L_i + a_5 F_i + {}_5 W_i + a_6 H_i + u_i \qquad (15)$$

In this formulation equation, E_f is the total time per week in fuel-wood collection for household $i=i(1,2,3...n)$, while t, w, and y represent total, women, men and youth[15] (boys and girls) categories respectively. W_e^* is the shadow wage, D_i stands for the household demographics and composition, F_i is the ownership of land by the household, V_i is total household off-farm income, L_i and W_i are household farm time and water collection variables, respectively, and H_i is the dummy for agro-ecological characteristics. The a_i's are the unknown coefficients that measure the effects of the respective variables on E_{fi}, and u_i is the error term. Some variables, including shadow prices and wages, wage and agricultural income, household head's educational level, household size and remittances, were estimated in log form. The advantage of log transformation is that it helps reduce heteroscedasticity and also enables us to interpret the coefficients directly as elasticities.

Broadly, a few expected results from this estimation are explained. Family composition is expected to influence fuel-collection positively, both because of increased energy demand (for example, for cooking) and because of increased supply

[15] The analytical discussion suggests boys and girls are participants in fuel-wood collection and farm activities. Unfortunately, due to limited observations for each category as boys and girls, they were aggregated into a single 'youth' category for regression analysis but not for the descriptive analysis. Thus, it was not possible to include separate regressions for boys and girls but instead 'youth' was used in the estimation of collection equations.

of labour for collection and other activities. More fuel-wood is expected to be collected during the wet season given the extra heating needs, depending on site location (highlands or lowlands). Higher non-labour income reduces dependence of households on fuel-wood collection and hence reduces pressure to collect. Also higher labour income tends to reduce households' participation in fuel-wood collection by facilitating their purchase of fuel-wood. Educated household heads are less likely to collect and consume fuel-wood due to substitution possibilities for these households. Shadow wages are expected to have negative effects on collection/consumption of fuel-wood. Table 4.1 below provides a description of the variables used and their expected signs.

Similarly, in order to explain the possible association between deforestation and household labour input in farming, the following farm labour input equations are estimated:

$$L_i^{t,w,m,y} = a_1C_i + a_2D_i + a_3Y_i + a_4V_i + a_5T_i + a_6W_i + a_7H_i + u_i \qquad (16)$$

In this formulation equation, L_i is on-farm person time per day for household $i=i(1,2,3...n)$, while t, w, m and y represent total, women, men and youth[16] (boys and girls) categories respectively. C_i is the proportion of land area under crops, D_i stands for the household demographics, Y_i and V_i are on-farm and off-farm income respectively, T_i and W_i are the deforestation (time per trip) and water collection variables, respectively. H_i is the dummy for agro-ecological characteristics. The a_i's are the unknown coefficients that measure the effects of the respective variables on L_i, and u_i is the error term, presumed to have no correlation with the respective explanatory variables and to have the usual properties for ordinary least squares (OLS) estimation. Finally on estimation issues, since the dependent variable is continuous (labour input to farming in hours per day), the ordinary least squares (OLS) technique was used for the total equations because all households in the sample reported positive time on the farms. A detailed list of variables, with their definitions, means, standard deviations and indication of expected effects is provided in Table 4.1.

[16] Although the analytical model suggests boys and girls are major participants in on-farm activities, due to limited observations for boys and girls as separate categories, they were they were aggregated for regression analysis but not for the descriptive analysis.

Table 4.1 Variable definitions, means, standard deviations and expected sign on fuel-wood collection and farm work

Explanatory Variables			Std	Exp. Sign	
Variable	Definition	Mean	Dev.	Fuel-wood	Farm Labour
Boys	Number of boys aged 6-14	1.05	1.05	+	+
Girls	Number of girls aged 6-14	1.14	1.16	+	+
Men	Number of adult men (>14 years)	1.67	1.08	+	+
Women	Number of adult women (>14 years)	1.69	0.98	+	+
Children	Number of children below 6 years	1.19	1.18	+	?
Household size	Number of people in household	6.76	2.98	+	+
Heads education (yrs)	Number of education years of head	8.04	4.60	-	-
Agehh	Age of household head	8.04	4.60	+	+
AgeSQ	Age of household head squared	43.35	13.56	-	-
Marital	Heads marital status (1=married; 0=No)	0.88	0.31	?	?
Highlands (Hi)	Agro-ecological zone (1=Highlands;0=Lowlands)			?	?
Livestock	Number of cattle owned by household	5.99	6.34	?	?
Agricultural income (Yi)	Log of income from sale of products from one's own farm (in shillings per month)	11.38	0.97	-	-
Wage income	Log of income from off-farm employment (per month) (Ri)	6.68	0.43		-
Shadow wages	Opportunity cost of time	0.48	0.04	-	
Shadow prices	Proxy for price of wood	97.4	51.49	+	
Remittances	Total amount of remittances to household in Shillings	10.26	1.57	-	-
Crop area (Ci)	Proportion of land area under crops in acres	1.16	0.64	+	+
Hired workers	Household hired workers (1=YES; 0=No)	0.51	0.50	-	?
Fuel-wood collection effort -Ti)	Time per trip of fuel-wood (hours/per trip)	8.82	10.56		-
Water collection time	Time spent by household collecting water per day	0.76	0.90	-	-
Left hand side variables (Li) Fuel-wood Collection					
Fuel-wood per week	Quantity of fuel-wood consumed per week in kilograms	75.09	79.20		
Total collection time	Total time spent by household collecting fuel-wood	8.82	10.56		
Women's collection time	Time spent by women collecting fuel-wood	5.67	6.84		
Men's collection time	Time spent by men in collecting fuel-wood	1.07	3.56		
Girls collection time	Time spent by girls in collecting fuel-wood	1.36	3.79		
Boys collection time	Time spent by boys in collecting fuel-wood	0.72	2.95		
Farm work					
Total farm labour input, t	Total household labour input to farming (hours per day)	10.96	7.06	-	
Women's farm labour input (w)	Women's farm-labour input to farming (hours/day)	3.61	3.36		
Men's farm labour input (m)	Men's farm-labour input to farming (hours/ day)	4.20	3.39		
Boys farm labour input(b)	Boys farm-labour input to farming (hours/day)	0.98	2.08		
Girls farm labour input (g)	Girls farm-labour input to farming (hours/day)	1.15	2.14		

Like any other econometric model, it is important to discuss some limitations of these models. First, all household farm-models discussed thus far assume preferences and incomes are shared by all household members. Although this assumption is convenient, it obviously represents a simplification of the real world, in which individual interests of household members may diverge and all incomes and activities may not enter into a "common pot". The critical issue here in terms of the choice of model is not whether the models discussed present simplifications of reality, but rather, what are their costs, in terms of explanatory power and potential prediction bias when compared to alternative behavioral equations for each household member and a more complex model of joint decision making. Modeling such situations requires new data (particularly related to individual specific transaction costs) as well as theoretical and econometric extensions of household farm models. Therefore, the modeling framework presented in this chapter could be extended to consider these issues, but data do not permit such extensions.

Thus, even though the model may have simplified the real world situation, it does incorporate critical elements which give rise to some of the most significant relationships existing in Uganda. The limitation of simplicity of the model may be overcome by the fact that the model incorporates more aspects that affect farm-household behaviour such as seasonality, agro-climatic and sociological problems of household size, education and composition, and the nature of Uganda labour and fuel-wood markets.

4.7 Conclusion

The farm-household model developed in this chapter brings out the importance of a non-separable model in the analysis of farm-household behaviour in Eastern Uganda. Using the foundations of Becker (1965) and Low (1986), the model adopts a quantitative approach to the analysis of farm behaviour and has been modified to include a number of variables such as seasonality, gender, and household composition, some of which could not be easily integrated in the Low model (see Low, 1986;44-46). Two model specifications are considered: a perfect market classical model is one which markets exist for all products including land and labour, and a missing market scenario, where some markets are missing possibly due to high

transaction costs and inefficiency of markets. Rural Uganda is characterized by subsistence production with some households producing little or no surplus for the market. If a household lacks markets for either labour or some of its products, it is forced to be self-sufficient in staples and fuel-wood, and production and consumption decisions are guided by a subjective valuation of staples, or "shadow prices". The non-separable model developed here is a static model and is applicable to the Ugandan situation where there are missing markets for fuel-wood, and in some cases also for labour, including that needed to collect fuel-wood. The goal of this framework has been to develop an empirical model of subsistence agriculture for Uganda. The analysis in the subsequent chapters is therefore confined to the assumptions upon which the non-separable model is based and testing the implications of the model in relation to farm-household behaviour in rural areas of Eastern Uganda. Before implementing the empirical models, the data sources, sampling methods, descriptive statistics and results of focus group discussions held in the study area are presented.

Chapter 5

The study setting: Survey, data and descriptive results

5.1 Introduction

In this chapter, a discussion of the survey design, data collection procedures and a description of the study area are presented. These data are based on a survey conducted in rural areas of Eastern Uganda and focus group discussions with various communities in the area. Data collected was on household time use, wage and non-wage income, and individual, household and community level characteristics.

Figure 8. Map of Uganda showing study area

5.2 Data collection

5.2.1 The household survey

The development of the survey instrument is perhaps the most important aspect in a study of this kind[17]. If the process of data collection is to be successful, then it is critical that the process involved in undertaking the study be understood, tested, and improved. This section details how the study was conducted and developed.

The initial phase of this study involved a rapid appraisal of the village households living in the study area. This pilot was later used to identify the sample population, establish the appropriate cultural protocol and clarify logistical details required for the main survey[18]. The survey instrument was fashioned around theoretical considerations and the pilot study. The questionnaire was translated from English into the four major local languages spoken in the selected districts, namely; Ateso, Lumasaba, Sabiny and Japadhola. Subsequently, the local language versions were back translated into English to verify the accuracy of the translation. The questionnaire was refined and critically examined for language related flaws with the help of an expert[19] group and for cultural flaws with the help of local informants. The questionnaires were pre-coded and interviewers trained to use both the local language and English version of the questionnaires. Based on consultations, the questionnaire was shortened and modified to ease comprehension, to lessen respondent fatigue, and to reflect local words employed for key concepts such as natural resource degradation.

The most critical and useful step in developing the questionnaire was the pre-test of the survey instrument, which was administered to 10 households. The pre-test motivated several additional changes in the questionnaire. The codes and conditions used in the questionnaire were revised. The pre-test also served as a further training session for the interviewers, and helped the interviewers better understand key aspects

[17] Funding from Makerere University and African Economic Research Consortium is acknowledged and appreciated.

[18] Many of the villages are isolated and could only be reached by walking for several hours. Letters had to be hand delivered in advance to the local council officials seeking permission to conduct the survey.

[19] The expert group who reviewed the questionnaire included staff from the Institute of Social Research at the University of Michigan, USA and Makerere University, Uganda.

of the survey. Thus, the final survey instrument was significantly different from the original and reflected input from experts, survey administrators, and local villagers.

The questionnaire (see Appendix 1) was divided into 5 main sections. Section one focused on the household roster. It collected information on general household composition and characteristics such as relationship, age, gender, marital status and education. The next section focused on housing characteristics such as type and ownership of dwelling, access to water and sanitation. Section three focused on household energy sources, time use and forest conditions while section four collected information on agricultural activities, land use and ownership, inputs and outputs. The last section focused on regular activities of household members above seven years of age. These included both farm and non-farm income generating activities. As can be seen from the survey instrument, information collected covered both individual and household level aspects. Using focus group discussions, at the community level, information on village level characteristics such as village environmental history, wages and prices of commodities was collected. Supplementary information such as national and community level changes of forests and the National Forest Policy was obtained from the Uganda Bureau of Statistics (UBOS) and the National Biomass Study (Ministry of Lands, Energy and Natural Resources).

Data on household time allocation were obtained by setting up a series of recall instruments geared at specific activities being measured. Since two survey rounds were made, it was possible to obtain some ideas about the seasonal pattern of time allocation. However, a major limitation, as in many surveys, has been the recall problem. The recall period was limited to one week because unlike water, fuel-wood is not collected on a daily basis in many households. Experience suggested that households could not easily recall the number of trips and quantities over periods longer than a week and this caused a potential measurement error problem. Coupled with this was the problem of illiteracy. Some respondents did not know how to tell time and so were inclined to guess responses. However, the interviewers were asked to verify such information from the neighborhood or use the community level findings as benchmarks.

Eight carefully selected enumerators with knowledge of the local languages and of data collection conducted the household interviews. They were selected from undergraduate students of Social Sciences at Makerere University. The enumerators underwent two weeks of training on modes of survey administration and were guided through the process of household selection. For reasons of practicality as well as personal security, each field interview team consisted of two persons – one man and one woman – who also facilitated the separate interviewing of the household head or the spouse through same-sex interviews. The enumerators were supervised on a weekly basis and data from the questionnaire were reviewed and returned to the enumerators for clarification or correction usually within 2 to 3 days of each interview. Local council officials were used to identify the households, communities and also introduce the enumerators.

The survey was conducted in the rural areas of four districts in Eastern Uganda, namely; Kapchorwa, Kumi, Mbale and Tororo. The four districts differ in several aspects including geographically and climatically (see Appendix 3). Mbale and Kapchorwa districts are located in the highlands and belong to agro-ecological zone 1, while Kumi and Tororo are located in the lowlands and belong to agro-ecological zone 3 according to the National Biomass Study (2002) classification. The agro-climatic zones differ in temperature, precipitation, elevation and agricultural characteristics. Altitude is higher in agro-ecological zone 1(several mountain masses of about 4,000 meters in height above sea level) and the area receives more than 1,500 millimetres of rainfall annually. These areas produce temperate zone like crops for example, wheat, iris potatoes, bananas and Arabica coffee. Agro-ecological zone 3 is characterized by semi-moist lowland Savannah (standing at about 1,500 meters above sea level) areas with low mean annual rainfall of about 800 millimetres. It is characterised by short grass and growing of cotton, millet and sorghum. Thus, agro-ecological zone 1 is higher, wetter, cooler and consequently more fertile.

The agro-ecological zones also differ in terms of infrastructure. Road transport and markets are relatively easily accessible in Kumi, Tororo and some parts of Mbale. The terrain in Kapchorwa makes road transport more difficult. Also, because the highlands are more fertile, there are differences in resource stock, agricultural opportunity costs for labour, poverty and household fuel-wood consumption. For instance Mbale and

Kapchorwa districts are the leading producers of Arabica coffee in Uganda and also support a variety of other crops such as wheat, maize and bananas while Kumi and Tororo typically produce food crops and rear livestock. There may also be demographic distinctions between these geographic areas. For instance, Mbale is said to have among the highest fertility rates in Uganda while Kumi has among the lowest rates[20].

Households were selected from the sample frame through a stratified random sampling procedure. The Eastern region has 14 districts and these were split into two strata, highlands (agro-ecological zone 1) and lowlands (agro-ecological zone 3). From each of these strata, two districts were randomly selected. A multi-stage sampling procedure was adopted. From each of the four selected districts, a random sample of two counties was selected. From each of the two selected counties, a random sample of two sub-counties was chosen and two villages were then randomly chosen from the sub-counties[21]. The sampling frame consisted of villages in the selected sub-counties. From each village, between 6 and 15 households were interviewed. This was considered to be fairly representative of the village (the national household surveys use about 10 households per enumeration area - village). This kind of sampling was done to cover variations in altitude, access to roads and markets, tribal groupings and degree of deforestation. The village that was used for the pre-test was not included in the final survey. A total of 418 households were interviewed in 32 villages.

Data were collected through two separate sets of interviews. The first round was conducted during the wet season in the months of September to November (2001) and the second round was conducted in the dry season in the months of January to March of 2002. This was designed in order to capture seasonality in household activities. In an effort to obtain both lowland and highland agricultural characteristics in the survey, almost equal numbers of households were interviewed in each district. Each of the surveys covered about 208 households - approximately 52 selected from each of the four districts. The enumerators were the same during the two visits and this was

[20] See UBOS 2002 and 2003 (draft population census results)
[21] The number of counties per district and sub-counties per county in Uganda vary from two to five while the number of villages per sub-county is more than five, in most cases.

useful for purposes of consistency and the development of a well functioning questionnaire. Although, ideally, data on the same set of households would be necessary for this study, different households were visited during the two visits for two major reasons, logistical[22] and attrition problems.

Given that the survey was conducted over two rounds, it is necessary to show that the two sets of households sampled look the same on all aspects except those that are determined by seasonal factors. The statistical difference of means test was used to show that the distribution of these variables were the same across the dry and wet season. All variables were statistically comparable, indicating that the two samples were representative and not biased by sampling problems[23]. Detailed results are presented in Table 5.1. To ensure that seasonal impacts were not interpreted as household impacts in disguise, the analysis was performed with "dry" and "wet" season distributions.

After obvious problems such as duplicates and incomplete questionnaires had been sorted out, the data were entered into an SPSS database and later converted to the STATA software package. Other data discrepancies and coding problems were identified and cleaned using a manual correction procedure. The next cleaning stage was undertaken during preliminary data analysis, which checked for consistency between data files and observations, and for missing values.

At the time of the survey, government was restricting transportation of timber products to areas outside the respective districts. However, it was observed that the ability of the Forest Department to enforce this restriction was very weak. In districts like Kapchorwa and Mbale (the Mt. Elgon forest reserve), there have been recent conflicts between government and squatters on forest reserves. These conflicts have sometimes led to violent clashes between government security workers (especially forest warders) and the local populations. Whereas government insists on protection of forest reserves, the local inhabitants are in dire need of extra farming land and fuel-

[22] The most pronounced problem was that some households were not willing to give information for the second consecutive time; they demanded some financial reward which was logistically difficult.
[23] All variables tested (*ttest*) returned P-values greater than 0.10, indicating variables were not statistically different.

wood due to increasing population pressure. In the lowlands, informal village institutions have attempted to enhance the rules of collecting only dry and fallen wood. However, field observations suggest there are serious violations since some areas have come under increasingly intense tree cutting by "powerful" people in the districts. Such asymmetries in social power are demonstrably leading to over exploitation of forest stocks. Whereas this is recognized as a serious problem in Uganda, the analysis in this study ignores it as there is limited or no data to capture such effects.

5.2.2 Focus group discussions

While the survey was being conducted, focus group research was under way with the help of trained facilitators from Makerere University. Focus group discussion is a semi-structured interview in which a trained facilitator guides between 5 and 15 participants through a series of related topics to discuss their opinions and the thinking and experiences that shape these positions. The facilitator worked through the issues raised in the guide (Appendix 2) using probe techniques or additional questions to encourage discussions as well as the deeper explanations and the expression of alternate or contradictory views. Due to limited resources, only two focus group discussions were conducted in the study area. One in the highlands (Kongasis County in Kapchorwa district) and the other in the lowlands (Bukedea County in Kumi district). Calder (1977) recommends that when "trying to get someone's perspective" only a few groups are necessary if there is a high degree of moderator imposed structure. The two group discussions were purposively located in the highlands and lowlands to ensure that a broad range of agro-ecological and socio-economic contexts was covered.

The purpose of focus group discussions was to validate the information collected from the household survey and to provide complementary information where necessary. The sessions consequently centered around the use of natural resources, the levels of degradation, time use, farming, awareness of government structures dealing with environmental degradation problems, the knowledge of alternatives to fuel-wood use and the socio-economic effects of natural resource degradation. The groups' members were selected carefully and randomly with the help of the local councils, reflecting the

socio-economic setup of the area. These members included community elders and leaders, school teachers, local men, women and the youth. Members of the focus groups were invited by the researcher and local council leaders, but participation was entirely voluntary. Before the discussions, the research team was in contact with the participants to ensure participation. The discussions were held near the local council offices in the area. However, not everybody invited turned up for the discussions. The lowest participation was that of the representatives of the academic sphere, mostly school teachers who live in these rural areas.

Each focus group discussion was designed and moderated by the principle researcher and a facilitator. To preclude the introduction of bias into the discussion, the facilitator had no formal association with the project. The list of discussion questions was given to the facilitator a few days prior to the scheduled discussions. Conversations consisted of dialogues among participants and comments directed at the facilitator. Sessions typically lasted between two and three hours. At the conclusion of each discussion, the researcher and facilitator reviewed the discussion and notes.

Analysis of the focus group data is supposed to follow a prescribed, sequential process that is verifiable and that permits researchers to arrive at similar conclusions. Analysis begins with the original intent of the study. As Krueger (1988) suggests, if the study is narrow, then elaborate analysis may not be necessary. However, it is important to consider the analysis as a continuum consisting of raw data (statements made by the respondents), description (summary statements of the respondents' comments), and interpretation (building on the summary statements and presenting the meaning of the data). However, it should be noted that the focus group discussions were not meant to stand alone in this analysis, but rather to compliment the quantitative analysis from the survey data.

After the focus group discussion notes were transcribed, the transcripts were reviewed for similar ideas and themes. In the analysis of the discussions, thematic issues were identified. The themes natural resource degradation, farming and fuel-wood scarcity, which are highly important from the aspect of this study, were highlighted in every group discussion. As Morgan (1988) shows, a theme is verified when two or more

groups include it in their discussions. In the next section, the findings of the focus group discussions are presented and discussed.

5.3 Focus group discussions: Analysis of natural resource degradation and household activities

The use of focus group discussions proved valuable in this study. Participants knew their various fields well and raised important issues. Most participants in the group discussions were from families which had lived for several generations in the communities in which they were interviewed. They were familiar with the changes occurring in their environment and were surprisingly good at analyzing the practices affecting their natural environments. At the same time, participants were rather skeptical about the possibility of restricting natural resource exploitation, but proposed measures that, applied step by step, could help control degradation of the resource. Insights were gained about (1) how farm households perceived the problem of natural resource degradation (2) how the public perceives the changes occurring in the farming sector (3) potential solutions to resource degradation problems in these areas.

The focus group discussions opened with the moderator requesting participants to identify problems affecting their natural environment. As expected, most participants unanimously rated over-exploitation and poor control among the biggest problems. Some participants believed that the state of the environment was worsening and that there was no serious effort to abate this situation.

> *Conditions are worse than they were twenty years ago. Our area has suffered from destruction of the natural environment for a long time. I'm really worried. But what can I do? I have to survive and earn a living from these resources which God has given us (Ojangole 45-50 years, interviewed in Kumi).*

> *It takes a long while to get to the fuel-wood sources these days. People have to climb many hills before they can get to fuel-wood sources. Sometimes even if the fuel-wood is near your home, everybody is targeting the same fuel-wood and many times it is not dry enough to provide good fuel. Everybody needs fuel-wood so we have to share the little that is left in the woodlands. (Chebet, female - Kapchorwa district)*

Land and trees used to be plentiful in the rural areas of Eastern Uganda. Thus according to the focus group discussions, households were self-sufficient in agricultural and fuel-wood products. However, the socioeconomic and political changes that have occurred in the recent past, such as increases in population growth and the need for more farm land due to population pressure and economic gain, have led to the clearing of trees on- and off-farm lands. Though the magnitude of charcoal burning was not clear, it was cited among the major causes of high deforestation. Fuel-wood prices and forest product availability have been affected by rising energy needs, slow rates of tree growth, poor forest management. Participants realize that, to survive, they must participate in gathering of forest products considerately.

Focus group participants expressed concerns that the slow pace of intervention by the relevant institutions would worsen the problem. The picture emerging from the group discussions was one of very loose formal management. Some branches of the literature suggest that this will lead to poor performance and high degradation. Indeed, the National Environment Management Authority (NEMA) ranks Eastern region as one with the highest degradation and with complications in control over resource use. Most of the participants in the focus group discussions agreed that the system of management was unclear[24].

> *In the past because land was plentiful, wild fruits were freely available and water and fuel-wood were accessible almost anytime. Nobody really worried about these natural resources. Today, everything is getting scarce. Even then, anybody can go to the woodlands and cut down a tree, nobody cares. If this condition continues, total destruction of these resources will come to our area. (Nambafu 70-75 years, Kapchorwa)*

Participants' perceptions of the importance of conservation and the consequences of degradation were fascinating. Natural resource degradation was frequently brought up in the discussion, as were suggestions on how the local government could control it. Participants in these focus group discussions appeared frustrated with what they viewed as lack of commitment by the authorities to control over-exploitation of

[24] Some participants with this view include Chemonges (Local council chairman), Ojangole James (Clan leader-Kumi) and Mafabi Mike (Kapchorwa) to mention but a few.

natural resources especially forests. They cited cases of high level persons in the society who cut down trees indiscriminately for personal gain.

> *One thing that causes disappointment among the people is the lack of the rule of law. People come here with trucks and chain saws, cut trees and just ferry the wood away. There should be some laws applied. (Chemonges, Local Council 1, Chairman, Kapchorwa)*

Most participants thought they would definitely not be penalized if they cut down trees from the commons for their own personal gain. Virtually all reported that they did not need any permission to collect fuel-wood and other forest products from the commons. Simply being a member of the community was sufficient for access.

An indicator of poor management may be the lack of participation by the villagers. As elsewhere in the developing world (see for example Khumar, 2002 and Nightingale, 2002), few participants thought they had influence on the management of the commons. Interestingly, despite the lack of formal controls, a few participants thought that the local council officials and villagers themselves monitored forest extractions. Most of the respondents felt that other villagers would not be happy if one person took too much fuel-wood from the commons. However, a minority thought that they could loose forest product privileges if they were caught over-exploiting the commons.

The effects of natural resource degradation on households and household activities were raised in these discussions. The participants in the focus group discussions believe that even though the conditions haven't turned severe enough so as to have them fail to obtain fuel-wood for cooking, fuel-wood scarcity is affecting the daily life of the collectors. However, a minority indicated they had ever gone without a meal due to lack of fuel-wood in the household. The groups identified the collectors of fuel-wood as mainly the women and girls, although the men and boys come in to help in situations of acute shortage or when fuel-wood is cut during the process of clearing the *shambas* (gardens). None of the participants indicated that they had left farming in order to go and search for fuel-wood or water. However, participants did concede that there were sometimes in the year, especially the planting season when fuel-wood is

scarce and therefore either all of them participate in its collection or the collectors spend longer periods searching for fuel-wood.

In connection with the household farming and water collection activities, the participants acknowledged to some extent they have to gather fuel-wood as they farm. Most participants were emphatic regarding the positive links between resource degradation and scarcity of environmental products experienced in their societies today. However, some focus group participants could not directly relate the problems of natural resource degradation to the activities in their households.

> *Women and girls go to search for fuel-wood sometimes immediately after lunch. They only return in the evening when the boys are bringing back the herds from grazing (Okalebo, Kumi).*

The picture that emerges from these discussions is that more time is being spent in collection of fuel-wood products today compared to the past. Participants were asked to compare the present and past ten years. A majority of the participants agreed that fuel-wood resources were getting more and more difficult to obtain today compared to the past and even in cases where one has to buy from the informal market, the prices are higher than they were ten years ago. Another observation that emerged from the focus group discussions was that a few households stockpile fuel-wood in the dry season and use it in the wet season when it becomes scarce. The participants were asked to rank the benefits they received from trees from one to five. The most important benefit was fuel-wood. Construction timber was second and shade and ambience came third. Fruits and nuts came fourth and then the others.

Probably as a response to the scarcity of fuel-wood and poor management, participants reported they have started on-farm tree planting. A majority of the participants in both focus group discussions reported they or their ancestors have planted trees on their own lands. In the event that they need fuel-wood from their own trees, they simply trim of the branches but do not cut down the trees. From field observations, the large number of trees in gardens suggests that households are beginning to recognize the need to plant own trees for their fuel-wood needs. The participants recognized the role of Non Governmental Organizations (NGO's) in

encouraging them to plant more trees in their gardens. Some of these organizations have given them free tree seedlings.

The members of the groups recognized the possible role of the government in controlling over-exploitation of resources. They expected the government to be well organized and capable of regulating the use of these resources. The priorities of the people were planting more trees and developing alternative energy sources to minimize over-exploitation. Also agricultural extension workers should regularly visit these areas in order to teach the farmers ways of improving yields without necessarily expanding land area by cutting down trees.

The use of focus groups in this study provided some useful insights regarding the links between natural resource degradation and household activities in Eastern Uganda. This part of the study demonstrated that households in Eastern Uganda feel very strongly about the degradation of natural resources and the need to control their use. It also underscored the point that if resource use is not controlled, there will be a serious scarcity problem in future. Further, increasing degradation is affecting their household activities but not as seriously as to cause a crisis. Emphasis on conservation was a key feature in the discussions.

5.4 Survey results: Household characteristics, labour allocation and resource use patterns

5.4.1 Demographic characteristics

As mentioned at the beginning of this chapter, the survey, which was designed to capture the two seasons in the area, namely the dry and wet season, was conducted between August 2001 and March 2002. The total sample eventually used in this analysis was 359 households; 59 observations (households) having been excluded, most of which had missing values for the important variables, or outliers in the data for collection time for fuel-wood, farming time and land ownership. In some sections of the analysis, the study area was divided into two distinct agro-ecological zones described earlier, namely the highlands (Kapchorwa and Mbale) and the lowlands (Kumi and Tororo). In others the site dummies (districts) were used to capture location specific factors. In this section, a tabular analysis providing indications of the

effects of deforestation on household fuel-wood collection and farm labour time is presented, but no rigorous statistical tests are provided except for the tests for the differences in distributions between seasons. This mainly serves to describe the observed outcomes of deforestation and disaggregate them by location or season.

Before presenting the multivariate results, selected demographic characteristics of sample households between the two samples are first presented. Table 5.1 shows that the average household size was 6.8 members, with no significant difference[25] between the households sampled in the two seasons. Similarly, in the sample, 7 percent were female-headed households and more women assumed headship as their age advances. This could be attributed to widowhood since the life expectancy of women is higher in Uganda than that of men, and since most women marry at a younger age than men do. It may have been further amplified by the civil wars, which affected some parts of the survey area in the previous decade.

The proportion of children below the age of six was 17 percent, while the corresponding figures for boys and girls aged between 6 and 15 years are 14 and 15 percent, respectively. The proportion of adult males was just higher than that of adult females (27 and 26 respectively). Further examination of the demographic characteristics showed that the group below 16 years of age constituted close to 50 percent of the total population in the area. This suggested that there was high dependency ratio exerting pressure on the adult groups. The average age of household heads in the sample was 43 years, with female-headed households being, on average, eight years older than male ones (51 versus 43).

[25] The t-test was used to test for the difference of means in this section.

Table 5.1 General household demographic and economic characteristics

Variable	Wet Season, Survey round 1 Mean	Std. Dev	Dry Season, Survey round 2 Mean	Std. Dev	Total Mean	Std. Dev
Age of household head	45.23	14.08	41.64	12.88	43.35	13.56
Female headed household	0.06	0.25	0.07	0.26	0.07	0.25
Household size	6.84	2.83	6.70	3.13	6.77	2.98
Prop. of female adults	0.26	0.13	0.27	0.14	0.26	0.13
Prop. of male adults	0.26	0.14	0.28	0.18	0.27	0.16
Prop. of boys	0.15	0.14	0.14	0.14	0.14	0.14
Prop. of girls	0.16	0.15	0.15	0.14	0.15	0.15
Prop. of children(<6)	0.17	0.17	0.17	0.16	0.17	0.16
Heads education years	8.40	4.81	7.72	4.40	8.04	4.60
Heads education below secondary	0.44	0.50	0.52	0.50	0.48	0.50
Heads education Secondary	0.29	0.46	0.27	0.44	0.28	0.45
Heads education above secondary	0.17	0.38	0.11	0.32	0.14	0.35
Head has no education	0.09	0.29	0.10	0.30	0.10	0.30
Wage income (Monthly Shillings)	170,670	154,482	121,101	121,154	144,7124	140,050

Observations: Wet season 171, dry season 188

Notes: t-test shows no statistically significant difference between the means for the two seasons. Adults defined as above 14 years, boys and girls aged 6-14, children less than 6 years

In Uganda, there are seven years of primary school before a student goes to secondary level. Secondary level may be divided into two; Ordinary level which takes four years (Senior 1 to 4) and Advanced level, which takes 2 years (senior 5 to 6). After secondary school a student may then join college, which takes at least two years depending on the course. The mean years of schooling for the household head was 8 with a standard deviation of 4.6, implying most heads at least went to primary school. The distribution was as follows: 48 percent of household heads attended primary school, 28 percent had secondary education and 14 percent had post-secondary education. The rest had no education at all. Overall, female-headed households tended to have less schooling than the male heads. These results are within the expected demographic pattern in developing countries[26].

Although income from farm activities was the main component of household income in the sample, some households also reported income earned from working outside

[26] See World Development Report and Human Development Report, 2002 and 2003

the family farm[27]. Only 30 percent of the households received remittances from relatives or friends; these averaged Uganda shillings 5,535 per month (US $ 3.07). Remittances to the household were used as a proxy for non-wage income. In terms of labour income (section 5 of the questionnaire), the households that reported having worked for a wage outside the farm (whether in agriculture or non agricultural employment) had a mean total monthly income of 144,712 shillings (about US dollars 80) reflecting high levels of poverty. However, classifying income by season showed significant differences. Households earned more labour income during the wet season than in the dry season (Shillings 170,670 compared to 121,101). Most of the income was derived from agricultural labour outside the home farms. These results showed potential substitution possibilities for households; households that do not collect fuel-wood can hire out their labour, and earn income, which they can later use to purchase the fuel-wood.

While about 95 percent of the respondents live in their own houses, the majority of the structures (77 percent) were semi-permanent or temporary, implying that housing conditions were quite poor in the study area (Table 5.2). The temporary structures consist of grass-thatched roof, mud and wattle walls and earth floor. Generally, the housing conditions in the study area were poor as depicted by the type of roof, wall and floor materials. Close to 90 percent of the households in both the highland and lowland areas live in semi-permanent or temporary structures. The lowland districts had the poorest roofing materials, with about 74 percent of the households living under grass thatched roofs as they could not afford better roofing materials like iron sheets.

[27] See last section of household survey questionnaire

Table 5.2. Characteristics of dwelling by agro-ecological zone; percent

Indicator		Highlands Percent	Lowlands Percent
Type of Ownership			
	Owned	91.45	99.52
	Rented	4.61	0.48
	Supplied free by employer	3.29	0
	Others	0.66	0
Type of Dwelling			
	Permanent	7.24	11.11
	Semi permanent	69.74	66.67
	Temporary	23.03	22.22
Type of roofing material			
	Thatching	21.05	74.4
	Corrugated iron	77.63	25.6
	Tin	1.32	0.0
Type of Wall material			
	Bricks	7.24	53.14
	Cement Blocks	0.66	4.83
	Wattle and Mud	84.87	39.13
	Wood (timber)	0.66	2.9
	Stone	0.66	0
	Others	5.92	0
Type of Floor Material			
	Earth and Cow dung	86.16	89.86
	Cement	13.16	8.7
	Mosaic and Tiles	0.66	0.97
	Stone	0	0.48
Type of Toilet			
	Ventilated Improved Pit latrine (VIP)	3.29	0.48
	Pit latrine	94.08	72.95
	Bush	1.32	26.09
	Bucket or other type	1.32	0.48
Type of lighting			
	Solar Power	1.32	0.48
	Electricity	0.66	0
	Kerosene lantern	41.45	12.08
	Tadooba	56.58	86.47
	Fuel-wood	0	0.97
Main source of water			
	Rain water	1.97	0
	Piped water	13.82	1.45
	Borehole	11.18	39.61
	Well/spring	61.18	58.45
	River/Lake	11.84	0.48

Notes: Highlands (agro-ecological zone 1) – Mbale and Kapchorwa
Lowlands (agro-ecological zone 3) - Kumi and Tororo

The primary source of water for most households was wells/springs (about 60 percent in both places) and boreholes (40 and 11 percent in lowland and highlands respectively). Only 14 percent in the highlands had access to piped water compared to only 1.5 percent in the lowlands. Only one percent of the households in the entire sample had been electrified. The main form of fuel for lighting is paraffin using lamps or *tadooba's*[28]. About 90 percent of the households in the study area reported using pit latrines as the toilet facility although use of the "bush"[29] is also common in the lowlands.

5.4.2 Fuel-wood collection and time allocation

All households sampled used fuel-wood as the major source of energy for cooking and heating. Most fuel-wood was collected from own farms, 67 and 46 percent respectively for highlands and lowlands. About 39 percent and 6.2 percent was from forests and purchased in the market, respectively. According to Table 5.3, a larger proportion of households that purchased fuel-wood from the markets were located in the highlands. In terms of distance, the largest proportion of households (41 and 36 percent) in both strata (highlands and lowlands) respectively, reported having to travel up to 5 kilometers in search of fuel-wood, and about 90 percent indicated they had experienced shortages of fuel-wood for cooking (Table 5.3). The main reason given for this shortage was that fuel-wood is getting scarce and household members spend more time today and travel greater distances to collect fuel-wood and forest products than they did 5 years previously. About 46 percent reported that the most serious problem facing forests and woody biomass was the unnecessary cutting of trees and pressure from agriculture for more cultivable land. These problems have reduced the availability of forest resources by decreasing the areas occupied by forests and woodlands[30].

[28] *Tadoobas* are small kerosene candle-like lamps made from tins and thread.
[29] The reason for persistent use of the bush is cultural, as some cultures in the lowlands believe use of toilets reduces people's reproductive abilities.
[30] Refer to questions 3.5 to 3.9 in the questionnaire (Appendix 1)

Table 5.3. Energy characteristics of households by Agro-ecological zone

	Highlands	Lowlands
Distance from fuel-wood source to Dwelling		
Less than 100m	11.84	8.21
100m-less than 500m	18.42	27.05
500m - less than 1km	25.66	28.5
1km - less than 5km	41.45	35.75
5km or more	2.63	0.48
Does household experience fuel-wood shortages		
Yes	86.18	94.69
No	13.82	5.39
Reasons for fuel-wood shortage in household		
Fuel-wood getting scarce	63.82	80.19
Distance to collect too far	12.5	5.31
Less time to collect	3.29	2.9
Nobody to collect	3.29	1.93
No money to purchase	8.55	4.35
Other	8.55	5.31
Main source of fuel-wood		
Gathered from forest	25.0	42.3
Purchased from market	8.6	4.4
Collected from own farm	66.5	46.4

Notes: Highlands (agro-ecological zone 1) – Mbale and Kapchorwa
Lowlands (agro-ecological zone 3) - Kumi and Tororo

Survey respondents were asked to recollect their labour allocations in the areas included in the analytical model (fuel-wood and farming). Although survey questions that focus on past activities are known to suffer biased answers, valid responses can be expected when the household has fairly regular work patterns (Juster and Stafford, 1991), a situation that can be expected in the rural areas of Eastern Uganda. In order to focus on time allocation of working people, the sample included boys and girls of 6-15 years, because they make an important contribution, especially in fuel-wood collection and on the farms. Table 5.4 below shows the breakdown for collection and consumption of fuel-wood and allocation of time for men, women, boys and girls in the study area.

Table 5.4. Fuel-wood consumption and time allocation

Variable	Mean	Std. Dev.
Fuel-wood Collection		
Mean household weekly collection in Kilograms	75.09	79.20
Average number of trips per week	4.85	5.35
Time boys spend to collect hours per week	0.72	2.95
Time girls spend to collect hours per week	1.36	3.79
Time men spend to collect hours per week	1.07	3.56
Time women spend to collect hours per week	5.67	6.84
Total Collection time in hours per week	8.82	10.56
Average time per trip	3.37	2.40
Average price of fuel-wood per 15kg bundle (shillings)	1250	431.77

Households spent on average more than three hours per trip in collection of fuel-wood and made about five trips per week. This definitely shows that either the levels of consumption were very high or the amounts collected per trip were very low. Female adults spent the highest amount of time (6 hours) in fuel-wood collection (5 times as much as the men) while girls spent about 2 times (1.36 hours) that spent by the boys. The difference was statistically significant and this result is comparable to the findings from other studies (Cooke, 1996; Gunnar, 1998; Mekonnen, 1998), which show that women and children (Nankhuni and Fendeis, 2003) spend more time in fuel-wood collection than the other members of the household. Boys spent the least time in collection because they were engaged in other activities such as grazing livestock, which, the girls don't usually perform in this area. Similarly it is the traditional belief that tasks related to cooking are the province of females in the household.

There was some seasonal variation in the time allocation and fuel-wood consumption variables. During the rainy (wet) season, total collection time was longer (9.49 hours) than in the dry season (8.20 hours) and this difference was statistically significant (Table 5.5). The reason was that fuel-wood was more easily accessible during the dry season. Scarcity also increases during the wet season because most of the fuel-wood is wet and cannot be readily used.

Table 5.5. Seasonal and agro-ecological pattern of time allocation

	Aug-Nov	Dec-Feb	Highlands	Lowlands
Variable	Rainy Season	Dry Season		
Fuel-wood collection	Mean	Mean	Mean	Mean
Mean household weekly collection in Kilograms	80.87	69.84	74.32	75.66
Average number of trips per week	5.78	4.00	4.82	4.86
Boys collection time (hours per week)	1.30	0.19	1.31	0.28
Girls collection time (hours per week)	1.93	0.83	1.18	1.49
Adult men collection time (hours per week)	0.81	1.31	1.46	0.79
Adult women collection time (hours per week)	5.45	5.88	3.89	6.98
Total collection time (hours per week)	9.49	8.21	7.84	9.53

Respondents also argued that during the wet season, less time was available for them to collect these products since most of their time was spent in the fields; this was later verified in the empirical analysis. In terms of amounts of fuel-wood collected, the households collected and consumed more fuel-wood during the wet (rainy) season probably because of the need to warm their houses. Contrary to the statistical findings, field observations suggested that some fuel-wood was gathered during the dry season and stored for use over the wet or rainy season because of the difficulty of finding fuel-wood then. This situation was evident for a few households in Tororo district, indicating that some households accumulated some precautionary stocks of fuel-wood. Rationally this makes sense. However, empirically the result showed that there was little or no stock-piling during the dry season and it did not significantly offset the limited availability during the wet season, because households still spent more time collecting fuel-wood during the wet season.

The relative differences in allocation of time by age groups and gender remained the same during the dry and wet seasons, with girls spending almost twice as much time as boys. However, both boys and girls became more involved in collection activities during the wet season, implying increased scarcity during the wet season. There was a significant difference between their time allocations for fuel-wood collection between seasons. Regardless of the season, women spent more time in collection than men did. However, aggregate time spent in collection activities was still more in the wet season. The interesting point was that collection time by adults rises when time spent by boys and girls fall. The reason for this could be as a result of labour substitution by the adult males as boys and girls go to school. However, because the two rounds of

the survey covered both school and holiday time, it was not easily possible to ascertain how much of this substitution was due to the timing of school holidays and how much of it was due to alternative activities undertaken by adults.

The collection time for men in the highlands was higher than that of their counterparts in the lowlands. In contrast, women in the lowlands spent significantly more time than their counterparts in the highlands. According to focus group discussions and field observations in the lowland areas, vast tracts of land are cleared in search for arable land, pasture and fuel-wood, with observable physical effects. It was not surprising that households located in the lowlands experience more fuel-wood problems and spent more time in collection than those in the highlands.

As can be seen from Table 5.5, the mean household weekly collection was about 75 kilograms, with some seasonal variation. This was the sum of all fuel-wood collected by all household members during the week. A standard bundle was assumed to weigh about 15 kilograms and these bundles were converted to kilogram weight. Household fuel-wood collection varied directly with household size. There were statistically significant differences in the amount of fuel-wood collected and used per week during the wet season (81 kilograms) and in the dry season (70 kilograms) probably because of the extra heating required by the households during the wet season or probably due to the poor quality of wood used during the wet season. In terms of time, it took slightly longer to collect fuel-wood in the lowlands (3.7 hours per trip) compared to 2.9 hours per trip for the highlands. This was another indicator of the extent of deforestation in the lowlands, and supports the earlier findings of this chapter. However, they make approximately the same number of trips per week.

5.4.3 Land use and availability

A critical issue for peasant farmers in rural areas of Uganda is the shortage of farming land. Increased population and fragmentation of holdings have sharply reduced cultivated area per person. All households in the sample owned some land. The average amount of land owned by a household in the study area is about 5.2 acres with variations between the highlands and lowlands. In the lowlands, the households own an average 6.7 acres compared to 3.3 acres in the highlands (Table 5.6).

Moreover, about 90 per cent of this land is privately owned in the highlands compared to about 50 percent in the lowlands. Households also access common agricultural lands especially for fuel-wood collection and grazing.

Table 5.6. Land ownership, by ecological zone

	Highlands	Lowlands	Total
Land owned by household in acres	3.3	6.68	5.22
Type of ownership			
Communal	5.92	47.83	30.08
Private (Own farm)	91.45	50.24	67.69
Private (Rented)	1.97	0	0.84
Other	0.66	1.93	1.39
Land used for crops in acres	2.61	6.43	4.77
Arable land per capita in acres	0.58	0.99	0.81

Good farming land is becoming increasingly scarce. Most households in the study area reported that they plan to use all their available agricultural land in the coming farming season. The arable land per capita was about 0.8 acres for the study area as a whole (0.58 and 0.99 for the highland and lowlands, respectively). The arable land per capita is expected to decline further with rising populations and as parents give land to their children who are starting their own households.

Of the two agro-ecological zones, as expected the highland districts had the least land per capita and therefore the highest population densities (Table 5.6). Some households in the highlands depended on renting or borrowing of land for agricultural purposes although the proportion was very small (2 percent). Households with land not in use usually lend or rent it to those with insufficient land, such as newly formed households. As might be expected, the most densely populated areas had the highest proportions of borrowed or rented land in cultivation. An important feature of land-use, which also became evident during focus group discussions, was that many households cultivated multiple or fragmented pieces of land. There is little published information about the extent of fragmentation and its impact on farming systems in Uganda. It was widely accepted that a few farmers cultivate unitary holdings and the extent of fragmentation sometimes depended on inheritance.

Rural farmers in Eastern Uganda utilize most of their land for crop cultivation (taking cropland and permanent pasture separately). About 90 percent of the households used

all or most of their land for cropping purposes. This means that their type of land-use determines households' income generating potential. Initially, households clear a small area of their land for subsistence crops, followed soon after by clearing for cash crops such as cotton and coffee. As the land gradually looses fertility (despite the soil quality being high in most of the study area), new areas get cleared. This expansion of cropland in Eastern Uganda reflects opening up of new lands. Forest and woodland areas are being depleted with consequent deleterious impacts on the environment.

5.4.4 Farming and household time allocation

Adult women spent slightly more time on farms (4.61 hours per day) compared to men (4.21 hours) (Table 5.7). Regardless of the season, it was still evident that the contribution of women's labour time to agriculture exceeded that of men and boys and girls in both the rainy and dry season. This division of labour was replicated for boys and girls in the study area, with girls spending relatively more time. The time allocation data for men, women, boys and girls presented in Table 5.7 show that the most intense period was during the rainy season when the average total time spent by all household members on their farms was on average about 11 hours per day. During the rainy season in Uganda, farming activities are compressed into a few, extremely busy months and there is a significant difference in the total amount of time spent on the farm during the two seasons by all household members. For obvious reasons, during the dry season (December-February), less time was spent on agricultural work, but it was the peak period for production support activities such as preparing and clearing farmland for the next planting season.

The boys and girls spent relatively less time in farm work than adults, with boys spending significantly less time than girls in all the seasons. During the dry season, women trade, process and sell some agricultural produce, brew and sell beer in the villages. Water collection, a woman's responsibility, may take more time in the dry season as the nearby wells dry up. However, irrespective of the seasonal activity, women's labour input in the farm exceeds that of men at all times of the year.

Table 5.7. Seasonal and ecological pattern of farm time allocation

Variable	Total	Aug-Nov Rainy Season	Dec-Feb Dry Season	Highlands	Lowlands
Time	Mean	Mean	Mean	Mean	Mean
Boys farm/hours per day	0.98	1.01	0.95	1.10	0.90
Girls farm/hours per day	1.15	1.20	1.11	1.13	1.18
Men farm/hours per day	4.21	4.40	4.02	3.21	4.93
Women farm/hours per day	4.61	4.75	4.49	3.73	5.26
Child farm/hours per day[31]	0.06	0.07	0.03	0.06	0.05
Total household farm hours per day	11.01	11.43	10.60	9.23	12.32

Source: Survey of Eastern Uganda, 2001/2.

Most households (60 percent) reported that the time they spent on the farm had decreased over the preceding 10 years, although 23 percent reported that it had increased. The households that reported a decline believed this had led to a decline in output. The possible reasons for the decline were associated with lower prices for agricultural goods, labour migration and diseases and pests. From the formal discussions with the village leaders, shortages of agricultural labour in general were now common in the study area and by extension many other rural areas in Uganda. These shortages were a result of migration of young people to urban areas in search of better paying job opportunities and also the devastating effect of HIV/AIDS. As a result, hiring of labour (mostly seasonal) was becoming common in the study area.

The heaviest demand for hired labour amongst villages and households occurs around the beginning of the long rains and towards harvesting. Demands for hired labour in these communities were less evenly distributed. More labour was demanded during the two rainy seasons when they were employed for longer periods. For instance, 54 percent reported hiring labour during the peak farming seasons. Wages paid to the hired labour varied between agro-ecological locations[32]. The average wage was about Uganda shillings 1,000 per day (US $ 0.6). Households usually opt to hire labour at critical times such as weeding and harvesting and this critical time falls at the same time for all households. The resulting shortage of labour can raise the cost to amounts

[31] Some households reported children below 6 years participating in farming, but observations in Eastern Uganda indicate that most children accompany their mothers to the gardens but may not actually contribute to farm work.

[32] In some areas, labour was paid in kind, for example units of maize per day worked, while others organized a "rotating system" where households formed small groups to jointly work on a member's farm for a particular period and kept shifting from farm to farm.

greater than Uganda shillings 1,000 per day depending on the urgency and nature of work. For instance, during the harvesting season, which falls at more or less the same time for all households, the daily wage rates were said to sometimes double the usual rates. The high cost of hiring labour was a special concern for the village leaders who said it had forced some households to reduce their farm sizes[33].

5.4.5 Crop yields

Crop yields in the study area are very similar to those for the other regions with similar agricultural patterns (agro-ecological zones). Crop cultivation includes cash crops, mainly coffee (in the highlands) and cotton (in the lowlands) – and subsistence food crops (maize, millet, bananas, potatoes, cassava, sorghum). The region has a variety of other crops and fruits including beans, sesame, groundnuts, peas, yams, oranges and passion fruit. More than 50 percent of the households reported a decline in output over the last 10 years. The reasons for this decline include overuse of the soil, changing weather conditions and changing household demands for labour time. Some households reported losses due to migration of labour to urban areas in search of better paying jobs. The effect of HIV/AIDS could not be easily ascertained, as the respondents were reluctant to divulge information. Table 5.8 provides a summary of output for selected crops by district. It should be emphasized that estimation of agricultural outputs proved difficult because of the non-standardized units of measurement such as tins, bags, heaps and head loads. In this study only the staples were considered: the conversion factors for the units were based on those developed for the Uganda National Household Budget Survey. Although income from farm activities was the main component of household income, less than 5 percent of the households reported selling food crop produce.

There was significant variation in mean household output by district and specifically agro-ecological zone. The table shows that there are differences in crops grown between the highlands and lowlands. The largest amount of maize was produced in the highland districts of Kapchorwa and Mbale, respectively, where it is a staple crop.

[33] Personal discussions with village/community leaders

Table 5.8 Mean household yields of principal crops and livestock; by District

Crop (Kilograms)	Highlands		Lowlands	
	Kapchorwa	Mbale	Kumi	Tororo
Millet	0.00	172.00	936.33	859.26
Maize	1471.15	392.23	189.29	304.15
Coffee	77.78	151.19	0.00	0.00
Bananas (Bunches)	9.69	74.79	0.00	2.01
Cassava	0.00	280.25	576.87	720.00
Potatoes	0.00	488.88	636.64	311.27
Beans	93.57	149.71	12.74	14.15
Cattle (Number)	2.57	2.32	3.17	2.3
Goats (Number)	1.6	1.68	3.67	2.32

Source: Survey of Eastern Uganda, 2001/2.

On the other hand, millet is the staple crop in the lowlands (Kumi and Tororo). According to Table 5.8, coffee is the major cash crop in the highlands and it is not grown in the lowlands. In the recent past, low prices and the coffee wilt disease affected the coffee sector. In the lowlands, cotton growing has drastically declined over the past years due to pricing and marketing problems, and also the reluctance of farmers to grow cotton, as it was said to affect soil fertility. The other crops, cassava, potatoes and beans are used to supplement the staples. However, potatoes and cassava are grown to serve both domestic and commercial purposes in the districts of Kumi and Tororo.

Livestock form an important component of agricultural production in rural areas of Eastern Uganda. With intensification of crop production, the absolute requirement for animal labour increases, especially in the lowland areas of Kumi and Tororo. Livestock, especially oxen, are used for ploughing, while also providing manure for the farms. They are important in maintaining or improving crop yields, and their availability help determine area cropped. In addition to factor services, livestock also provide income and important nutritional benefits to households. There was a wide variation in household and ecological distribution of livestock in Eastern Uganda. At the household level, more livestock were reared in the lowlands (2.7 heads of cattle) than in the highlands (2.4 heads of cattle). This was expected since, generally, the lowlands tend to provide better grazing lands and terrain for livestock rearing. The relatively high stocking levels in the lowlands probably explain part of the high degradation in these areas as well. More than two–thirds of households in the study area owned cattle and goats, most of them owning only a few head (the mean number

being 2.6 and 2.4 head per household for cattle and goats respectively). About 85 percent owned some sheep or pigs although in very small numbers. Almost all households reared chicken.

Mechanization of farming was almost non-existent in the rural areas of Eastern Uganda. Households typically lacked technologies to relieve them of time-consuming agricultural tasks such as weeding and harvesting. Whether this was due to the absence of suitable technologies or to financial, cultural or other reasons is a question this study did not attempt to address. However, a small proportion of households reported use of basic equipment such as tractors and sprayers. Most of these were rented from private sources.

5.5 Summary of the main characteristics of the study area

In this chapter, a review of the data collection process and some of the descriptive statistics for households and communities in Eastern Uganda considering the two seasons and agro-ecological zones have been presented. It is clear from the above discussion that seasonal factors affect intra-household allocation of collection time among men, women, boys and girls. Girls and adult women spent more time collecting fuel-wood compared to their male counterparts, an observation that was not surprising in this part of the country. The descriptive results also showed that there was some correlation between time allocation for fuel-wood collection and the level of degradation. In terms of land ownership, households in the highlands owned less land both in total and per capita terms compared to the lowland households. The focus group discussions show little or no control over resource use, a factor likely to enhance continued over exploitation. They also show that women and girls are the main collectors. They further suggested that the scarcity of fuel-wood and other forest resources is worsening. While this summary applies to average collection time across all households in the sample, there was some variation within the sample.

The interviews and focus group studies described here indicated a set of socio-economic characteristics which could restrict the theoretical model developed in Chapter 4. First, from field observations, it was observed that, in the rural areas of Eastern Uganda, the labour market was not perfect. Whereas households may hire in

labour to work on their farms and also hire out their labour to work on other farm and non-farm activities at a given market wage, they do not hire labour for fuel-wood collection.

Secondly, all households in the sample consumed fuel-wood. Those households that did not collect fuel-wood (6 percent) purchased their fuel-wood from informal markets. No households in the sample reported selling fuel-wood. The decision to collect or purchase fuel-wood was based on their valuations of their own labour opportunities and this valuation was measured using virtual (shadow) prices (and wages) instead of market prices. Purchased and collected fuel-wood were considered perfect substitutes in consumption.

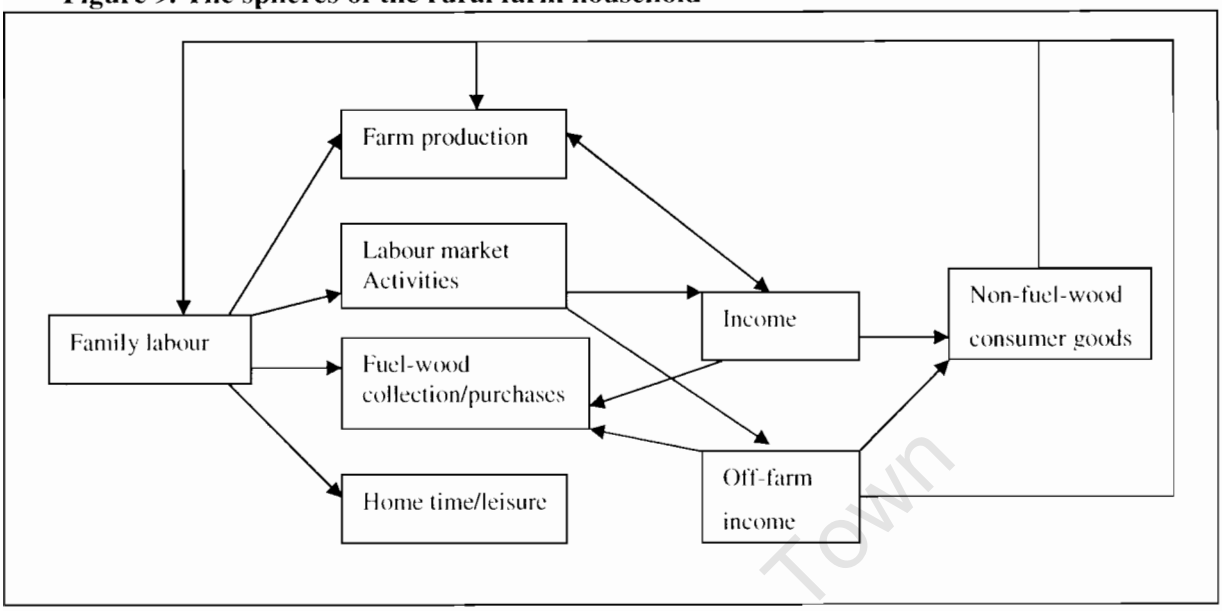
Thirdly, although labour market opportunities at existing wages were assumed to exist for men and women, hired and family labour on the farm are not perfect substitutes. Hired labour incurs a supervisory cost and is paid according to hours worked or area worked, this does not apply to family labour. The inclusion of children further complicates household labour supply since they may be considered volunteers who are active in home production. The descriptive results showed that households gather fuel-wood from either their own farms or the commons, but did not provide clear demarcations. However, focus group discussions revealed that most households gathered their fuel-wood from the commons, which tend to be further away from their homesteads. This implied that some households prefer to collect fuel-wood from the commons and to conserve their own sources, which is in line with the theory of the commons.

In order to understand the wider implications of household responses, the starting point for this analysis was the behavioral response of fuel-wood consumers to deforestation. The behavioral principle of the household is to maximize utility, which is a positive function of consumption and home time. The household maximizes utility by allocating the labour time of household members and other resources to farm and off-farm activities, subject to time and budget constraints. Each household allocates labour to fuel-wood collection according to an implicit virtual wage that is unknown except to the household itself. Fuel-wood demand is influenced by income and price factors, as well as fixed demand factors such as family size. In areas where

households use some of their labour in collection of forest products, maintenance of their supply implies that this labour increases with deforestation. If they also provide labour in agriculture, then the consequences for production depend on their ability to take on more work. In the analysis, changes in fuel-wood consumption, shadow and market wages and changes in the time costs of collecting fuel-wood will be used to represent the consequences of deforestation.

Figure 9 below gives a schematic representation of the household decision process analyzed in this study. Reading from left to right, the household allocates its resources to home time and other productive activities such as fuel-wood collection, farm production and wage employment. Home time is time not spent in directly productive and labour market activities. It includes leisure, family maintenance and family reproduction. Wage employment and fuel-wood collection require only family labour, while farm production combines family labour with hired labour and other inputs. Hired labour and other inputs can be purchased using their own incomes. Wage employment and farm production both yield income which is spent on consumption of fuel and non-fuel-wood products.

Figure 9. The spheres of the rural farm household



From the schematic view of the farm household, the two spheres of the household (production and consumption) interact, and the characteristics of consumption affect labour (production) decisions just like the characteristics of the farm household and production affect consumption. The endogeneity of home production means that fuel-wood depletion can reasonably lead to lower collection effort and more agricultural or market work by household members. It could also mean that fuel-wood prices would go up, thereby encouraging more collection by market workers, hence more depletion.

In conclusion, from the tabular analysis, mixed results regarding the association of deforestation and household time allocation to several activities are obtained. Household family labour is allocated to four principal activities, namely leisure, farm time, labour market and fuel-wood collection activities. With the exception of leisure time, all the other activities yield incomes either directly or indirectly. Some of this income can be used to purchase fuel-wood from the market, especially for households that find the opportunity costs of collection relatively high. This income is also used to purchase non-fuel-wood goods which are used to support farm production or household labour. Descriptive analysis is limited since these patterns could be driven by several characteristics of household members or (agro-ecological) locational factors. The econometric analysis in the next chapter should enable a definitive assessment of these relationships. The objective in the next chapter is not to convince

the reader of the time consuming nature of farm work and fuel-wood collection, but rather to explore how changes in the environment on the margin may influence time allocation to various activities. The determinants of fuel-wood and agricultural production based on the conditions described above are analysed. Structural forms are estimated and marginal revenue products (shadow wages and prices) which are then used to analyse household demand for fuel-wood and labour are derived. The shadow wage is determined within the household and is a function of household preferences and all other fixed inputs and characteristics affecting household choices.

Chapter 6

Determinants of labour allocation to fuel-wood collection activities and forest use in Uganda

6.1 Introduction

This chapter examines the factors influencing labour allocation to fuel-wood collection and forest use. This analysis is motivated by methodological and empirical concerns reviewed in chapter 4. From a methodological perspective, a time allocation model in which households allocate time specifically to fuel-wood collection is estimated. The model draws on the broader literature exploring labour supply decisions in agricultural households (Adhikari *et al.* 2004; Kimhi and Rapaport, 2004; Sadoulet *et al.* 1998; Abdulai and Delgado, 1999; Jacoby, 1993; Low, 1986) discussed in chapter 4. Further, it extends existing knowledge in modeling household time allocation by explicitly incorporating fuel-wood use as an input in household production and consumption. Empirically, distinctive features of this analysis are the inclusion of seasonal variables, gender disaggregation and agro-ecological zones. Natural resource degradation occurs both, when forest is cleared for agricultural expansion and when households extract forest products at a level exceeding sustainable yield. By including data on a variety of variables, this chapter provides a comprehensive assessment of the factors determining labour allocation to fuel-wood collection and consumption. Estimating labour time allocation equations also provides a theoretically consistent treatment that leads to economic and policy insights about the relationship between household behaviour and natural resource use in developing countries.

Although, the economic theory of consumer demand takes the individual as a unit of analysis, empirical work on consumer demand is usually based on data that takes the household as the unit of analysis. This is largely because most data on household behaviour such as consumption expenditure are collected (or available) at the household level as a single unit (Deaton, 1997). Accordingly, the household is the unit of analysis in this study. Consequently, concepts such as shadow wages and prices which are usually individual level issues, are used to refer to household specific shadow wages and prices as is done in conventional related empirical literature (see

for instance Taylor and Adelman, 2003; Taylor, 1984; Bluffstone, 1995 and 2001; Amacher *et al.* 1993; Jacoby, 1992; Mekonnen, 1998; Skoufias, 1994; Kooreman and Wunderink, 1997). The rest of the chapter proceeds by examining the implications of deforestation for fuel-wood collection; estimating shadow wages for eastern Uganda (the study area); and estimating a model for determinants of demand for fuel-wood, as well as labour-time allocation for fuel-wood collection. This chapter also examines the intra-household and gender breakdown of collection activities. The goal for this breakdown is to test the hypothesis that there exist gender and age differences to time allocation within the household. The conclusion summarizes the results.

6.2 Implications of deforestation for fuel-wood collection

The question to be answered in this section is; how does deforestation impact on households' labour allocation to fuel-wood collection? As deforestation proceeds, the stock of fuel-wood accessible to households diminishes. Hence, the total workload to obtain/collect fuel-wood increases and time spent on other directly productive activities like farming is reduced. In the long run, several possible situations may arise. Households may respond by shifting to other sources of fuel to substitute for the fast depleting fuel-wood resources. For instance, fuel-wood may be replaced by crop residues or dung as fuel, yet these resources are primarily used as fertilizers. This may have adverse effects on soil fertility and productivity. Alternatively, households may respond by becoming less selective on the type of fuel-wood collected while others may decide to purchase fuel-wood from the local informal markets as a way of saving time. All these changes can have adverse effects on production activities and household welfare.

In presenting the empirical results, the production (collection) function for fuel-wood is estimated first. As explained in the theoretical model of chapter 4, non-separable agricultural models are estimated. These models employ the concept of virtual (shadow) wages, which are estimated from a production function that does not necessarily exhibit constant returns to scale (Jacoby 1993; Amacher *et al.* 1996; Thornton, 1994). Once the shadow wages or prices are determined, the budget constraint in equation (7) of chapter 4 can be linearised at the optimum values of the relevant variables, and demand and/or supply functions derived and estimated. The

demand and supply functions for fuel-wood include endogenous shadow wages and prices as explanatory variables, the endogeneity prompts that they be estimated using instrumental variables (two stage least squares-2SLS). In this formulation, non-separability requires that the demand functions include all shadow wages and prices and other exogenous (production and consumption) variables as explanatory variables.

In the estimation of fuel-wood collection functions for households, some potential sources of bias may arise. First, some households did not spend any time in collection activities. Such non-participation by households leads to zero censoring in their collection equations. In the sample, approximately 6 percent of the households did not collect fuel-wood from the farm or forests, but purchased it from the informal market. Since there are some households in the sample that do not collect fuel-wood a generalized Tobit procedure was run to check for sample bias. There was evidence of sample selection bias for those observations that were censored at zero, and the results indicated OLS would return biased results. To solve this problem a version of the Tobit[34] (see Greene 2000) model, which produces consistent and efficient estimates, was used. Tobit estimation accounts for a dependent variable that has zero limit and measurement error. The application of Tobit analysis is preferred in such cases because it uses both data at the limit and data above the limit to estimate regressions.

A second selection problem may be due to a household's choice of a collection site. As already indicated in the descriptive statistics in chapter 5, households collected fuel-wood from both own farms and communal forests. Economic theory predicts that the collection time of an environmental product partly depends on the location of the collection site. It is expected that collecting fuel-wood from one's own land involves less time per trip than collecting from the commons. However, this presumes that own farms are all close to the household. In the case of Eastern Uganda where land fragmentation is pronounced, this may not be the case. Although the data indicated the place of collection, the respondents did not specify whether fuel-wood was gathered on own farms near to or distant from the homestead. Fragmentation of land

[34] In the context of time allocation, Skoufias (1993) warns that the Tobit estimator is restrictive, in that it presumes the determinants of participation in an activity are identical to the determinants of hours allocated to the activity. If the two were different, the estimated coefficients would be biased.

makes it difficult to assess the extent to which collection decisions (regarding where to collect) are influenced by availability of forest resources. Normally, a probit model would be used to establish whether or not households collect on their own land. But since households did not indicate the extent of fragmentation and because most households indicated that they collected from both own farms and commons, the probit model was not estimated. The data provides only total collection times with limited or no ability to break these into collection from own farms or commons. Estimates for the production function for total collection of fuel-wood are presented in Table 6.1 below.

Table 6.1 Tobit estimates for fuel-wood collection function in kilograms per week

Dependent Variable: Amount of fuel-wood collected in kgms/week	
Time spent in collection	0.723***
	[0.023]
Highlands (1=Highlands; 0=Lowlands)	0.125*
	[0.069]
Number of men in household	0.104
	[0.098]
Number of women in household	0.195*
	[0.107]
Number of girls in household	0.059
	[0.060]
Number of children in household	0.083
	[0.058]
Dummy for Season (1= Wet season; 0 = Dry season)	0.188***
	[0.063]
Number of years of schooling for household head	0.004
	[0.007]
Constant	-0.816***
	[0.173]
Number of observations	359
Log likelihood[35]	-306.52

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
The dependent variable, number of adult males and females, male and female youth, education years of household head and time spent are expressed in logarithms

Starting with time estimates, the time variable is significant, has the expected positive sign and is consistent with the theoretical predictions in chapter 4. Among the household composition variables, the number of adult women was the only significant

[35] The model was subjected to the likelihood ratio test for misspecification. The p-values returned indicated the model was not misspecified.

variable. Larger numbers of women in the household mean more labour for the collection of fuel-wood. The site dummy representing the agro-ecological zones (highlands versus lowlands) was positive and significant implying possible spatial effects of increased consumption of fuel-wood in the highlands due to the extra heating required given that this area is generally cold. The positive sign for the highlands could probably also indicate that more competition for fuel-wood resources means more consumption per household. The collection of fuel-wood products in Eastern Uganda was highly seasonal. More fuel-wood was collected by households during the wet season. However, conclusions concerning the implications of these results cannot be made before undertaking further analysis - using time related dependent variables.

In general, the results in Table 6.1 indicate that apart from time spent collecting fuel-wood, there are variations in the factors that determine total collection of fuel-wood by households. These results may be interpreted as consumption effects. They may also be interpreted as indicators of seasonality and specialization in collection. The fuel-wood collection functions estimated here are used to derive the shadow wages and prices, as illustrated in the next section.

6.3 Estimation of shadow wages/prices for fuel-wood for Eastern Uganda

As explained in the theoretical chapter, the equation estimated in the previous regression (collection function) was meant to provide estimates of the marginal product of labour in fuel-wood collection. The process of computing the marginal revenue product of labour (shadow wage) was described in detail in the empirical model in chapter 4 and its estimation was based on Sadoulet *et al.* (1998), Skoufias, (1993, 1994) and Jacoby (1993). Since in the estimation of the collection function some dependent variables were expressed in logarithms and given the functional form used in this estimation, the marginal revenue product of labour was estimated by taking the product of the labour input elasticities (the parameter value for time input) and the ratio of predicted quantities collected to time spent (see equation 14).

In order to understand the implications of household responses to fuel-wood scarcity, the behavioral response of deforestation on fuel-wood demand must be analyzed.

Fuel-wood demand is expected to be influenced by income and price factors, as well as fixed demand factors such as household size. Wealth and other factors such as location also influence fuel-wood demand. Since fuel-wood markets are not perfect, shadow "prices" based on the time needed to collect a load of fuel-wood, and shadow wages, are used as indicators of scarcity. Recall that these measures are household specific.

To measure virtual or shadow prices of fuel-wood, the time spent to collect a unit of fuel-wood and the shadow wage is combined. In this study, since time is itself considered a scarce resource, the time spent by a household serves as a good indicator of the scarcity of fuel-wood. The time taken to make a round trip to collect fuel-wood shows how costly it is to access fuel-wood. Shadow wages measure the opportunity cost of time, and therefore influence the shadow price of fuel-wood. The shadow wages are therefore assumed to reflect the relative fuel-wood scarcity each household faces (Cooke 1998a). The greater the extent of forest degradation in a locality, the lower the marginal physical product of household labour in collection of fuel-wood and the higher its shadow price. In other words, the longer it takes to collect a unit of fuel-wood, the higher the opportunity cost of labour per unit of fuel-wood and thus the higher the shadow price of fuel-wood. The shadow prices therefore vary across households and seasons because they are based on household characteristics and endowments[36].

The estimated marginal physical product of household labour was 0.486 kilograms per hour on average. Comparing by season, the marginal product of labour for collection in the wet season (0.499) was statistically different from that in the dry season (0.474). However, since these are household level marginal products (shadow wages), they could not be compared with the average market wages. Moreover, since there was no labour hired for fuel-wood collection, explaining the difference was not plausible. Multiplying marginal products by the time per trip, gives the average household level shadow price of fuel-wood of 97.4, while the shadow prices for the wet and dry season are 101.4 and 92.96, respectively. These shadow prices are statistically different. The shadow prices in the wet season are higher than in the dry

[36] In this case, the use of shadow prices instead of community level prices is justified.

season. Presumably the shadow prices are higher in the rainy season because the market value of labour goes up, and the market price of fuel-wood rises, so the shadow price of fuel-wood rises due to both of these effects.

6.4 Determinants of fuel-wood demand in Eastern Uganda

In this section consumption functions for fuel-wood are discussed for all consumers (collectors and non-collectors). In order to account for the potential presence of measurement error in the estimated household shadow wages and prices, and to correct for inconsistency that may be caused by endogeneity[37] of shadow wages and prices, which are included as explanatory variables in the demand equation, a Two-Stage Least Squares (2SLS) approach (see also Bluffstone, 2001; Mekonnen, 1998; Cooke, 1998) was applied. The instrumental variable approach (2SLS) was used since the marginal products used in the estimation of the shadow wages are derived from the first regression presented in Table 6.1. Shadow wages are included as endogenous variables in this regression. It can be argued that such an estimation strategy would lead to inefficient estimates and some circularity since the error terms may be correlated across the equations. However, this would not be a problem if the equations have identical explanatory variables (see Greene, 2000), which is the case with this study. Cross-sectional demand functions using 2SLS are estimated for the rainy and dry seasons separately. Because all households sampled indicated consumption/use of fuel-wood, there was no need to check for sample selection bias caused by exclusion of zero values. However, this was not the case for time collection variables for men, women and youth, analyzed in the next section.

The results for fuel-wood demand functions, with shadow wages and prices included, are presented in Table 6.2 under the columns "Wet" and "Dry" season. The estimated model performed well in terms of overall fit; 34 percent of the variation in fuel-wood demand being explained by the variables included in the model. The results of the model also generally conform to prior expectation (see Table 4.1). The elasticities derived show that households in rural areas of Eastern Uganda are generally responsive to labour opportunities. As expected, shadow wages have a significant and

[37] The Durbin-Wu-Hausman test for endogeneity was conducted and the results indicated there was no endogeneity. The p-values (prob F= 0.0005) returned indicated OLS estimation was not consistent.

negative effect on amount of fuel-wood consumed by the household in both seasons. This means that as shadow wages increase, or rather as labour's opportunity costs increase, households respond by decreasing their consumption of fuel-wood, holding other factors constant.

Table 6.2 Determinants of demand for fuel-wood (Kilograms/week)

Independent Variable	Wet season	Dry season
Shadow wage	-5.720***	-12.146***
	[4.52]	[4.71]
Household size	0.433***	0.866***
	[3.49]	[5.37]
Dummy: Female household head	0.439	-0.236
	[1.21]	[0.79]
Dummy: Married household head	0.206	-0.631***
	[0.61]	[2.80]
Dummy for Kapchorwa district	-0.691***	0.386
	[3.30]	[0.85]
Dummy for Kumi district	0.047	2.505***
	[0.28]	[6.04]
Dummy for Mbale district	0.874***	2.148***
	[4.80]	[4.73]
Ownership of agricultural land	0.11	0.038
	[1.01]	[0.24]
Number of years of schooling for head	0.154**	0.112
	[2.00]	[1.33]
Total household wage income	0.008	0.028
	[0.42]	[0.82]
Total household agricultural income	0.033	0.078
	[0.51]	[0.97]
Shadow price	0.206**	0.559***
	[2.50]	[4.64]
Net remittances	0.011	0.031*
	[1.03]	[1.91]
Constant	-3.444***	-11.330***
	[2.61]	[4.18]
Observations	171	188
Adjusted R-squared	0.34	0.34

Absolute value of t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variable Estimation (2SLS) [38]
The dependent variable is log of fuel-wood consumed (kg/week), number of household members size, education, Shadow prices, wages, income, remittances in logarithms

[38] Instruments for shadow wage: household size, female head, marital status of head, Kapchorwa, Kumi, Mbale, Tororo, land owned, education years of head, wage income, income from agricultural goods, remittances, shadow price, total collection time, boys and girls, male and female adults.

This result is consistent with the theoretical predictions and further confirms the evidence from Ethiopia (see Mekonnen, 1998) showing that shadow wages have a significant and negative effect on amount of fuel-wood consumed by households. Unsurprisingly, households respond to changes in opportunity costs of collecting fuel-wood by cutting down the quantity of it demanded and increasing the probability that they will purchase it (See Figure 9 in Chapter 5). The shadow price coefficients for fuel-wood demand are significant and positive in both seasons.

With respect to the demographic variables, household size has positive and significant impacts on fuel-wood consumption. This result is consistent with the theoretical expectation in chapter 4. With one extra person in the household, the odds of a household increasing its fuel-wood collection are 43 and 86 percent higher in the wet and dry season respectively. This directly implies that larger households create greater need for fuel-wood. On the supply side, larger household size also means more labour for fuel-wood collection. The education variable, number of years in school for the household head, was positive and significant in the wet season, but only at a 5 percent level. The result for education is difficult to explain, even theory predicted that it would be mixed. This result indicates that households with more educated heads (expected to be richer) do not substitute away from fuel-wood products even as they become scarce. This result also suggests that education puts more pressure on the environment. It is also possible that this result was picking up the spatial aspects of the household since the study is dealing with typically rural households where the returns to education are not as high as in urban areas.

The indicators of wealth used in this estimation return mixed results. Non-wage income through remittances increases demand for fuel-wood products in the dry season but not the wet season. Workers move back to the rural areas during the rainy season and therefore remittances do fall. On the other hand, in the dry season, there are more remittances as workers send more of their earnings back home especially for the festive Christmas season. This result partly implies that in the dry season, households that earn remittances tend to increase their demand (consumption) either through purchases (see Figure 9 in chapter 5) or gathering from the farm or forest. The dry season also coincides with the festive season of December and holiday time

for school children hence demand for fuel-wood tends to increase. These estimated functional relationships imply that the amount of fuel-wood consumed does not entirely depend on household wealth variables. In sum, the results of the wealth variables show that there was limited wealth effect on fuel-wood demand.

Finally, there was seasonal variation in consumption of fuel-wood across the districts. Fuel-wood demand was lower in Kapchorwa district relative to Tororo but higher in Mbale district, in the wet season. Possible reasons for higher fuel-wood demand in Mbale could be attributed to lower temperatures during the wet season. On the other hand, in the dry season, Kumi and Mbale districts experienced increased fuel-wood demand compared to Tororo district.

In this section, fuel-wood shadow wages and prices are used in the estimation of fuel-wood collection and demand functions for households in Eastern Uganda. The results indicate that labour time, remittance, household composition, shadow prices and wages, seasonality as well as location are important independent variables. Most of the results confirm those by Heltberg *et al.* (2000), Bluffstone (2001), Adhikari *et al.* (2004) and Mekonnen (1998).

6.5 Determinants of household labour allocated to fuel -wood collection

The analysis in this section focuses on intra-household allocation of time for fuel-wood collection. Decision equations are estimated separately for men, women, and youth[39]. This restriction does not only simplify the exposition, it also corresponds to the predominant household type in Ugandan societies, where there are different gender allocations of labour.

It is important to recognize at the outset that the relation of different gender groups to the environment depends on the specific environment under consideration, and is thus location specific. It depends for example, on whether one is looking at peasant women and men in rural areas, educated women in urban areas or households in highland or lowland areas. The nature of economic activity by gender differs significantly across

[39] Girls and boys were combined into one group due to limited number of observations for participation for each category.

these contexts, as does the availability of and use of resources. Here, the main concern is a rural peasant environment where different gender and age groups have varying contributions to economic activities such as on the farm or in collection of fuel-wood, as well as other activities that sustain the household.

In order to examine possible differences, the key dependent variable was time allocated by different gender and age groups to fuel-wood collection. Total time spent by the household as a whole and that spent by men, women, and youth constitute the dependent variables. Analysis of this issue must take two important factors into account. First is the gender component of labour reallocation decisions. Women play an important role in fuel-wood collection and therefore it is expected that their allocation of time to fuel-wood collection is more sensitive to scarcity of the good than that of males. A second important aspect is seasonality. It is expected that intra-household labour allocation to collection activities varies significantly between seasons. Shadow wages for self-collected fuel-wood products will vary across seasons as well as with changes in product availability and collection conditions.

Tables 6.3 and 6.4 give the results of the cross-sectional demand for household labour input (time) for collection estimates for the wet season and dry season, respectively. From the theoretical section, shadow wages are assumed to reflect the relative opportunity cost of collecting environmental products to the household. Controlling for endogenous productivity factors, this cost is largely determined by the environmental conditions a household faces and the marginal products of labour. These factors and conditions have already been explained in the previous sections.

The results suggest that shadow wages have significant and negative effects on total household and women's collection time, but increase men's collection time. The results show that men increase their collection activities when fuel-wood becomes increasingly scarce in the wet season and decrease it with the presence of more women in the household. This result may be explained as an indication of men's relative valuation of the opportunity costs of their labour and by the fact that since the wet season is critical to household farming, when labour shortages occur in the household, men may come in to help the women collect fuel-wood.

Table 6.3 Determinants of household labour allocation to fuel-wood collection (Minutes per week): Tobit estimates - Wet season

Independent variables	Total	Women	Men	Youth
Number of boys in household	0.158	-0.048	2.099	1.353
	[0.69]	[0.18]	[1.64]	[1.43]
Number of girls in household	-0.328	-0.890***	-1.907	3.565***
	[1.49]	[3.52]	[1.55]	[3.75]
Number of men in household	-0.459	-1.336***	4.159**	-3.764***
	[1.36]	[3.43]	[2.25]	[2.66]
Number of women in household	1.124***	2.838***	-4.648**	-5.046***
	[2.99]	[6.59]	[2.25]	[3.16]
Agro-ecological zone(1 = Highlands; 0=Lowlands)	0.677**	0.662**	2.362*	1.087
	[2.58]	[2.21]	[1.72]	[1.05]
Ownership of agric land (1=YES; 0=No)	0.397**	0.11	1.371	2.348***
	[1.99]	[0.49]	[1.26]	[2.79]
Years of schooling for household head	0.182	0.145	-1.213	-0.013
	[1.25]	[0.87]	[1.55]	[0.02]
Wage Income (Off-farm income)	0.078*	-0.019	1.085***	0.31
	[1.95]	[0.42]	[2.67]	[1.47]
Shadow wage	-15.480***	-20.237***	31.178***	3.246
	[7.93]	[8.85]	[2.90]	[0.41]
Total household farm time (hours/day)	0.719***	0.962***	-1.548	2.741***
	[3.78]	[4.29]	[1.59]	[3.28]
Water collection time per trip (in hours)	0.227*	0.310**	-0.776	-0.216
	[1.68]	[2.01]	[1.17]	[0.40]
Constant	-14.721***	-19.777***	20.402*	-17.624*
	[6.67]	[7.45]	[1.84]	[1.94]
Observations	171	171	171	171
Log likelihood[40]	-293.7	-305.95	-168.28	-252.75
Chi-Squared	80.5	106.35	47.14	74.37

Absolute value of t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

The results also show that the increase in total fuel-wood collection time in the wet season comes primarily from women's time. This result is consistent with the theoretical expectations that labour allocation decisions in the household are sometime based on gender, thus, women tend to take on more tasks in the households, more especially in the wet season when labour demands for both agriculture and fuel-wood collection are highest. However, more women in the household lead to decreased collection times not only by men but also by youth. This result shows possible substitution between female labour on the one hand and boys and girls on the

other, especially in the wet season when labour demands for farm and collection work are at a peak. With more women in the household, men, boys and girls tend to decrease their participation, probably diverting their time to other activities such as farming, leisure or grazing for men and possibly on-farm activities such as planting and weeding, and school time for the boys and girls. The result was replicated for the presence of more men in the household. There was an observed decrease in collection time for women's, and boys and girls with more men in the household, other factors remaining constant. However, the effect of more men in the household was of lower magnitude than that of women on men's collection time. With respect to the girls, their presence in the household significantly offsets (decreases) women's collection time hence suggesting that girls substitute for adult female labour in fuel-wood collection. Thus, there is possible intra-household substitution of labour for fuel-wood collection among the different categories of household members in the wet season.

Other variables of interest include time spent on the farm and in the collection of water. The results suggest that fuel-wood collection is positively correlated with water collection and agricultural labour. This result is consistent with Bluffstone *et al.'s* (2001) study of farm household behaviour in the Bolivian Andes. An increase in time spent on the farm for total, women's and youth equations had a significantly positive effect on their respective collection times. The results for time spent collecting water are positive and significant for the total and women's equations. Another important variable is income received from work rendered outside the home. This result was mixed for the different groups. The result for the total and men's equations showed a positive and significant effect on their collection times, implying that increased wage income increases collection times. Total, men's and women's collection times also increased in the highlands, confirming earlier findings in chapter 5. The ownership of land was positive and significant in the total and youth equations.

Table 6.4 below reports the results for the dry season estimates of time spent in collection of fuel-wood for the different categories. A comparison with the wet season results shows that shadow wages maintain their expected negative signs and are significant in all the estimated equations. Total collection time increases with number

[40] The model was subjected to the likelihood ratio test for misspecification. The p-values (0.0015) returned indicated the model was not misspecified

of men and girls in the household, but not for women in the household. This shows that men and girls mostly perform collection activities in the dry season as women undertake other tasks in the household. On the other hand, more girls significantly reduce men's collection time but increases youth collection times. This, like earlier results, implies some degree of substitution between the men and girls.

Table 6.4 Determinants of household labour allocation to fuel-wood collection (Minutes per week): Tobit estimates - Dry season

Variable	Total	Women	Men	Youth
Number of boys in household	0.129	0.119	1.204	0.38
	[0.49]	[0.34]	[0.79]	[0.22]
Number of girls in household	0.462*	0.479	-4.716***	7.425***
	[1.76]	[1.39]	[2.78]	[3.45]
Number of men in household	1.120**	0.022	8.461***	3.954
	[2.55]	[0.04]	[3.09]	[1.26]
Number of women in household	0.683	2.458***	-2.514	-4.599
	[1.34]	[3.62]	[0.91]	[1.38]
Highlands(1=Highlands; 0=Lowlands)	-0.019	-0.972	12.359***	4.354
	[0.04]	[1.63]	[3.57]	[1.44]
Ownership of land (1=Yes; 0=No)	-0.808**	-1.004**	-4.29	1.143
	[2.56]	[2.42]	[1.53]	[0.54]
Years of schooling for household head	0.275	0.479**	-0.78	1.651
	[1.59]	[2.10]	[0.80]	[1.21]
Total household wage income	0.06	0.003	0.853**	0.193
	[1.25]	[0.04]	[2.53]	[0.63]
Shadow wage	-8.850***	-5.403*	-31.786*	-32.217*
	[3.63]	[1.68]	[1.86]	[1.81]
Time spent on household farm	0.01	-0.256	1.562	2.665
	[0.04]	[0.79]	[1.07]	[1.48]
Time spent collecting water	0.212	-0.038	1.567	0.769
	[1.28]	[0.17]	[1.60]	[0.70]
Constant	-3.634	0.944	-52.099***	-63.724***
	[1.28]	[0.25]	[2.70]	[2.90]
Observations	188	188	188	188
Log likelihood[41]	-359.14	-390.1	-171.23	-150.59
Chi-Squared	43.88	42.38	39.9	35.28

Absolute value of t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

In the dry season, women's collection time significantly increases with the number of education years of the household head and the number of women in the household. The land variable suggests that increased ownership of agricultural land significantly

[41] The models were subjected to the likelihood ratio test for misspecification. The p-values (0.0013) returned indicated the models were not misspecified

reduced collection time for the households and women in particular. This could be because affluent households and women, who are the main collectors, have more opportunities to collect fuel-wood from their own farms. Discussions with the community leaders in Tororo district provided supporting evidence for this result. Finally, location and total household wage income are important factors in men's labour allocation to farming in the dry season. Men's collection time significantly increases in the highlands compared with the lowlands.

6.7 Conclusion

This chapter shows that decisions to collect and consume fuel-wood in rural areas of eastern Uganda are determined by several social, economic and ecological factors. Specifically, the results reveal the importance of total household and gender dimensions, shadow wages and seasonality in determining household labour allocation to fuel-wood collection for the different household categories. They also show some avenues along which scarcity of environmental products could influence the allocation of labour to fuel-wood collection by gender. The relationship between environmental good scarcity and gender time allocation presented in this chapter is a very close one. In general, the results show that women spent more time in collection activities than the men and youth. The collection functions for total and women's time suggest that women are the core collectors of fuel-wood in the wet season, although men increasingly participate in the dry season. Shadow wages are higher in the wet season due to the associated opportunity costs. According to the results, shadow wages and prices are important determinants of fuel-wood collection and consumption activities. Location of the household by agro-ecological zone (highlands) was also a significant determinant of labour allocation to collect fuel-wood in the wet season (as it was of time spent collecting water and working on the farm). This result suggests that rural villages in Eastern Uganda are not homogenous entities (with regard to fuel-wood collection and consumption) that can be isolated and identified by a single objective. The collection patterns show some evidence of substitutability between male, female and girls' labour. Land holdings, household composition, individual characteristics and gender roles in the household do exert more influence on fuel-wood collection than for example, time spent on the farm or collecting water.

Chapter 7

Deforestation, land use, and household agricultural activities in Eastern Uganda

7.1 Introduction

What are the consequences of increased deforestation for agricultural labour input, and what other factors influence household time inputs to agriculture? This chapter attempts to answer these questions by examining the relationship between deforestation and participation in agricultural activities by household members in rural areas of Eastern Uganda. In the previous chapter, it was shown that increasing deforestation leads rural households to spend more time in collection activities. A gender-disaggregated analysis on the effects of deforestation on collection activities among rural households in Uganda was done and showed that women spend more time in fuel-wood collection activities than men and youth. This chapter explores a further link between deforestation and household agricultural activities. Natural resources, or more specifically their scarcity, may influence household time allocation to agriculture.

As in many other developing countries, households in rural areas of Eastern Uganda rely heavily on own labour to meet daily farm labour requirements. These households provide their own labour for planting, weeding, harvesting and other farm activities. However, peak labour demand occurs during the wet season when households are involved in planting, weeding and harvesting. This coincides with a seasonal rise in fuel-wood demand. At the same time dry fuel-wood becomes more difficult to find. This combination of effects seems likely, a priori, to influence allocation of time at household and gender specific levels. One possible result is the reallocation of labour time from other productive activities such as own-farm agricultural work to fuel-wood collection. This is a particularly pertinent issue for rural areas in Eastern Uganda where agriculture is very labour intensive. There has been little formal analysis of the link between the environment and agriculture despite its potentially serious

consequences for subsistence level agriculturalists. This chapter thus offers an empirical study of a topic which has received little attention thus far.

7.2 Determinants of household labour allocation to farming in Eastern Uganda

The main empirical question in this section is: Does deforestation (measured by time to collect fuel-wood) affect household participation in agricultural activities? It should be noted that agricultural activities like ploughing, planting, weeding and harvesting consume significant amounts of family members' time and correspond to the busiest seasons of the year, so household members' involvement in these activities are taken as the best available indicators of participation in farm activities. These activities include garden clearing during the dry season.

In the theoretical framework (chapter 4) and in Figure 9 (chapter 5), it was argued that the participation of households in agricultural activities depends on several factors including land use, deforestation, on-farm and off-farm income, household consumption needs (household size and composition), availability of other labour and individual characteristics of household members such as education, gender and age. In this section, the estimation procedure follows that proposed in the theoretical framework and used elsewhere by Bluffstone *et al.* (2001) and Thapa *et al.* (1996). The key dependant variables are household time allocation to farming[42] by family members including men, women and youth (boys and girls), measured in hours per day. Total household labour on-farm time allocation, as well as on-farm labour allocation by adult men, women, and youth is expected to be a function of, first, household cropping characteristics such as proportion of land under crops (in acres); second, use of hired labour and existence of wage (off-farm) income; third, household composition (size, gender, age, education); fourth, deforestation; and fifth, location specific factors explained by agro-ecological zones (either highlands or lowlands).

To reduce risk, rural households in Eastern Uganda allocate their land to different uses, including cash and subsistence crops and sometimes pasture. Variations in land use can have significant effects on the demand for labour. For instance, the cultivation

[42] Farming activities in this study are defined as garden clearing ploughing, planting, weeding and harvesting while wage-work includes work outside the family farm for a wage

of crops, especially mixed crops is more labour intensive than raising livestock, and many households in Eastern Uganda work more in crop production than in raising livestock. The larger the area in crops, the higher the demand for labour, including men's, women's and youths labour. On the other hand, if households have smaller areas of land under crop cultivation, the demand for labour is lower, which may mean less involvement of men, youth and women in agricultural activities.

One potentially important variable that may affect household members' participation in agricultural activities is their ability to hire labour. Hired labour in Eastern Uganda may be wage labour or it may be part of reciprocal labour sharing arrangements in which no money or goods actually change hands. Hired labour may be used to complement own labour or simply to provide a substitute. However, because of the complications in measuring hired labour, and to resolve the problem of individual versus household specific opportunity cost of time, a dummy variable is used to show whether a household hired labour or not. The effect of hiring in labour may be mixed.

Off-farm income arising from higher market wages or remittances is expected to reduce on-farm labour inputs by household members because it reduces households' dependence on production from own farms (see also Figure 9 in Chapter 5). In other words, there may be less need for that household to farm its own land and hence less need for household members to be involved in agricultural activities on their own farms. Off-farm income is considered an integral part of a labour supply model. An increase in off-farm income may also confer an income effect on leisure (Ilahi and Grimard, 2000). Wages may also represent the opportunity cost of time to the household. A market wage that is exogenous to the household or its members is observed and it is expected that as the opportunity cost of time rises, households will allocate less time to household chores, including farm work, and more to the market. In this study markets for farm labour exist since about 51 percent of the households in the sample reported hiring some agricultural labour, who are therefore paid wages either in cash or in kind as explained above. The decision to allocate household labour to off-farm activities can be viewed as part of a household "survival strategy' to diversify sources of income as a method of coping with uncertainties of agricultural production. From a gender perspective, when men work away from home, women may have to take on additional responsibilities on family farms. This reduces men's

labour input on the family farm, leaving women to take on greater farm responsibilities.

On-farm income (mainly income from the sale of agricultural goods) may show mixed results depending on the expected income gains (Nieuwoudt and Vink, 1989). First, sometimes with increased income, households may hire labour either to meet the seasonal labour deficit experienced on the farm (especially in the busy wet season). Increased on-farm income may provide households the means to pay for hired labour allowing a reduction in the household's own farm time. Through the income effect the household would want to purchase more leisure if leisure is a normal good. Secondly, as profitability from on-farm income increases, the opportunity cost of leisure increases therefore households may opt to work more on the farm than take on leisure. Thirdly, the effect may also be through real increases in farm income which mean that farming will become more attractive relative to non farming employment. Lastly, increased incomes could also lead to greater investment in farming.

Household size and household composition affect the conditions of production in peasant households, in which peasants produce for both their own consumption as well as for the market (Ellis, 1988). The availability of more men and youth in the family can substitute for women's labour in production, but its effect is indeterminate *a priori*, because the presence of more adults also increases consumption needs, thereby increasing labour demand, including female labour. Likewise, women's involvement in farm activities may also free up men's and youths' time, enabling men and youth to undertake other activities like forest clearing or raising livestock. On the other hand, a larger number of children is expected to have negative effects on women's participation in farm activities because of the women's responsibility for the children's care. More children in the household may also increase household members labour input to farming through the "consumption effect". Higher consumption needs imply a need for more production and therefore additional labour demand and burden on household members' time.

In this formulation, the variable of greatest interest is the degree of deforestation measured by the time taken to collect a unit of fuel-wood. *A priori*, up to some point

deforestation should reduce labour time on the farm because it takes away time from farmers and their farms as they search for fuel-wood. Labour in this study is complimented by agricultural land, which is assumed to be the proportion of land used for crop cultivation (crop area)[43]. As the local area cultivated rises a point may be reached at which fuel-wood collection time decreases and a fuel-wood market emerges in which labour time in agriculture is effectively traded for the labour time of specialist wood growers or harvesters from other areas.

In order to control for the effects upon on-farm time allocation of individuals and households of geographical heterogeneity and seasons, other variables that do not directly arise from the theoretical model in chapter four are included. In order to control for agro-ecological differences, each study area was identified by a dummy variable. Seasonality also presented problems: some households were interviewed during the dry and wet season. The data were consequently analyzed using two separate models (one for wet season and the other for the dry season).

Individual characteristics like education and age of the household head may have direct effects on the household time allocation to farming activities. Since farm activities have lower status than off-farm employment, more educated household heads are less likely to work in farm activities than in off-farm. The allocation of household labour may also change over the life cycle of the household head (Godoy *et al.* 1998 and Low, 1986). Older household heads are less likely to work on farms because they have grown children to substitute for them, and also because they are less able to take part in farm activities, which are physically quite demanding. To assess the extent to which forest/farm labour allocations change over time, two variables: age of the household head and the head's age squared (AGESQ) are included in the model. The inclusion of such variables is standard in the literature on time allocation[44].

In line with the above discussion, Thapa *et al.* (1996) argued that household members' participation in productive activities is mainly a function of household

[43] This excludes area under pasture area because most household's reported grazing livestock in communal grazing grounds

labour demand relative to available family labour supply. Furthermore, economic needs may justify breaking the traditional norms regarding the gender division of labour.

Results of the estimation equations for household effort in agricultural production for the wet and dry season are presented in Table 7.1. The OLS results (Column 2 and 3) show that the overall models are statistically significant (F values =12.03 and 14.75), with 46 and 49 percent of the variations in labour allocated to farming in the wet and dry seasons respectively, explained by the models. This is quite satisfactory for household level data. The models were inspected and corrected for omitted variables and heteroscedasticity using the Ramsey reset test and Breusch-Pagan/Cook-Weisburg test[45], respectively.

With respect to the individual explanatory variables, area in crops has a significant positive effect on total household labour input to farming in the wet season only. This suggests that it is not the total land area cleared or owned by the household *per se*, but the area allocated to crops that creates a labour demand that directly influences the amount of total labour time households allocate to their farms. This is an important result: the way in which the land is used combines with the total area cleared or deforested to determine household labour allocation to farming in Eastern Uganda.

Regarding the other variables, off-farm income has a significant negative effect on household farm activities, as expected, apparently easing pressures on households to work on the farm in the wet season. On the other hand, higher on-farm income (income from sale of agricultural products) tends to reduce household members' participation by facilitating their replacement by hired labour (see also Nieuwoudt and Vink, 1989). With increased incomes, as explained earlier, through the income effect households would want to purchase more leisure if leisure is a normal good.

[44] See for instance Nankhuni and Findeis, 2003; Ilahi and Grimard, 2000; Mekonnen, 1998; Cooke 2000.

[45] Ramsey rest test for omitted variables: Wet season- Prob>F =0.37 and Dry season- Prob>F=0.38. The estimates were corrected for heteroscedasticity using the method of White (1980)

Table 7.1 Determinants of household labour allocation to farming (hours per day)

Independent Variables	Total-Wet season	Total-Dry season
Household employed (hired) workers	1.587	0.32
	[0.988]	[0.938]
Age of the household head	0.427**	0.495***
	[0.208]	[0.176]
Age of household head squared	-0.004*	-0.005**
	[0.002]	[0.002]
Dummy: Female Headed Household	-2.44	3.786**
	[1.655]	[1.581]
Livestock	0.143**	0.151**
	[0.066]	[0.071]
Wage Income (Off-farm income)	-3.183***	-0.41
	[0.967]	[1.401]
Agricultural income (On-farm income)	-1.133**	-0.708
	[0.469]	[0.516]
Agro-ecological zone(1= Highlands; 0=Lowlands)	-0.992	0.433
	[0.969]	[1.280]
Number of years of schooling for household head	-0.038	-0.193*
	[0.100]	[0.098]
Proportion of area under crops, (proportion)	1.337**	-0.378
	[0.531]	[0.931]
Household size	1.123***	1.274***
	[0.158]	[0.148]
Time per trip of fuel –wood (in hours)	0.288	0.131
	[0.301]	[0.309]
Water collection time per trip (in hours)	0.649	-0.486
	[0.840]	[0.388]
Constant	23.662***	1.693
	[8.745]	[11.279]
Observations	171	188
Adjusted R-squared	0.46	0.49
F-Value	12.03**	14.75**

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

With regard to the other household-level variables: household size has a positive and significant impact on household labour inputs to agriculture in both seasons, as expected. The findings, which are in line with Kumar and Hothckiss (1988), are consistent with theory, since larger family implies greater demand for food and more labour available for farming. The individual characteristics of the household head, education and age have the expected effects on household farm labour inputs. More

educated household heads are less likely to work on farms, but only in the dry season. The results of the estimation revealed a life cycle pattern of labour allocation among for rural households in Eastern Uganda. The life-cycle working pattern seen here is important because it reveals the fact that most rural households in Eastern Uganda undergo stages related to the age of the household head in the course of their normal development (see also Low, 1986). The gender of the household head is positively associated with increased farm labour input in the dry season. Female headed households tend to be associated with increased labour input to farm work in the dry season.

Livestock owned by the household are a proxy for wealth and is found to positively associated with increased labour input on farms in both seasons. It appears that households with large livestock numbers spent a lot of time on their farms. In general, wealthier households may have more land and livestock, may spend more time farming. In addition, a *t-test* of the difference in the coefficients shows that the effects of livestock are not significantly different between the two seasons.

Results of this analysis do not support the hypothesis of a negative relationship between total household labour allocation to farming and deforestation at the household level. However, the proportion of land area under crops, wage income and on-farm income, number of livestock owned, household size, age, gender and education of the household head are important determinants of total household farm labour allocation. In the next section the effects of deforestation on intra-household allocation of labour are analyzed.

7.3 Determinants of intra-household labour allocation to farming in Uganda

The estimation described in this section focuses on the likelihood that time allocation on agricultural activities by age and gender changes as a result of deforestation. However, the dependent variable is censored since some members of each category did not participate in farm activities. The Tobit estimation procedure was used for these particular equations.

Table 7.2 Determinants of labour allocation to farming by gender and age: Wet season (hours per day)

Independent Variables	Women	Men	Youth
Age of the household head	0.389***	0.254*	0.645**
	[0.119]	[0.130]	[0.262]
Age of household head squared	-0.003***	-0.002*	-0.005**
	[0.001]	[0.001]	[0.003]
Household employed (hired) workers	0.595	-0.062	2.310**
	[0.535]	[0.601]	[1.118]
Proportion of children in household	-3.332	9.671***	11.007**
	[2.021]	[2.336]	[4.822]
Proportion of boys in household	-6.568***	6.767***	27.631***
	[2.134]	[2.469]	[5.079]
Proportion of girls in household	-8.415***	8.505***	19.651***
	[1.942]	[2.209]	[4.479]
Proportion of men in household	-12.889***	17.549***	-9.949
	[2.512]	[2.768]	[6.027]
Dummy: Female household head	-1.3	-2.144**	-2.089
	[0.925]	[1.072]	[1.991]
Livestock	0.105***	0.109***	0
	[0.035]	[0.039]	[0.073]
Number of years of schooling household head	-0.05	-0.164***	0.088
	[0.055]	[0.062]	[0.112]
Time per trip of fuel-wood (hours/per trip)	0.305*	0.231	0.488
	[0.161]	[0.179]	[0.344]
Agro-ecological zone(1= Highlands; 0=Lowlands)	-1.050**	-1.382**	-0.901
	[0.531]	[0.590]	[1.101]
Water collection time per trip (in hours)	0.894*	0.238	-0.649
	[0.456]	[0.506]	[0.891]
Proportion of area under crops, (proportion)	0.563**	0.523*	0.631
	[0.285]	[0.312]	[0.511]
Wage income (Off-farm income)	-0.508	-0.971	-3.401***
	[0.525]	[0.591]	[1.121]
Agricultural income (Yi) (On-farm income)	-0.227	-0.231	0
	[0.258]	[0.286]	[0.527]
Constant	4.835	-1.34	-5.931
	[4.783]	[5.368]	[10.158]
Observations	171	171	171
Log likelihood[46]	-404.27	-399.67	-255.57
LR Chi-Squared	83.93	83.71	106.92

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7.2 above presents results for time allocation to farming for men, women and youth in the wet season. The estimates for boys and girls were aggregated to form one regression equation 'youth' due to limited observations for each category as already

mentioned. The story these results tell is perhaps more striking than those for total household labour allocation to farming activities. Interestingly, women's labour allocation to farm work in the wet season is positively related to time spent to collect a trip of fuel–wood (increased deforestation), rejecting our hypothesis. In this equation, all else equal, fuel-wood collection effort does not necessarily lead to reduced farm effort by household members. Likewise, water collection time is positively related to women's farm time input in the wet season. It appears that the scarcity of these environmental goods does not have significant negative impacts on household farm labour allocation. This is not terribly surprising when one considers the nature of collection of these goods. Fuel-wood is not collected everyday. It is possible to store fuel-wood and, therefore, it is possible to coordinate fuel-wood collection times with slacker agricultural times. This result is consistent with the findings of Bluffstone *et al.* (2001) and Cooke (1998).

Both the women's and men's time allocation to farming in the wet season is positively related to the land under crops, as expected. More labour is required as the area under crops increases, and both men and women become more involved during the peak farming season.

With regard to the household variables, more children in the household increase men's and youths' supply of farm labour in the wet season. This may represent a demand effect (increasing consumption needs of the household) in that children increase household food requirements. On the other hand, it appears that women's farm labour burdens are relieved somewhat by the presence of an additional adult male, girl or boy in the household. While total men's and youth's time increases when another man or boy or girl is present, there is some evidence that women's time decreases. The availability of more men, boys and girls in the family can substitute for women's labour in production.

Agro-ecological zones significantly affected gender and intra-household time allocation to farming in the wet season. Generally, women and men located in the highlands tend to work for significantly less time on their farms than do those located

[46] The model was subjected to the likelihood ratio test for misspecification. The p-values (0.0012) returned indicated the model was not misspecified

in the lowlands. This result can probably be explained by the differences in land fertility and mean land area owned, in the different agro-climatic zones of Uganda.

The individual characteristics have the expected effects on labour allocation to farm work. The life cycle pattern of household development is again confirmed in the results for the different gender and age groups. Education of the household head is negative and significant for men in the wet season implying that a higher education level provides a wider range of employment opportunities and reduces farm dependency. Generally, among families in which the head is educated, certain class values discourage men from agricultural work except when necessary for the family's survival. Thus, educated household heads are less likely to devote many hours to, or even to participate in, farming activities. This result confirms the theoretical predictions that more educated household head are less likely to participate in farming activities. Gender of the household head has a significant negative effect on labour allocation to farm work for men. Men staying in female headed households are less likely to work on farms in the wet season. A probable explanation for this is that in Uganda, often these men are *de facto* husbands who frequently visit and stay in these female-headed households but do not actively participate in the household farming activities.

Regarding other variables, off-farm income has a significant negative effect on youth farm activities, thus easing pressure on the youth to work on the farm in the wet season. Higher off-farm income could imply that households can use this income to pay for hired labour and leave the youth to go to school or perform other household activities like grazing livestock. Like in the previous estimation, ownership of livestock is positively associated with increased labour input on farms for women and men. Hiring of workers in the wet season has a significant positive effect on the time input of the youth. This result is difficult to explain since it would be expected that more hired workers would relieve the youth from farming activities. From field observations, a possible reason for the positive relationship is that when households hire labour especially during the harvest season, they may need extra supervision to minimize theft and losses. Analysis of the wet season results justifies the need for the dry season comparison.

Table 7.3 Determinants of labour allocation to farming by gender and age: Dry season (hours per day)

Independent Variables	Women	Men	Youth
Age of the household head	0.390***	0.340***	0.771***
	[0.096]	[0.111]	[0.277]
Age of household head squared	-0.003***	-0.003**	-0.007**
	[0.001]	[0.001]	[0.003]
Household employed (hired) workers	1.256**	1.131**	-1.332
	[0.498]	[0.571]	[1.182]
Proportion of children in household	-4.422**	6.418***	11.678**
	[2.120]	[2.389]	[5.828]
Proportion of boys in household	-3.658*	1.016	22.090***
	[2.210]	[2.491]	[5.999]
Proportion of girls in household	-6.147***	4.326*	22.241***
	[2.097]	[2.376]	[5.525]
Proportion of men in household	-10.512***	7.601***	0.283
	[2.275]	[2.344]	[5.977]
Dummy: Female household head	0.558	-0.827	2.178
	[0.879]	[1.029]	[2.051]
Livestock	0.063*	0.091**	0.183**
	[0.037]	[0.042]	[0.084]
Number of years of schooling for head	-0.055	-0.078	-0.240*
	[0.052]	[0.061]	[0.124]
Time per trip of fuel-wood (hours/per trip)	0.480***	0.163	0.156
	[0.162]	[0.185]	[0.384]
Agro-ecological zone(1=Highlands; 0=Lowlands)	0.52	-1.549*	-1.304
	[0.690]	[0.791]	[1.707]
Water collection time per trip (in hours)	0.097	0.175	-4.214***
	[0.207]	[0.236]	[0.993]
Proportion of area under crops	-0.571	0.736	0.411
	[0.500]	[0.570]	[1.140]
Wage income (Off-farm income)	-0.143	-0.645	-1.193
	[0.742]	[0.859]	[1.748]
Agricultural income (Yi) (On-farm income)	-0.344	-0.418	-0.698
	[0.279]	[0.317]	[0.697]
Constant	3.117	-0.792	-9.973
	[6.199]	[7.153]	[15.543]
Observations	188	188	188
Log likelihood[47]	-439.63	-439.1	-266.17
LR Chi-Squared	96.11	65.11	93.26

Standard errors in brackets

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

[47] The model was subjected to the likelihood ratio test for misspecification. The p-values (0.0010) returned indicated the model was not misspecified

Table 7.3 above presents the results for the dry season regressions. The dry season estimates yield interesting results. Even though most agricultural activities occur during the wet season, it is observed that there are changes in significance levels for various variables between the wet and dry seasons. Like in the wet season, the results of the dry season confirm the life cycle pattern of family development. Hiring of workers in the dry season has a positive effect on the time allocation of men and women. Since wages tend to be lower in the off-peak dry season, household's that can afford to hire labour may have to increase their supervisory or complementary roles in the dry season.

Interestingly, the results of the effects of the deforestation on household activities in the dry season confirm previous results in the wet season: deforestation increases women's time allocation to farming. This is not significant for youth or adult males. However, the effect of increased water collection time is negative for the youth. This result suggests that youth have to decrease their farm participation in the dry season in order to fetch water for the household. Generally, water is scarce in these areas during the dry season. This is consistent with the field observations and the cultural task allocations highlighted in the focus group discussions. Like in the wet season, men located in the highlands tend to spend less time on their farms than do those in the lowlands. Unlike the wet season, the education of the household head has a negative and significant effect on youth farm labour input to farming. As expected, the household composition variables returned mixed results again suggesting potential labour substitution and complementation to farm work among the various gender and age categories. Therefore, empirically, farm time allocation by gender and age group varied seasonally. This was consistent with other studies (Cooke, 1999; Alderman and Christi, 1991; Fafchamps and Quisumbing, 1998). Livestock remains positively significant for all the three equations confirming earlier results.

7.4 Conclusion

The relationship between the environment and rural agricultural activities is a close one in many areas of the developing world. This chapter has examined some ways by which scarcity of fuel-wood can influence household level labour allocation to agriculture in Eastern Uganda. This study has provided no support for the claim that

rural households, and more especially women, spend less time farming when it becomes more costly to collect environmental products like fuel-wood. Estimates of the determinants of total household agricultural time allocation show instead that it responds rather to the proportion of land area under crops, wage income and agricultural income, number of livestock owned, household size and composition, age, gender and education of the household head.

A gender disaggregated analysis suggests that deforestation is in fact positively associated with farm time allocation of women in both seasons. Other important determinants of labour allocation to farming by men, women and youths include; age, education and gender of the household head, agro-ecological zone, time spent in water collection per day, proportion of land under crops, ownership of livestock and household composition. Seasonality was also an important determinant of labour allocation for all these groups.

Nonetheless, it remains plausible that households may reallocate labour when opportunity costs become high. It is quite conceivable that agriculture is such a high priority activity for these rural households that other less crucial activities (including leisure) are sacrificed before agricultural labour time is reduced. This explanation is supported by the lack of evidence for labour relocation away from agriculture to fuel-wood collection, that is, agriculture is so important an activity that fuel-wood products have not become costly enough to significantly tighten household labour constraints. An alternative explanation for this result is that the timing of agricultural and fuel-wood collection activities may be such that labour reductions in the agricultural sector are not necessary. For example, fuel-wood is not collected everyday. It may be collected and stored for some time before it is used. This line of reasoning also helps to explain why there may be little or no evidence of labour relocation between agriculture and fuel-wood collection activities in the rural areas of Eastern Uganda.

Chapter 8

Conclusions, implications for policy and future research

8.1 Conclusions

This study examines the economic impacts of deforestation by linking fuel-wood depletion to the time allocation of rural labour. The motivation for such analysis is threefold. One, to improve the understanding of how changes in natural resource availability alter the allocation of tasks and time of household members in rural areas of Eastern Uganda. Two, to understand the effect of seasonality on the consumption of environmental products and the allocation of time between collection activities and farming. Three, to assess the gender and intra-household distribution of tasks based on changes in the environmental conditions and seasons. Much of the analysis in this report was devoted to measuring the effect of deforestation on fuel-wood demand and collection, and farm labour input among rural households in Uganda.

Such analysis is important for policy purposes, not only because it serves as a guide for the development of policy to protect the scarce forest resources, but also it establishes the importance of various social and economic factors, both within or beyond the control of policy makers. This kind of information may be useful as a guide to policymakers in the design of effective institutional programs and the choice of farming and energy saving systems to be given to rural communities in Uganda. A number of conclusions and policies were derived, beginning with those related to the effects of deforestation on fuel-wood collection and consumption, and then farm labour input.

The main objective in this thesis was to obtain testable predictions from a non-separable household model. The model excluded the existence of fuel-wood markets but included labour markets in agriculture for a random sample of 359 rural households in Eastern Uganda. Due to the conditions that existed, that is, the non-separability between production and consumption decisions caused by imperfect markets for fuel-wood and labour for its collection, household specific shadow wages

and prices were derived for use as explanatory variables in place of market wages and prices. The shadow wages were computed from the marginal revenue product of labour, while shadow prices were computed as the product of the shadow wages and time per trip for fuel-wood. Most results support the predictions of the theoretical model. However, the effects of deforestation on agricultural time allocation derived in the study do not support the hypothesis that households and individuals will divert time from farming when fuel-wood products become scarce. This implies that increasing fuel-wood scarcity – associated with higher collection time- does not lead to diversion of time from agricultural activities. This time could be diverted from other household activities.

Both quantitative and qualitative analyses presented in this study suggest that fuel-wood collection activities and farming are correlated with household socio-economic attributes and seasonal and agro-ecological factors. The results of the extraction (collection) and demand functions for fuel-wood showed that the more traditional measures of economic conditions – shadow wages and prices, labour time, demographic composition of the household and agro-ecological or locational factors – have an effect on fuel-wood collection activities and therefore consumption (demand). There is a distinguishable pattern in these effects in both seasons. The absence of perfect markets for fuel-wood (non-separable model) played a significant role in defining the picture of time use, seasonality as well as agro-ecological zones. Rural households in Eastern Uganda reduced their consumption of fuel-wood and spent more time collecting fuel-wood when it became scarce. It was also evident that the increased labour burden to collect fuel-wood came mostly from increases in women's collection time. On average, women in the sample households spent over 6 hours a week collecting fuel-wood. Though household members made several trips per week, fuel-wood collection may not be a daily activity in all households. However, from the analysis, it is evident that environmental goods (fuel-wood) are very important to rural farm households as all households reported consuming them.

The analysis suggests that the composition of households was important in the determination of fuel-wood collection (demand). There was evidence of substitution of collection labour time between the different gender and age groups. The results also show the importance of seasonality. Studies based on a one-time survey may

draw conclusions that are not accurate for other times of the year, or on average. This study showed that rural household labour allocation decisions vary substantially between seasons. The most demanding time is the wet (rainy season) when most household members respond to scarcity by increasing fuel-wood collection time. This pattern is well justified given the direct impact of rains on fuel-wood needs, as households need more fuel-wood for heating and cooking. In addition, fuel-wood is more difficult to gather in the wet season, as shown by the tabular and econometric analysis. Generally, women spent more time in collection fuel-wood and on the farms in all seasons. Men helped out when there were less employment opportunities with higher pay outside the farm.

The research suggests that shadow wages had a negative impact on collection time for all categories, implying that an increase in the opportunity cost of time leads to a reduction in collection time expended by household members. Equally, an increase in the labour shadow wages draws labour away from fuel-wood collection into other better paid activities. This result confirms the Ranis-Fei theories earlier discussed in Chapter 3 and the theoretical proposition, that households will supply labour to an activity until the marginal product is equal to the wages, if the wages are higher, then they opt to work outside the farm and earn income, which they can use to purchase food or other necessities. Households responded to higher shadow prices of fuel-wood by spending more time in its collection. Of course, such an increase cannot go on indefinitely because there are obvious constraints on the amount of time households and individual members can devote to collecting increasingly scarce fuel-wood. Substitutes for gathered fuel-wood exist, especially purchased fuel-wood. Households that can afford these turn to them, while the others may opt to use inferior self-gathered substitutes such as dung or grass. Though this would have been an interesting addition to the analysis, the sample provided little evidence of the households making use of these alternative fuels.

The study further suggests that Eastern Uganda is not a homogenous entity that can be isolated and identified by a single objective or a common interest. The results of the agro-ecological conditions confirm this. Policies based on assumptions of village cohesiveness and homogeneity cannot guarantee the equity of resource distribution even if resources are managed under community ownership. Differences in use of

natural resources apply not only to wealth, but also to location specific preferences, norms, and interests. Hence, priorities for the use of forest resources and systems of management are also likely to differ, as are capacities and powers to defend those priorities (Adhikari *et al.* 2004). In fact, there are different types of resource users, having different economic and social status, perspectives, knowledge systems, values, understanding and objectives. The impacts of policy are likely to depend on the type of resource user and their characteristics.

This study also examined ways in which scarcity of fuel-wood (deforestation) can influence household labour input to farming in rural areas. Generally, the findings provide no support for previous studies which show that as deforestation increases and fuel-wood gets more scarce, household members will divert time away from farming. It is important to note from the results that the effect of deforestation is positively associated with women's labour input in both seasons. This implies that reallocation of time to fuel-wood collection does not come from agricultural labour but from other productive activities such as leisure, cooking and water collection, which have not been identified in this study. However, the results provide a strong justification for the high value households place on agricultural labour because farming is the source of their livelihoods. Therefore, households would not readily reallocate time away from agriculture but rather get time from other activities. Despite the importance of fuel-wood to households, the analysis showed that it does not pose major problems to household labour allocation to agriculture. The positive relationship between the time women spend on the farms and collecting fuel-wood provides a cautionary message for policy makers and others concerned with the fate of Uganda's forests and agriculture.

It appears that seasonal factors, hired labour, household composition (education, age, size) and traditional gender roles exert more influence on households' allocation of labour to farming than does an increase in the cost of collecting fuel-wood. Four data interpretations were appraised. First, although fuel-wood was a vitally important good for rural Ugandans, fuel-wood scarcity has not raised its price enough to significantly induce reallocation of labour from farming to fuel-wood collection. Secondly, the timing of agricultural and collection activities (seasonality) may be such that it is not necessary to reallocate labour. Thirdly, this suggests that to reduce the collection

burdens for farming rural households, policies should focus more on planting trees especially on own farms. According to focus group discussions, poor management and institutional weaknesses seem to have further affected the forest sector and therefore, there is a need for a thorough review of laws and regulations governing the use of natural resources to ensure consistency. The fourth would again be institutional reform – increase the viability of commercial agriculture and of opportunities for household members to sell their labour and buy firewood.

Finally, the study does not claim that fuel-wood scarcity will never lead to diversion of agricultural time of rural households. Given the current conditions, it appears that such diversion will not be the first response of households. In parts of Uganda where there may be acute scarcity, labour diversion may ensue especially if the substitutes are limited or if households cannot afford them and also if participation in the cash economy as a migrant, as a farmer or as an agricultural employee is not a viable option. Clearly, households that would reallocate labour would do this as a short run solution, but would later on turn to planting trees on own farms. Therefore the aim in this study was not to convince the reader of the time consuming nature of fuel-wood collection activities and farm work, but rather, to explore how changes in the natural environment in the margin, may influence household time allocation to various activities. In the next section the policy implications of this study are explained.

8.2 Implications for policy

Several policy insights can be obtained from this study. For conservationists and policymakers concerned about how to make Ugandan agriculture more environmentally sustainable, policies aimed at promoting the growing of trees on own farms (agro-forestry) should be encouraged. This can be justified in terms of lowering the opportunity cost of fuel-wood collection to households. Tree resources are of fundamental importance to farming systems, and rural people may become much more involved in tree planting and management when trees/fuel-wood become scarce. However, it should be noted that, fuel-wood scarcity in the economic sense cannot always be equated with tree scarcity. So, tree planting interventions which are intended to be responsive to fuel-wood scarcities will likely miss the point. For this to be effective, tree planting and management interventions must be more responsive to

the much broader needs of the farming system. The aim should be to increase both the number and productivity of trees grown on own farms. Positive externalities from trees on own farms, such as reduced degradation, could justify support for this. This indicates a possibility of policy interventions that will reduce the relative price of fuel-wood and the net impact will be to offset the burden put on common forest resources, thus raising the output from agricultural land. However, seeking to increase the stock of forest through reforestation and own plantation works may have limited impacts unless the underlying causes of deforestation are addressed. The importance of policies that reduce fuel-wood collection time and thereby increase the time available for other activities such as agricultural production, cooking, leisure and child care should be emphasized.

From the results of this study, wages and farm incomes are important determinants and vary inversely with household total labour allocation to collection activities and farming suggesting that households, which rely on off-farm employment and farm incomes, may work on their farms less intensively in the wet season. An important benefit from increased wages and off-farm employment is that with increased off-farm employment, especially if it is not agriculturally based, there would be, first, reduced pressure on households to clear forests and land, and second, reduced demands on household and gender specific labour. Unfortunately, except for the public sector jobs like teaching, most off-farm employment in Eastern Uganda is also in agriculture, and is poorly paid. Policies to promote off-farm employment and non-agricultural income generating opportunities may therefore reduce stress on the environment.

Emphasis should also be put on targeting high value added crops and thus raising the implicit value of farm labour. This is because with higher income, households will be able to purchase substitute fuels from the market and thus reduce pressure on forests. However, presently, agricultural production is largely subsistence oriented, not very productive and based on low value crops such as like maize, millet and cassava. These crops (even coffee of late) attract very low prices and therefore the level of rural market development is very low. In the short run, there is a need to improve productivity of the traditional crops through the use of existing technologies that are already in place, thus promoting a shift away from pure subsistence farming to

production for the market. This strategy may lead to the development of rural markets and could also provide a base for a gradual shift (in the long run) into more specialized high value products like horticulture. This requires focused investments in research and extension. However an interesting question is whether policies intended to raise productivity in commercial agriculture, and hence raise agricultural incomes, would threaten the environment by raising the incentive to clear land or benefit it by making it more feasible for households to use purchased fuel rather than collecting.

To increase the productivity of labour, and more especially women's labour, it is recommended that technologies (for example dissemination of seed technology or improved varieties) that will reduce the time and energy households and women especially expend in carrying out agricultural and non-agricultural activities be developed and disseminated. However, whether increased productivity would translate into increased wages would depend on the elasticity of labour supply. Also to increase productivity, research should be conducted on labour-saving tools and equipment that are financially accessible and viable, suitable for the time and mobility of household members and women in particular. Rural infrastructure and facilities like roads and markets should be improved and expanded.

The implications from the focus group discussion results point towards concerted efforts to strengthen the forest department and to encourage rural conservation units. A very important policy implication of this study is that if the forest stock is to be increased through say reforestation, it may not achieve much impact unless the institutions are strongly involved. Improving the performance of these institutions requires a stronger forest policy, enforcement of rights and less political interference. This also raises the need for increased community level management of forests. The Local Council system could be a good starting point for the formulation of environmental goods user groups. These groups should be trained to manage their environmental resources to ensure their sustainable use, for example, restricting collection to only dry and fallen wood. Through enforcement of controlled use, forest resources would increase and collection becomes easier. Therefore, the challenge is to develop management institutions, which limit forest degradation and ensure a fair distribution of benefits.

When fuel-wood becomes less available, its consumption can be reduced, but sometimes at a very high short term cost to the household. Low-cost strategies for reducing fuel consumption when fuel-wood is scarce should be developed. Fire management may be the most obvious low-cost means of reducing fuel-wood consumption. For instance, studies have shown that the efficiency of a three-stone fire can be quite high, if the fire is closely tended and managed. Therefore a change in the cooking habits of households may help overcome fuel-wood shortages at a very low cost. Related to this strategy, changed strategies of preparing food can also reduce fuel-wood consumption. The soaking of foods such as beans and peas can greatly reduce cooking time. Also the adoption of metal pots and the abandonment of clay pots may help cook the food more quickly and be more convenient. Improved stoves should also be encouraged although they are difficult to get to households in the rural areas. Cost, availability, and know-how all preclude widespread adoption of stoves at the moment.

As mentioned earlier, efforts to protect forests may not realize meaningful results unless the underlying causes of deforestation are addressed. This is because the other factors that cause deforestation, such as increased population and the growth of rural non-farm employment opportunities, may continue to increase the demand for fuel-wood even if governments enforce control measures on forest use. This is the exact situation faced in the Mt. Elgon forest reserve in Eastern Uganda where there is tension between the local communities and government enforcement agents due to high population growth rates and the need for more farmland. Therefore, reforestation or controlled use of forests alone is not enough. It has to accompany policies that aim at controlling the other causes of deforestation and improve the performance of management institutions.

This study showed that households with larger numbers of children more likely to collect more fuel-wood. Fertility levels are especially high in Mbale district. With large numbers of children, the women, more especially endure the simultaneous burden of bearing and raising children as well as working on their farms and collecting fuel-wood. This kind of situation may be more pronounced for young families just starting to settle on their land. During the times when labour demand peaks, children often accompany their mothers to the gardens and forests (if they are

not attending school), so the presence of young children is generally compatible with the mother's economic participation. Strategies that control household size and cultural imbalances should be adopted. Such strategies include the provision of family planning services. Family planning programs could offer a way to reduce the childcare burden on women as well as eventually reduce future deforestation by the young members as they become adults and form their own households.

There are significant gender variations in on-farm and collection activities of the household. It is clear that women bear most of the responsibility for fuel-wood collection and farm work in rural Ugandan households, but it appears men help out when there are few opportunities for higher valued work. Some of these gender imbalances were more of cultural oriented in that rural households of Eastern Uganda are male dominated especially in terms of decision-making. This would suggest that policies geared toward relieving the burden of collection and farm activities for rural households, and more especially for the women, should focus more on transforming the cultural rigidities that exist and education of household members.

8.3 Suggestions for future research

The strengths of the results presented here provide an interesting ground for future research. Due to logistical and data limitations, the choice of variables used here was limited by the available data. The data did not cover the entire range of household activities like cooking, leisure and childcare and disaggregated agricultural activities like weeding, planting, harvesting and clearing. These activities are very important in determining household time allocation. Therefore, based on improved data sets, future studies in this area should integrate these activities into the analysis. If possible, a panel data set should be constructed so as to observe changes overtime and the sample size should be increased so as to draw stronger conclusions on the relationships between deforestation and these household activities. Understanding the conditions under which rural households pursue different coping strategies for fuel-wood scarcity and the impact of these strategies on farming decisions would provide excellent avenues for future research. Analysis of the determinants of collective action, performance of resource management institutions and the constraints facing the village participatory management systems are very important issues to be

investigated. These types of studies can point towards practical policy interventions as well as offer new insights into natural resource and human activity relations in developing countries.

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Appendix 1: Household survey questionnaire

STRICTLY CONFIDENTIAL

QUESTIONNAIRE: Study of the environment and its relation to household activities in Eastern Uganda

Good (Morning/afternoon/evening), I'm ---------- and we are conducting a survey for Makerere University Institute of Economics . This study is about our environment, how we are protecting it and the effects of loss of some natural products on our households. Your household was chosen to provide this information because we think your views are very not only very important but also very useful for the future development of our areas. The information you will provide will be kept strictly confidential. Thank You.

Name of Interviewer .....

Date **of Interview** **Time Begun:** ..... **Ended** .....

Household identification particulars.

District	
County	
Sub county	
Parish	
Village	
Household Serial Number	

Interviewers comments: Please fill this section after the interview.

.....

.....

.....

SECTION 1: Household Roster

1	2	3	4	5	6	7	8	9
ID CODE	List members living in this household. Starting with household. head use first names only eg John,Moses	Relationship to household head eg brother, son, daughter-in -law, father, mother, niece etc	Gender Male -01 Female-02	Age in Years	Marital Status Use Codes Marital Status (Codes) 01 – Married 02 - Single 03 - Separated/Divorced 04 – Widowed Code	What is the Highest educational qualification attained by.... Use Codes Education Codes 01- Never completed primary 02- Completed primary 03-Never completed S4 04-Completed S4 05- Completed S6 06- Tertiary level 07- University or Higher 09- No School Code	Number of Years in school e.g. 12, 4.	Has ------- lived here for more than 15 days of the last 30 days YES = 01 NO = 02
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Section 2: Characteristics of Dwelling.

2.1 Type of Dwelling

Permanent			01
Semi permanent			02
Temporary			03

2.2 Type of Tenure

Owned	01
Rented	02
Supplied free by employer	03
Supplied free or rent paid by other person	04
Other (specify)	09

2.3 Materials

Roof		**Wall**	**Wall**	**Floor**	
Thatching	01	Bricks	01	Earth	01
Tiles	02	Thatching	02	Earth and cow dung	02
Asbestos	03	Cement block	03	Cement	03
Corrugated iron	04	Wattle and mud	04	Mosaic or Tiles	04
Tin	06	Wood (timber)	06	Bricks	06
Cement	07	Stone	07	Stone	07
Others	09	Others	09	Wood	08
				Other.	09

2.4 Water Source

What is the main source of water for members of your family

Rain water	01
Piped	02
Borehole	03
Well/spring	04
River/Lake (other.. Specify)	09

2.5 How far is the drinking water source from the dwelling ? .....Km

Less than 100m		01
100m - les than 500m		02
500m - less than 1 km		03
1 km - less than 5 km		04
5 km or more		05

2.6 How long does it take to get to the water source, get water and back (in minutes) ..... Minutes

2.7 What kind of toilet does the household use?

Flush toilet	01
Improved pit latrine (VIP)	02
Other pit latrine	03
Bucket toilet	04
Bush	05
Other .	09

2.8 How far is the toilet facility from your dwelling (nearest meter) ..... Meters

2.9 What type of lighting is normally used in your household

Solar power	01
Electricity	02
Kerosene lantern	03
Tadooba	04
Candle (wax)	05
Firewood	06
Other (specify)	09

SECTION 3: ENERGY

3.1 What type of fuel is normally used in your household (for cooking, boiling water, heating etc)

Firewood	01
Charcoal	02
Paraffin/Kerosene	03
Electricity	04
Gas	05
Solar	09
Other (specify)	09

3.2 If firewood is mentioned as a source of energy for cooking/lighting, **ASK, What is the main source of your firewood products?** else go to 3.6

Gathered for forest	01
Purchased from market	02
Collected from own farm	03

3.3 What is the second source of your firewood products

Gathered for forest	01
Purchased from market	02
Collected from own farm	03
No other	04

3.4 If firewood is mentioned as a source of energy; Who in the household usually collects the wood?

Interviewer: Prompt for upto 4 people by asking: Anybody else?

		3a	3b	3c	3d	3e	3f	3g
		Person fire	**collecting wood**	**Av. Number of trips per week**	**Quantity per person per trip**	**How long does each round trip take on average Minutes/hours**	**Amount of wood sold (Value)** (last week)	**Price per Unit**
		ID code	**Name**					
First Mention								
Second mention								
Third mention								
Fourth mention								

3.5 . How far is the fuelwood source from the dwelling (household) .....Kilometers.

Less than 100m	01
100m - les than 500m	02
500m - less tha 1 km	03
1 km - less than 5 km	04
5 km or more	05

3.6 Does your household experience any fuelwood shortages?

Yes 01 No 02 If No, GO to 3.8

3.7. If YES, what in your view are the major reasons for this shortages

Firewood is getting scarce		01
Distance to collect to far		02
Less time to collect		03
Nobody to collect		04
No money to purchase		05
Other (Explain)		09

3.8 If firewood is purchased from the market, what is the price per unit.

Units	Price
Less than 10 Kg	
10 - less than 20 Kg	
More than 20 Kg	

3.9 Compared to the past 5 years, do you spend more time, less time or the same time collecting forest products

More time	01
less time	02
same time	03

3.10 What other products do you get from Natural forest/woody biomass.

	Person collecting		Av. Numb of trips per week	Quantity per person trip per trip	How long does each round trip take on average Minutes/hours	Amount of sold (Value)	Price per Unit
	ID code	Name					
Twigs and branches							
Leaves for fuel							
green manure							
Bamboo							
Poles							
Wood for tools							
Logs							
Broom sticks							
food plants /fruits							
Herbs							

3.11 Compared to the last 5 years, do you travel greater distances, shorter distances or the same distance to collect forest products

Greater distances	01
Shorter distance	02
Same distance	03

3.12 How has the current availability of forest products affected your daily time allocation?

Increased greatly	01
Decreased greatly	02
No effect	03

3.13 About how much did the household spend last week on.....?

Item	Code	Amount in Shs
Firewood	01	
Charcoal	02	
Paraffin	03	
Electricity	04	
Candles	05	
Other energy sources	09	

3.14 What are the most important problems facing forests/woody biomass in your village?

Unnecessary cutting of trees	01
Pressure from agriculture	02
Greater need for firewood	03
Greater need for building materials	04
Others (specify)	09

3.15 How have these problems affected the forests/woody biomass

Reduced availability (area)	01
Increased area	02
No difference	03

3.16 In your opinion, what should be done to protect forests/woody biomass

.....
.....

Section 4: Agriculture

4.1 How much agricultural land does your household own? ..... Acres

4.2 Is this land communal, private owned or private but rented

Communal	01
Private (Own Farm)	02
Private (Rented)	03
Other (specify)	04

4.3 How much of this land does the household use for crops and grazing animals

All for crops	01
Most for crops	02
Half for Crops and half for grazing	03
Most for grazing	04
All for grazing	05

4.4 What is the total size of all land that is available to household members for growing crops (agricultural purposes)? .....Acres

4.5 Thinking about last year. Of the land that the household could have used for growing crops, about how much did it actually use?

Less than Half	01
About Half	02
More than Half	03
All	04
None	05

Please explain why? ....
....

4.6 And, what proportion of the land has the household used or does it plan to use in 2002.

Less than Half	01
About Half	02
More than Half	03
All	04
None	05

4.7 About how many hours do you spend on your farm every day. ..... Hours

4.8 Compared to the past 10 years, has this time increased, decreased or remained the same?

Increased	01
Decreased	02
Remained the same	03

Give some reasons for this situation.
Explain..... .....

4.9 How has this situation affected your output? Has it increased, decreased or remained the same?

Increased	01
Decreased	02
Remained the same	03

4.10 On average, how much income did the household earn from the sale of its farm products last year?

4.11 If farming is mentioned,; Ask Who in the household participates in the farming?
Prompt by asking: Anybody else? First record person codes and names in the grid below. Then ask c,d and e.
(all members aged 7 and above should be included here)

	c Person working ID code	on the farm Name	d From Time	e to Daily
First Mention				
Second mention				
Third mention				
Fourth mention				
.....				
.....				

4.12 Do you employ any workers on the farm

YES 01 NO 02

4.13 If YES, how much do workers work for per day/week/month? .....Shs per .....
In what other ways do you pay your workers? Please explain.

4.14 Agricultural production

	Crop Name	In what unit does the household usually measure the crop of....?		How many units of ... crop were harvested in the past 6	How many units of crop did the household sell in the past 6 months		How many units of ... crop were given to	How many units of ..... Crop were given to pay for use of the land.
		Unit	Code	months. No.	Number	Av. Price/unit	pay for labour	Number
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

4.15 Compared to the last ten years, how do your rate your agricultural output?

Increased	01
Decreased	02
Same	03

4.16. What do you think are the reasons for this change? .....

4.17 How many livestock does the household own at moment?

	Cattle	Sheep	Goats	Pigs	Chicken
Number					

4.18 About how many litres of milk were obtained from your herd during the past (7days) (per day) .....Litres
4.19 And how much of this was for this household's own use. ..... Litres
4.20 How much do you sell each litre. . .....Shillings

FARMING ASSETS

4.21 Does this household own any mechanized farm equipment?
YES - 01 NO – 02
4.22 If YES, Approximately how much could you sell them for? .... Shs
4.23 Does this household own other non mechanical farm tools (spades, hoes etc)
YES - 01 No- 02
4.24 IF YES, Approximately how much could you sell them for? .... Shs

4.25 Other Farming Costs.

Did you pay in cash and credit for :

	Cash	Credit
Wages for workers who helped in farming		
Farming materials, like seed, fertilizers		
Petrol, diesel and oil for machines		
Food for poultry or farm animals		
Rented equipment, e.g. tractors, oxen etc		
Interest on loans		
Any other costs describe		

4.26 How do you use you agricultural residues?

Fuel	01
Thatching	02
Compost	03
Sell	04
Fodder	05
Other	09

4.27 Does the family receive money from relatives and friends? YES - '01 NO - 02

4.28 If Yes, how much? .....Shs per year

4.29 Does the family give money to relatives and friends? YES - '01 NO - 02

4.30 If Yes, how much? .....Shs per year

4.31 On average, how much money do you spend per month for feeding and other needs? Shs per month

SECTION 5: USUAL ACTIVITY STATUS (FOR USUAL MEMBERS 7 YEARS AND ABOVE)

	MAIN ACTIVITY				
Was he/she active economically during last 30 days (employed or available for employt) **Codes.** Yes and usually employed .....01 Yes but usually not employed .....02 No 03	If usually employed (code 1) the nature of main employment status (describe and code) **Occupation codes** Employer - 01 Own a/c worker - 02 Unpaid farm worker - 03 Gov't permanent - 04 Gov't temporary - 05 Private permanent - 06 private temporary - 07 Private casual - 08 Other (specify) - 09	Worked for Day (D) Week (W) Month (M)	Wage per Unit of work **Shs/Unit**	If No, in col.(2), assign reason of not being economically active (Use codes) **Reason for not working** Too Young or old 01 Disabled/ not able to work 02 Student 03 Unpaid domestic worker 04 Unpaid community/voluntary worker pensioner 06 Not interested in work 07 Other (specify) 09	
2a	2b	2c	2d	2h	

Section 6: Day preceding interview (preferably not Sunday)

Time	What did you do	Time Begun	Time ended	Location Where	List other persons with you	Doing Anything else
6.00 am						
7.00 am						
8.00 am						
9.00 am						
10.00 am						
11.00 am						
12.00 am						
1.00 pm						
2.00 pm						
3.00 pm						
4.00 pm						
5.00 pm						
6.00 pm						

4.32 What do you think is your monthly income range?

Less than 20,000	01
21,000- 50,000	02
51,000 - 100,000	03
101,000- 500,000	04
More than 500,000	05

THANK YOU

Appendix 2

Focus group discussions guide

I. Moderator.

Hello, my name is … and I am the moderator for this discussion. My job is to move the conversation along and make sure that we cover several different subjects. There is no right or wrong answer to any of the questions that I will pose to you. The purpose of this research is to find out what the people of this village honestly think. We are conducting this study for Makerere University Institute of Economics. This study is about our environment, how we are using and protecting it and the effects of loss of some natural products on our households. That is why there are no right answers or wrong answers. In fact, you may find that you disagree with another person's opinion, and I hope you will say so when that happens -- in a respectful and polite way, of course. In fact, you may find today that you disagree with another person's opinion, that there are multiple valid opinions on the same question, and I hope you will say so when that happens, in a respectful and polite way, of course. You have been chosen to provide your opinions about this information because we think your views are not only important but also very useful for the future development of this area.

Important rule: one person speaking at one time. Because we want to respect everyone and make sure that everyone is heard, we have one basic rule in this session – we will allow only one person to speak at a time. We want to have an organized session, and in order to do this, I ask that you respect the person who is speaking, and wait for him [or her] to finish her thoughts.

Introductions: Now let's go around the group and introduce ourselves. Just say one or two things about yourself, and how long you have lived in this community.

[AFTER INTRODUCTIONS:] OK, thank you. Now let us begin.

II. Questions

1. Please tell us about the state of the environment in this village during your lifetime here? Are things going generally in the right direction? What is the best thing and worst thing about the current situation at the present? What is your biggest disappointment at this point?
2. How are things in terms of the natural environment going these days for your family? What is the best thing and worst thing that has happened in terms of the natural environment and your family in recent times?
3. Do households have the same access to resources from the forests as before?
4. Which particular resources are getting scarce and what do you think is responsible for this situation? How had this affected your household and community?
5. What type of energy do most villagers use for cooking and heating?
6. What is the main source of this energy and how far is it from the village community centre?
7. Please, let us rank the benefits you receive from trees in this area, what is the most important benefit you receive from trees?

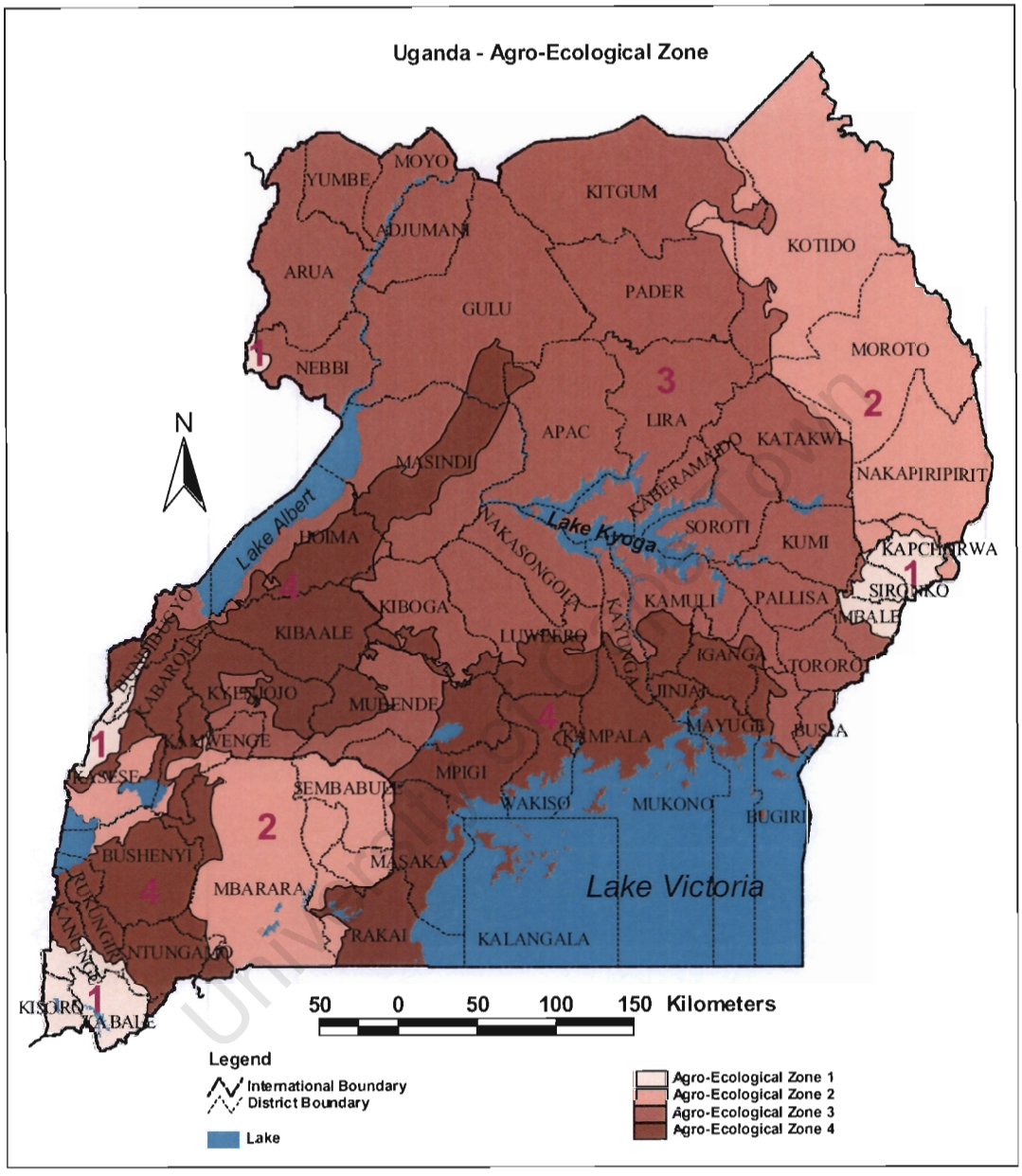
8. Compared to the past 5 years, do you spend more time, less time or the same time collecting forest products?
9. Who mainly collects fuel-wood for the households in this village?
10. Over the past few years, has any of you ever failed to prepare food or missed a meal due to lack of fuel-wood for cooking?
11. Who in the household participates in farming?
12. In your opinion, what is the current relationship between the changes in the availability of forest resources and your farming activities?
13. Is the system of management of these resources clear and understandable?
14. Do you have influence on control of forest resource use in this village?
15. Do you help decide who the managers of the forest resources are?
16. Tell me what you think the highest priority should be for the government in terms of our natural environment. What is the most urgent problem that needs to be addressed?
17. What are the other current problems facing the management forest resources?
18. What solutions do you suggest?
19. Are you optimistic or pessimistic about this village and the state of the environment for the next year? About the next five years?

Thank you. Those are all the questions I have for today.

III. The Groups

In focus group research it is standard practice to recruit participants for each discussion who, while having certain common characteristics, are not personally known to each other. Usually in ideal circumstances, the participants should be randomly recruited, although local communication (transport costs) meant that this goal was not always achieved with this study. Therefore, it was decided to mix the composition of the groups to include village leaders and elders, school teachers, local men, women and the youth. This was based on recommendations from the literature and on the advice of local colleagues who had done similar studies in these areas. The justification for this composition was because it was believed that there was less difficulty mixing participants from neighboring local council areas than in outlying villages. All the participants were therefore recruited from within the neighboring local council areas.

Appendix 3. Agro-ecological zones of Uganda



Source: National Biomass Study, Department of Forestry (2002)

Agro-ecological zone 1, that is, High altitude areas covering south western corner of Uganda (Kigezi/Kabale) and Mt. Rwenzori in Kabarole district; Mt. Elgon (Mbale, Kapchorwa in the east, and a small part of Nebbi and Arua districts. These areas produce temperate zone like crops for example wheat, iris potatoes, and coffee arabica.

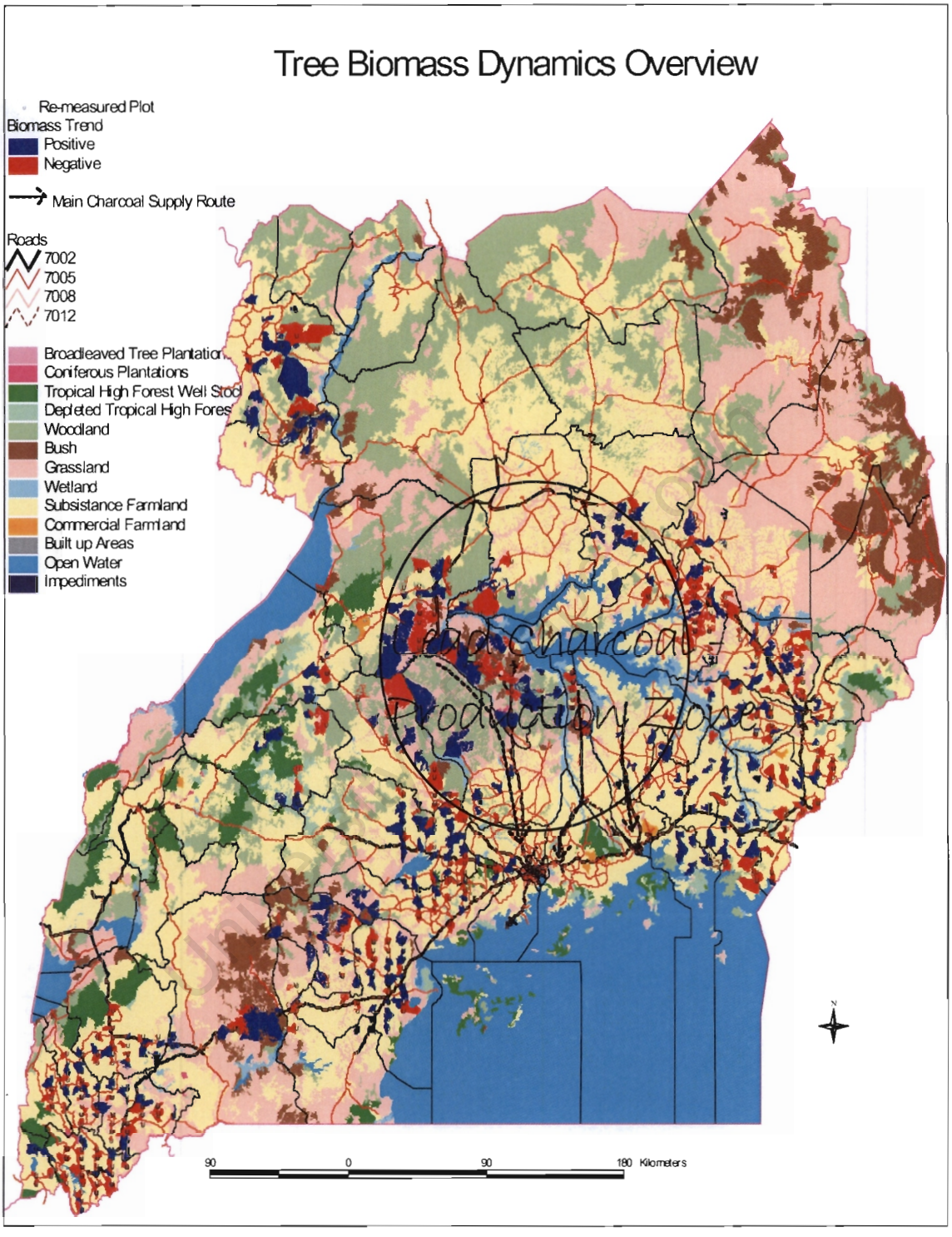
Agro-ecological zone 2, that is, Pastoral dry to Semi Arid rangeland areas covering: Mbarara and Western Masaka in the south west and Moroto and Kotido in the north east. The dominant agricultural system is pastoralism.

Agro-ecological zone 3, Semi-moist lowland Savannah areas covering Northern and Eastern Uganda districts for example, Arua, Adjumani, Moyo, Nebbi, Yumbe, Gulu, Kitgum and Lira characterised by short grass and growing of cotton, millet and sorghum.

Agro-ecological zone 4, that is, Moist lowland and medium altitude areas covering most of Southern and Western Uganda in the Districts of Mpigi, Masaka, Kabarole, Hoima, Kabale, Kisoro, Nebbi and Mbale.

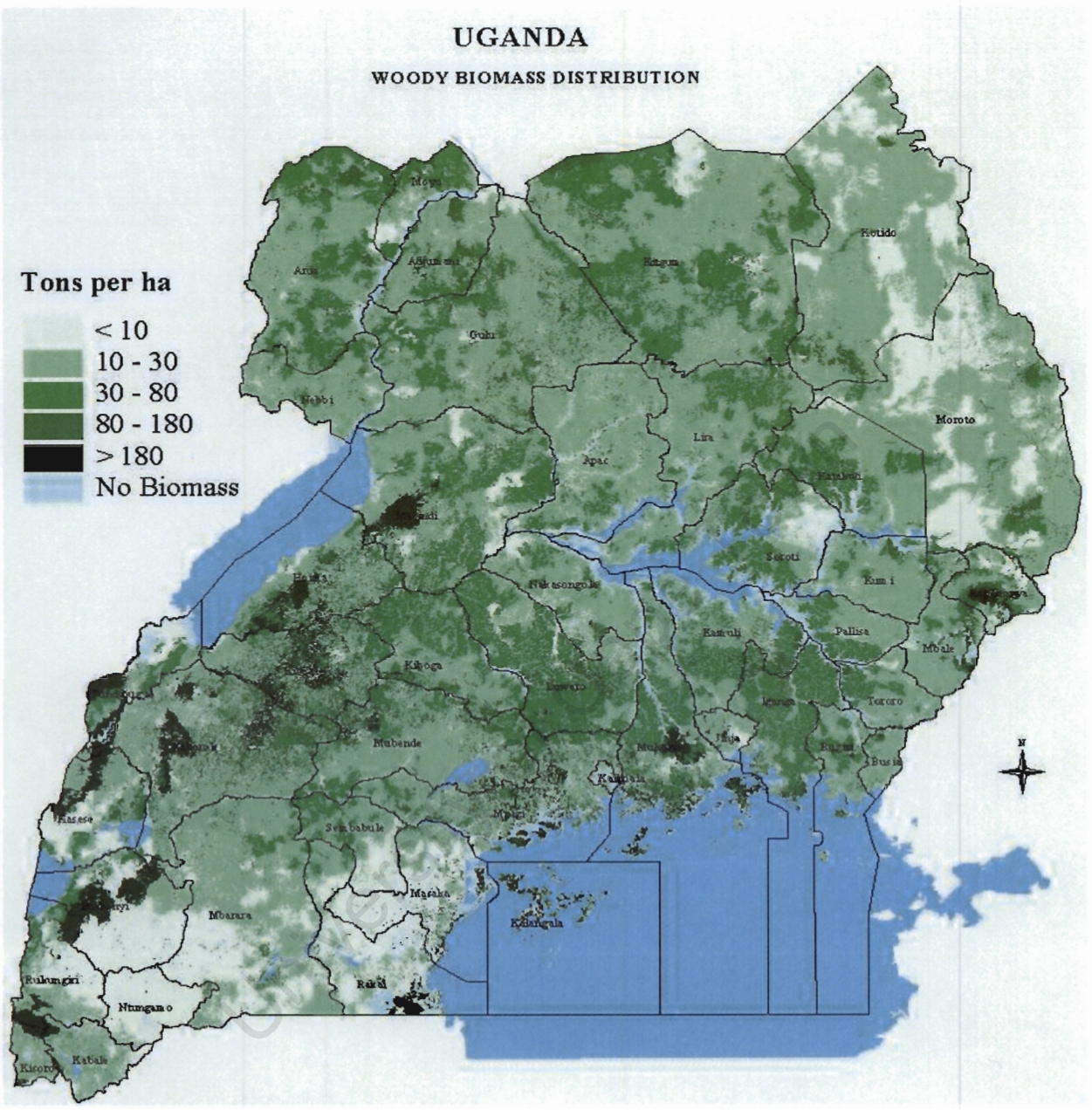
Appendix 4. Depleted or encroached tropical high forest: Mabira forest reserve

Appendix 5. Biomass dynamics and main charcoal producing areas



Source: National Biomass Study, 2002

Appendix 6. National biomass density distribution (Tons/ha)



Source: National Biomass Study, 2002.