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A Comparative Analysis of Household Owned Woodlots and Fuelwood Sufficiency Between Female and Male Headed Households: A Pilot Study in Rural Malawi, Africa

By

Mercy Gwazeni Chikoko

A DISSERTATION

Submitted to

Oregon State University

in partial fulfillment of

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degree of

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TABLE OF CONTENTS

Page

CHAPTER 1- INTRODUCTION 1

Statement of the problem 3

Statement of purpose 5

Justification 6

Research questions 8

Definition of terms 9

CHAPTER 2-LITERATURE REVIEW 13

Background of the deforestation problem 13

Related research on fuelwood problem 20

Fuelwood availability and shortage-measures 22

Factors that affect fuelwood shortage 25

The theoretical framework of the study 28

CHAPTER 3- METHODOLOGY 49

Selection of sample 49

Instruments for data collection 51

Statistical analysis. 63

CHAPTER 4-RESULTS AND DISCUSSION 65

Missing data 66

Sample size 67

Sample demographics 68

Woodlot demographics 73

Research questions 1-4 (differences between household types) 79

TABLE OF CONTENTS (CONTINUED)

Page

Resaerch question-9 (factors that affect fuelwood shortage)..... 134
Study limitations and strengths 147
CHAPTER 5- RECOMMENDATIONS AND CONCLUSIONS..... 150
The research process 150
Results from the study 152
Application of systems theory to study findings..... 164
Study implications and recommendations 169
Further research 176
Conclusion..... 177
BIBLIOGRAPHY 181
APPENDICES..... 190

LIST OF FIGURES

Figure		Page
1.	Components of the Family System	44
2.	Variables as inputs, throughputs and outputs	45
3.	Between household input, throughput and output analysis	167
4.	Within male-headed household input, throughput and outputs analysis	168

LIST OF TABLES

Table		Page
1.	Variables for logistic regression Q 9-1 and 2	62
2.	Sample and woodlot demographics variables	63
3.	Education levels for women and men (%)	71
4.	Household size, education, age, and income	72
5.	Major trees species planted in the woodlot (%)	75
6.	Woodlot age, number of trees, woodlot and land size	78
7.	Tree parts women prefer for firewood	81
8.	Reasons for women's tree part preference for fuelwood	82
9.	Most harvested tree parts collected for firewood in the past 12 months	85
10.	Reason for collecting tree parts	87
11.	Amount of fuelwood in head loads collected per week	91
12.	Number of trips per month to collect fuelwood	92
13.	Main sources of fuelwood, poles, fodder etc (%)	95
14.	Percentage of households who experienced fuelwood shortage	97
15.	Household primary cooking fuel	100
16.	Households secondary cooking	100
17.	Percentage of households that cooked with different types of fuels the past 6 months	101
18.	Benefits from fuelwood, medicine fodder and food	104
19.	Perceived benefits from poles and lumber*	108
20.	Income from sale of products in Malawi currency	109
21.	Primary reasons for establishing the woodlot	116
22.	Secondary reasons for establishing the woodlot	116
23.	Important tree attributes in tree planting by household type	117

LIST OF TABLES (CONTINUED)

Table | Page

24. Important tree attributes in tree planting decisions by gender within male-headed households 118

25. Types of trees households intend to plant by household type (%) 121

26. Types of trees men and women intend to plant in male headed households 121

27. Role in harvesting woodlot products for household use* 124

28. Roles in harvesting woodlot products for sale 125

29. Share of woodlot work by family members 127

30. Men and women decision making influence on harvesting tree parts 129

31. Percentage of respondents who collect tree parts without asking permission from spouse 133

32. Model fit information for Hypothesis 9-1 135

33. Likelihood ratio Tests for hypothesis 9-1 136

34. Parameter estimates for model 2-Hypotheis 9-1 141

35. Model fit information for Hypothesis 9-2 142

36. Likelihood ratio Tests for hypothesis 9-2 143

37. Parameter estimates for model B-Hypothesis 9-2 146

38. Summary table between household type differences- Q1-4 155

39. Summary table for male- headed household gender analysis Q5-8 156

LIST OF APPENDICES

Appendix		Page
1.	Household Woodlot Questionnaire 2002	191
2.	Benefits from the woodlot reported by men and women in the two household types	204
3.	Benefits from the woodlot reported by women in two household types	205
4.	Distribution of income	206
5.	Sample of proportions	207
6.	Proportion of woodlot income to total income-	208
7.	Income from sale of woodlot products reported by women from both households-107	208
8.	Traditional 3 stone fire place.	209
9.	Institutional Review Board Approval Document	210

This dissertation is dedicated to my husband Hastings and my son Timothy whose support and sacrifice is invaluable.

A Comparative Analysis of Household Owned Woodlots and Fuelwood Sufficiency Between Female and Male Headed Households: A Pilot Study in Rural Malawi, Africa

CHAPTER 1- INTRODUCTION

Fuelwood is a basic need for rural households in Third World countries such as Malawi. However, deforestation has reduced the supply of forest products such as fuelwood on which the households depend for their livelihood (Masangano, 1997). Deforestation has great impact on the lives of the poor, especially women who have the responsibility for collecting fuelwood. The growing population in Malawi is putting pressure on forest resources especially through conversion of vegetation areas such as forests to agricultural farmland. This has led to deforestation. In response to deforestation and the resultant fuelwood crisis, the government of Malawi sought to increase the supply of and reduce the demand for wood. The measures that were implemented included the establishment reforestation programs, such as community forestry, and promoting fuel-efficient stoves (The Malawi Government, 1996). Malawi Government community forestry program encompasses a wide variety of activities including farm forestry, agro-forestry, as well as establishing community and household owned woodlots.

There are potential difficulties in trying to solve the deforestation problem with supply enhancing and demand limiting approaches (Ham and Theron, 1999). One of the potential problems is ignoring the complex social, political and economic issues that may affect how communities and households relate to their environment (Van Horen and Eberhard, 1995).

One of the major concerns on the issue of increasing supply for wood products has to do with the position of men and women in social structures (Van Horen and Eberhard, 1995). It appears that programs intended to reduce the problem of the scarcity of fuelwood and forest products may not benefit men and women equally (Abbot and Lowore, 1999). Recently a consensus has emerged among researchers, policy makers and women advocates for the need to understand gender dynamics (such as family or community work roles, decision making power, access to and control over resources) that may operate within a community (Warren, 1992; Williams, 1982; Williams, 1992), which would affect households. Thus, understanding social structure and gender dynamics is central to the analysis of social, environmental and economic progress. Such an understanding is particularly important in designing effective policies that will not only increase the participation of men and women in community forestry projects but also ensure that men and women benefit (equally) from their participation.

STATEMENT OF THE PROBLEM

Deforestation has been a serious problem in Malawi for more than forty years. This has negatively affected poor people's livelihood, and especially women. Forests provide households with fuelwood and other forest products such as poles, lumber, fodder, food and medicines. Households depend on fuelwood for their daily energy needs such as cooking, lighting and heating. Due to fuelwood scarcity, women spend a great deal of time collecting fuelwood (Brouwer, Hart, Kamwendo and Heldens, 1996; Culler, Peterson, and Matenje, 1990; FAO 1992). Lack of time affects women's participation in other important activities. As fuelwood becomes scarce, women expend more time collecting it, leaving less time for food production, food preparation, income generation, and childcare.

In addition, fuelwood scarcity affects the nutritional and health status of families (FAO 1992; Masangano, 1997) in several ways. Fuelwood shortage may lead to reduced numbers of warm meals prepared per day ,or may lead to families avoiding cooking foods that are fuel intensive or food that take a long time to cook, such as dry beans. Fuelwood scarcity may also increase the incidence of illness resulting from improperly prepared food. In turn, the nutritional well being of household members, especially women and children, may suffer. Nutritional deficiencies and illness have negative effects on physical and mental development, reducing productivity and concentration.

The government of Malawi has implemented several reforestation programs in rural communities with the aim of increasing the supply of fuelwood and wood products. However, the question remains, will supply-enhancing and demand-limiting approaches to the fuelwood crisis solve the fuelwood problems? Or, are there additional factors, such as gender dynamics of power and decision making, that determine who gets what and how much from the woodlot that may affect fuelwood sufficiency?

This study seeks to answer these questions by examining household owned woodlots that are part of community forestry programs. Household owned woodlots are those whose trees are planted by a household to meet household needs. The technical definition of a woodlot requires that trees be planted in specially designated sites. However, trees may also be planted around the house, and along farm boundaries. This study will include as woodlots all trees planted by a household regardless of location or pattern of planting.

There are potential gender discrepancies in division of community forestry work roles, access to, and control over resources as well as decision-making power among men and women within a household or a community (Picard, 1996). For example, women may have the responsibility for collecting wood while men, may use wood for lumber/poles and make decisions over woodlot management. Reasons for growing trees, and thus the preferred attributes of a tree, may also differ between men and women. Men may be generally concerned with the construction attributes and income generating possibilities of lumber and thus

prefer straight and fast growing trees like blue gum. Women may focus instead on the burning attributes of wood (Park 1997). Gender differences in access and control of community resources are important factors to consider in woodlot management since the presence of a woodlot may not necessarily mean the household's fuelwood need is met. To formulate an effective basis for reforestation programs sufficient attention should be given to analysis of the special needs and priorities of rural households with reference to women

STATEMENT OF PURPOSE

The dual goals of this study are to explore the effects of gender of the household head on fuelwood sufficiency and to understand the gendered nature of household owned woodlot management in male-headed households. From these two specific goals, the researcher hopes to draw lessons to formulate community forestry policy.

In order to achieve this, six objectives are set up for the study.

1. To investigate fuelwood-harvesting patterns between female and male-headed households.

2. To describe variations in motivations to plant trees, and benefits gained from the woodlot between the two types of households.

3. To assess gender differences in woodlot management (work roles, proportion of work done by family members, access to woodlots, and

decision making power) between men and women in male-headed households.

4. To examine the underlying variables that influence fuelwood shortage.

5. To draw lessons from the analysis of household owned woodlots and fuelwood shortage and inform policy and research.

JUSTIFICATION

Demand and supply of fuelwood cannot be addressed by simply looking at function of production and consumption rates because factors other than these are also important. Specifically, it is necessary to identify social factors behind woodlot management that affect the household fuelwood sufficiency.

The fact that men and women utilize and exploit community forests differently has been demonstrated in many studies. However, the relationship of fuelwood shortage to access, decision-making power, labor inputs, management of, and distribution of these resources has not been delineated. Thus, central to the analysis of community forestry program is how men's labor inputs, access to, and control over woodlot resources compare to their wives at the household level, and how these affect household fuelwood sufficiency.

The study focuses on households, since the gender analysis begins within the household, the basic unit of production and consumption. This is because it is at the household level that decisions on tree planting, management and

subsequent use of tree products are made. In addition, households have the autonomy to decide on the inputs and outputs through woodlot management.

The study is, therefore, important from several aspects. A better understanding of factors affecting fuelwood sufficiency, such as gender, power and decision making among households would provide more fundamental insight into the design and implementation of effective community forestry projects that target households. The results from this study will provide feedback to the current community forestry programs as well as a basis for future community forestry programs specifically household owned woodlots.

The findings from this study will provide information on the contribution of household owned woodlots to household fuelwood sufficiency, as well as lumber, food, fodder and other woodlot products. And, most important, it will provide a better perspective of factors that affect fuelwood sufficiency, and procurement. In addition, a comparative analysis between male and female-headed households will provide some insight to how household owned woodlots affect the two types of households. Finally, some of the study participants especially those that still experience fuelwood shortage, will benefit from a fuel-efficient stove project to be funded by the American Association of University Women (AAUW)[1].

---

[1] The researcher has received a grant of $6000 from AAUW to implement a fuel efficient stoves a project in Malawi upon completion of the PhD.

RESEARCH QUESTIONS

In order to achieve the purpose of the study, the researcher seeks to answer the following questions:

1. What are the fuelwood harvesting patterns within the two types of household? Specifically: (a) what parts of trees do women gather for fuelwood? (b) Why do they collect this part? (c) What part of tree do women prefer to use for firewood? (d) Why women prefer to collect the part? (e) How much is collected and how often? (f) How much fuelwood was stored in the rainy season?
2. What is the contribution of household owned woodlots to household fuelwood sufficiency?
3. How beneficial are household owned woodlots in meeting household needs of fodder, poles, lumber, food, medicine and income? This question looks at: (a) Perceived benefit in meeting household needs, and (b) The amount of money the household received from sale of woodlot products in the past year.
4. What motivates men and women to plant trees?
5. What are the roles of women, men and family members in planting, care and harvesting of trees in household owned woodlots?
6. What is the proportion of work done by the wife, husband and other members of the family in woodlot management activities?
7. Who makes the decision on what trees to plant, when, what and how much to harvest?
8. Who has access to woodlots?

9. What are the important factors that affect woodlot sufficiency in meeting household fuelwood needs?

The focus of the research is to investigate factors that affect fuelwood sufficiency with emphasis on exploring to what extent gender of the household explains fuelwood shortage. The researcher will perform multi-variate analysis to explain household fuelwood shortage. Thus, all questions except for Q9 are exploratory and will be reported in descriptive, Chi-square and T-test statistics. Some aspects of the first seven research questions are set up to serve as predictor variables for fuelwood shortage and access to woodlots.

DEFINITION OF TERMS

Community forestry

Community forestry is where government, and non-governmental officers collaborate with the local communities in developing and implementing programs in order to improve the sustainable use of forest products. Community forestry involves two major activities. First, people's use of forest products to meet their subsistence needs such as fuelwood, poles, fruits, and medicinal plants. Second, community forestry includes activities people undertake to preserve or improve the existing forest resources (Williams 1992). Community forestry programs include agro-forestry, household owned and community woodlots as well as village forest areas.

A woodlot

A woodlot is piece of land dedicated to tree planting usually located around a household or within community. A woodlot may be owned by an individual, a household or by a community. A household woodlot is therefore a piece of land where the household members plants trees and have the rights over the trees planted and make their own management decisions

Customary land

Customary land is a piece of land that is owned by the community/ village. The chief/village headman is responsible for distributing this land to his people. Once the land is given to the household, it belongs to the household for generations. This land is considered private land and the household that owns the land has the rights to the land unless decided otherwise by the Chief. The household members cannot sell the land or redistribute it to other people besides their family and relatives.

Female and male-headed households

Female-headed households are households where women are the key providers in the household, and where an adult male is absent. This includes women, who live with and without children who are widowed, unmarried, and women who are divorced or separated. This study also included women whose husband's were absent from the household for at least 1 year, since it was

assumed these women would make independent fuelwood harvesting decisions while the husband was away.

Male-headed households are household where an adult male (mostly the husband) is present. For this study, the wife had to be present for interviews in order to enter into the study. The presence of the husband was important but not critical.

Matrilineal society

Matrilineal tribes in Malawi have several characteristics and practices. For example, when a man marries, he builds a house for the wife in her village and lives with her there. This man is called 'Mkamwini'. The man is the head of the household and makes most of the day-to-day decisions within his household. However, the man does not make decisions pertaining to his family's long-term welfare, such as giving away his daughter in marriage. The wife's brother would make such decisions. The wife's brother arranges his sister's children's marriages and the wife keeps the children in the case of divorce. In addition a "Mkamwini' can never be a chief of that village or take influential positions in the village. This is a practice in typical Chewa (study site) and Lomwe tribes.

However, the researcher is not very sure how far this is practiced in rural areas in recent years due to migration and mixing of patrilineal and matrilineal tribes. In addition, new families especially working families no longer live in

villages. Working families usually establish their own homes in the city/town they are working in.

CHAPTER 2-LITERATURE REVIEW

BACKGROUND OF THE DEFORESTATION PROBLEM

Deforestation in Malawi has been a problem for more than forty years. Based on the gap theory, some researchers have blamed deforestation on high demand for fuelwood. According to gap theorists, deforestation and forest degradation were largely due to fuelwood harvesting (APFSOS 1998, Dewees 1995 as cited in Park 1997, FAO 1997).

However, recent research has shown quite a different relationship between deforestation and fuelwood shortage. When the fuelwood gap theory was proposed, data on the origins of fuelwood were scarce and it was assumed that all fuelwood are from forests. Now that much more data have become available, an entirely different picture has emerged. Fuelwood use is no longer considered a major or general cause of deforestation, although, of course, in localized areas and under certain conditions, fuelwood use may contribute to the processes of deforestation and forest degradation.

Several authors agree that the main cause of deforestation is the conversion of forestland to agricultural land (Dewees, 1989; Munslow, Katerere, Ferf, O'Keefe, 1988). Population pressure has exacerbated the problem of deforestation. In most countries, forests are disappearing not because of the direct cutting of wood for fuel but because as population grows people clear land to

cultivate crops (Dewees, 1989, Eckholm, Foley, Barnard, and Timberlake, 1984, Leach, and Mearns, 1988).

By contrast, deforestation has lead to fuelwood scarcity. In addition, deforestation has reduced the availability of other forest products like lumber, fodder, food and medicines, on which the households/communities depend for their livelihood (Masangano 1997).

The fuelwood problem

Fuelwood is the main source of energy in Malawi and accounts for 93 percent of all energy consumed (Malawi Government, 1987, as cited in Masangano 1997). Households account for 72 percent of the total fuelwood consumption, (62 percent is consumed by rural households and 10 percent by urban households), 23 percent of the total fuelwood is used by the tobacco industry and the remaining 5 percent is shared between tea processing and brick making industries. In rural areas, fuelwood consumption is estimated at the rate of 1.1 cubic meters (m^3) or 0.66 tons per capita per year (Lele and Stone, 1989 cited in Chidamoyo 1997; Malawi Government, 1987, as cited in Masangano 1997). The rural community depends on fuelwood largely for cooking and other household needs since there is no electricity in most rural areas and electricity accounts for only 2.5% of all the energy utilized in Malawi (Malawi Government Ministry of Energy and Mining, 1992). Most Malawians also consider firewood to be a cheaper alternative than other forms of energy like electricity, kerosene and biogas

(Brouwler, et al, 1996). This is evident from the fact that even in households with electricity, there is still a high consumption of charcoal and firewood.

Fuelwood scarcity has a great impact on the lives of the poor, especially of women who have the responsibility for collecting fuelwood. Women walk long distances in search for fuelwood (Brouwer, Hart, Kamwendo and Heldens, 1996; Culler, Peterson, and Matenje, 1990). Gathering fuelwood is one of the major time-consuming activities carried out by women and children, in addition to food production activities and water collection (FAO 1992). A study conducted in Malawi by Culler, Peterson, and Matenje (1990), found that the closest source of fuelwood was an average of 3.36 miles away, with a range of 2.5 to 15 miles. The study further showed that the average number of trips per week was 2.5. The average time taken by the women to chop wood for two days' use was about 1.1 hours. Women spent additional time cutting big chunks of fuelwood before use. Brouwer, Hart, Kamwendo and Heldens (1996) had similar findings in another study also conducted in Malawi. Thus, with increasing deforestation, women are walking farther and farther in search of fuelwood.

In the same study conducted by Culler, Peterson, and Matenje (1990), about 10 percent of the respondents obtained fuelwood from a woodlot while 90 percent gathered their own wood from forests and other sources. This may be an indication that either woodlots are not available in the community in general, or women's access to the woodlots is limited. Thus, rural women often have a long working day because of fuelwood demands for daily use (Culler, Peterson, and

Matenje (1990) in addition to other domestic and agricultural responsibilities that women have. Further more, rudimentary utensils and procedures for food preparation and the scarcity of resources such as clean water, in addition to fuelwood, make women's household tasks more time consuming and laborious (FAO, 1992). As explained earlier, lack of time hampers women from participating in economic development and affects household's nutritional status (FAO, 1992, and Masangano, 1997).

Malawi Government response to deforestation and fuelwood problem

The Malawi government, realizing the increase in deforestation, has taken measures to address the problem. Among the measures was the environmental policy to guide programs such as reforestation and fuelwood efficient stoves.

Environmental Policy

In 1992, the Malawi government's Ministry of Research and Environmental Affairs formulated a national environmental policy (Malawi Government, 1996). Some of the policy goals are:

- To promote efficient utilization of nature and management of the country's natural resources and encourage, where appropriate, long term self-sufficiency in food, fuelwood, and other energy requirements.

- To ensure that individuals and economic entities are given appropriate incentives for sustainable resource use and environmental protection. Economic incentives can often induce changes in behavior of people and economic entities more effectively than enforcement of laws that prohibit certain behaviors. Priority will be given to establishing and enabling a positive economic environment.

- To promote community participation and empowerment so that social and economic benefits from natural resources are ensured. Natural resource conservation, protection and sustainable utilization can only be successful with the full participation of all the stakeholders and communities of interest. Both men and women should play a key role in the sustainable utilization of renewable resources.

- To facilitate women's participation in environmental decision-making, resource ownership and management and to recognize the importance of gender roles and gender dynamics in environmental management and in training programs at all levels.

- To promote private forestry and community based participation in the management of forest reserves and forests on customary land. To promote and support the conservation and protection of the forest ecosystem and the growing of trees by local communities, including the integration of forest and trees into farming systems and other land-use systems. Involve local communities in reforestation programs.

It should be noted that, although the environmental policies are very recent, the Malawi government took measures to address fuelwood scarcity as early as the mid 80's. Some of the earlier measures taken by the Malawi government include the introduction of fuel-efficient stoves and the establishment of reforestation programs.

Introduction of fuel conserving stoves and alternative fuels

The Malawi Government and non-governmental organizations (both local and international) introduced fuel saving stoves such as mud stoves in order to reduce the demand for fuelwood in the late 1980s and early 1990s. Alternative sources of fuel such as kerosene, solar cookers, and biogas electricity generators were introduced in rural areas as a way to reduce the demand for fuelwood (The Malawi National Commission for UNESCO 1996). Fuel-efficient stoves and alternative fuels offer many advantages such as fuel efficiency, reduced smoke emissions, (hence positive health impacts) as well as fire safety for children and families (Gandar, 1984; Grace and Arnoux, 1998). Although such is the case, generally stove programs and alternative fuels programs have a poor track record in developing countries such as Malawi (Bembridge, 1990; Foley, Moss, & Timberlake, 1984; Gander 1984; Hyman 1994). There are several reasons for this. First, there are capital investments required in the procurement and maintenance of most of the fuel-efficient stoves and alternative fuels, and many rural households could not afford such investments. Fuelwood, while scarce, is still a 'free good' (Eckholm, Foley, Barnard & Timberlake 1984; Hyde and Seve 1993;

Hyman 1994). Rural households may have more discretionary time than discretionary income and may substitute time used in other activities for fuelwood collection (Hyde and Seve 1993). Second, most of the stove designs required people to make changes in their cooking practices. For example, the traditional three-stone fireplace[2] could be made anywhere and moved at anytime, while fuel-efficient stoves require a permanent location (Hyman, 1994). Third, traditional open fires have multiple purposes like heating water, heating rooms, food preservation, and lighting. These are advantages over fuel-efficient stoves and alternative fuels (Grace and Arnoux, 1998; Hyman 1994).

Reforestation programs

The state president of Malawi instituted a national tree-planting day on Jan 21, 1976 in response to deforestation (Atuahene, 1991; Ham and Theron, 1999). Community forestry projects such as household owned woodlots are part of reforestation programs. Reforestation programs have been successful in terms of number of trees planted. In fact, Malawi is unique in the sense that reforestation has been rapid and has replaced deforested land with new sustainable forests containing both indigenous and exotic tree varieties, although the rate of deforestation still exceeds the rate of reforestation (Hyde and Seve, 1993). One of the reasons for this success is that besides fuelwood, community forests provide

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[2] In the traditional method of cooking, a saucepan rests on 3 stones based in a triangle formation. Firewood is placed underneath the saucepan

other products such as food, fodder, lumber and medicine on which the livelihood of rural Malawians depends (Groves, 1992). In addition, community forestry encourages the participation of the rural communities in the management of their environment and hence establishes a symbiotic relationship between people and their environments and help communities manage and utilize their forests in a sustainable manner.

Since community forestry offers some promise in increasing fuelwood supply and hence the possible reduction of fuelwood scarcity (Erro, 1992; Groves 1992), it is important to understand the factors that maybe at play in community forestry activities and benefits thereof. Thus, community forestry (with household owned woodlots as a point of reference) is the focus of this study.

The preceding discussion of government actions indicates that reforestation programs address the supply side of wood, and fuel conservation stoves address the demand side. As noted earlier, there may be several socio-cultural dynamics that also affect the allocation and utilization of fuelwood from the woodlots (Picard, 1996).

RELATED RESEARCH ON FUELWOOD PROBLEM

Abbot, and Lowore (1999) reported that in Malawi, firewood is commonly collected from wood as a by-product of other wood uses such as lumber and

poles. The commonly used fuelwood tree species, then, have been those commonly used for poles or for other purposes such as lumber and tool handles, and not necessary those specifically desired for firewood. Eighty-nine percent of firewood harvested consisted of dry matter, mostly dry branches remaining from trees cut previously for other purposes. (Abbot and Lowore, (1999). The results from the Abbot & Lowore (1999) research suggest that woodlots planted in response to government policies related to fuelwood scarcity may not be the most efficient way to reduce the burden of the fuelwood problem.

Abbot & Lowore (1999) also found that the type of wood harvested might be determined by the gender of harvesters. Women and girls mostly collect small size firewood while larger sizes of wood are left for boys and men to carry. Women usually use small tools like the machete when cutting firewood and they cut firewood from branches instead of cutting the whole tree. Thus, the type of tools may limit the size of firewood cut. Another constraint is the type of transportation used to carry the wood. Women usually carry firewood on their heads and thus may only carry small amounts and small pieces of wood. Another consideration is convenience. Women usually use a traditional three stone fireplace to cook food (Abbot and Lowore, 1999). This fireplace requires small pieces of wood. Thus, branches or twigs may be ideal for these women since they do not require cutting wood into smaller pieces before using them for cooking. Men, on the other hand, have access to axes and oxen power, which enable them to harvest and transport larger pieces of wood.

However, research done by Brouwler et al (1996), found that women prefer split wood (trunks) and bigger branches of wood over twigs because branches produce more charcoal, have longer burning duration, and need less attention in maintaining the fire (Brouwler et al, 1996). Thus to suggest that women collect smaller branches and twigs due to gender attributes may not be correct. Women may harvest branches and twigs due to lack of access to bigger pieces of wood, since tree trunks are saved for poles and women collect branches and twigs for firewood only as a by-product.

FUELWOOD AVAILABILITY AND SHORTAGE-MEASURES

Several authors (McClintock 1987, Fleuret 1983 and Leach, undated) have identified several manifestations of increasing fuelwood scarcity in a community. These fuelwood scarcity indicators include changes in fuelwood collection patterns, type of fuel harvested and fuel extraction patterns, use of less preferred and inferior biomass, increases in tree planting and the development of a fuelwood market.

The first indicator of fuelwood shortage is the change in fuel collection patterns, which include increases in collection time, as well as increases in distance traveled to collect wood. In addition, fuel shortage shifts the roles played in fuelwood collection. With increasing scarcity more men and children collect wood, which also changes the means of transporting wood from carrying it on the

head (head loads) as done by women to using bikes or oxcarts used by men (Leach, undated).

The second indicator of increased fuelwood scarcity is the changes in the type of fuel harvested and extraction practices. Individuals change from collecting dead wood to collecting green wood that includes cutting branches and living trees as well as cutting of younger trees. In addition, individuals use more of less preferred wood species as well as less preferred parts of the trees such as small branches, twigs, and roots, instead of split logs (Kamwiti, 1980 as cited in Fleuret 1983, and Leach, undated).

Third, fuelwood shortage increases the use of less preferred and inferior biomass such as crop and animal residues, maize cobs, maize stalks, tobacco stalks and animal dung (Kamwiti, 1980 as cited in Fleuret 1983, and Leach, undated).

The burning of crop or animal residues as fuel is one of the significant responses by rural households to fuelwood scarcity. Dependency on inferior fuels such as crop residues indicates that families are in dire stress since these fuels produce a great deal of smoke, odors, less heat, and burn too fast, calling for constant attention (McMlintock 1987, Fleuret 1983, and Leach, undated). These are undesirable attributes for women and hence the use of crop residue is most often the household's last resort. Households usually try to find other means of dealing with scarcity such as minimizing wood use in cooking methods such as simmering before switching to residues.

However, use of crop residues acts as a mediating factor and suppresses the severity of the shortage so households may not recognize fuelwood shortage as a problem. For instance, if firewood is difficult to acquire, women may use crop residue as substitutes. If these substitutes are readily available, households may not recognize that fuelwood shortage is as severe a problem as someone without alternatives (McClintock, 1987, and Leach, undated).

An increase in tree planting is the fourth indicator of fuelwood shortage. Households plant trees in order to increase woody biomass supplies in critical shortages. Tree planting may be in the form of planting trees on a farm, as hedges, live fencing, woodlots, etc; with wood-fuel byproducts as a major consideration, as well as planting trees specifically for fuel provision (Leach, undated).

Another important indicator of increasing fuelwood shortage is the development of, or an increase in, fuelwood markets. This includes increases in volume and range of locally marketed wood fuels and proportion of purchased wood fuels, as well as increases in household fuelwood expenditures[3] (Kamwiti, 1980 as cited in Fleuret 1983, and Leach, undated).

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[3] This is a function of available cash and mainly applicable to urban areas where fuelwood is considered as a commodity. In rural areas fuelwood is considered as a 'free good" and women may walk further and further to collect wood before resorting to buying wood. Time and energy is not considered as a commodity in this situation.

Other indicators of fuelwood scarcity include changes in fuel use practices like increasing time for cooking and by use of slower methods, such as simmering, in order to save fuel. Households may also make a deliberate attempt to economize (e.g., more careful fuel loading and quenching of fire after use). There may also be a reduction in less essential energy end-uses such as water and space heating, and social fires. Finally, an increase in the adoption of fuel-saving technologies such as improved fuel-efficient stoves and use of solar energy may take place in response to fuelwood shortage.

FACTORS THAT AFFECT FUELWOOD SHORTAGE

Factors that may determine the fuelwood supply in the household include number of trees planted, access for fuelwood purposes, type of trees planted, use of other fuels, harvesting of other products and gender of the household head.

Number of trees planted.

This is based on the principle that input will directly affect outputs holding all other factors constant. Or, in literal sense, "you reap what you sow". Thus, if a household plants many trees it is very likely that the household will be fuel sufficient.

Access to woodlots for fuelwood purposes

Access to woodlots includes physical as well as social access. Physical access is concerned with distance to the woodlots and the difficulty in reaching the woodlot due to terrain, slopes, etc. Social access factors are essentially concerned with the extent to which a resource is open or closed to individuals in the household (Leach, undated).

Issues of social access include ownership, household dynamics of gender and decision making power in harvesting woodlot products, as well as whether the person must seek permission or not in order to get fuelwood. Other access issues that may affect communities are land distribution, customary practices concerning the control of common land, and the physical and economic resources of consumers.

It is proposed that social factors may be the most important factors that dictate the distribution and acquisition of woodlot products. This is because social access reflects control of resources.

For example, within households, women lack decision-making power in fuelwood harvesting (Leach, undated). Thus, even when a woman who is responsible for collecting firewood sees the need for harvesting fuelwood, she is not able to decide on her own and hence may experience shortages even where trees are abundant.

Type of trees planted

Type of trees planted also affects fuelwood shortage. A study done by Bradley et al. (1985) in Kenya found that there were severe fuelwood shortages even in areas where households planted trees. This was later explained by the fact that the trees were grown for poles and not for firewood. For the same reason, if men plant trees, the choice of trees will depend first on the needs of the man, which is probably for poles and lumber. This confirms an earlier study done by Kamwiti (1980) as cited in Fleuret (1983).

Harvesting of other products

Harvesting of other products has a two-way effect. Women may have less to harvest since most of the trees are kept for other uses such as poles and lumber or for sale. On the other hand harvesting of other products may increase the amount of wood available to women as a byproduct in the form of branches, twigs, or roots.

Gender of the household head

As explained in the statement of purpose, gender of the household head may affect fuelwood shortage as this is confounded in decision-making power and access issues.

Household size.

This factor is based on the principle of demand and supply; if demand for fuelwood is high, the woodlot may not be sufficient to meet the needs of a big household as compared to a small household. Household size may also positively affect supply of fuelwood in cases where there are many family members who help in fuelwood collection, keeping other factors constant. However, economies of scale may exist relating to quantities of food prepared at one time.

THE THEORETICAL FRAMEWORK OF THE STUDY

The gap theory, a traditional view of fuelwood shortage

Between 1973 and 1974, most of the world was gripped by an energy crisis due to oil shocks, particularly in the developed countries. While the developing countries were experiencing the oil crisis, they were also gripped with yet another energy crisis, namely, the fuelwood problem. Fuelwood scarcity was commonly described in terms of a wood fuel 'gap' as a result of energy demand outstripping supply and hence the 'gap theory' emerged during this era (APFSOS, 1998, Kgathi, 1990, Mearns and Leach 1989). The basic premise of the gap theory is that fuelwood consumption is the main cause of deforestation and, therefore, of mounting fuelwood scarcities. According to the gap theory, then, a feedback system to deforestation would be to use supply enhancing and demand-constraining approaches, such as reforestation programs and fuel-efficient stoves,

respectively (Ham and Theron 1999, Thomas & Almalfitano 1982, Van Horen and Eberhard 1995).

The gap concept became widely accepted over two decades ago in development planning. For example, UNDP and the World Bank Energy sector for developing countries adapted the gap theory strategies. This was influenced by the FAO study in 1980 that estimated that over one billion people in Africa were living in fuel "deficit" areas due to deforestation caused by high-energy demands. Trees were being cut at a faster rate than they could re-grow (Leach and Mearns 1988).

However, research in the past 10 years has challenged the central idea of gap theory due to serious practical flaws of the theory (Kgathi 1990, Mearns and Leach 1989). Of interest to this research is the misconception that the use of wood for fuel was a root cause of deforestation. Many case studies and later evaluations have shown a different reality. Take, for example, how the gap theory was applied to Malawi. It was estimated that the annual demand for fuelwood in Malawi was somewhere between 8-12 million cubic meters. However, the sustainable yield from all known fuelwood sources (excluding national parks and game reserves) was not more than 3.5 million cubic meters. Woodlands, mainly on customary land, were disappearing at an overall annual rate of 3.5%. (Groves 1992). Such a calculation is misleading because the estimates of supply did not take into account all possible sources of fuel such as crop residue and dung (Chidamoyo 1997). In

addition, the estimates excluded national parks and game reserves as other possible sources of fuelwood (Abbot and Mace 1999).

When the fuelwood gap theory was proposed, data on the origins of fuelwood were scarce and it was assumed that that all fuelwood originated from forests. However, now that more data have become available, an entirely different picture has emerged (Kgathi, 1990). The major cause of deforestation is the ongoing conversion of forestland into other land uses, particularly agriculture. This is generally carried out by planned forest clearing or as a result of the gradual process of forest encroachment to develop cropland and grazing areas for livestock (Eckholm, E., Foley, G., Barnard, Timberlake, 1984).

Malawi, before and after independence in 1964, started developing cash crops for export. A great deal of land was cleared to plant cash crops. French (1986) calculated that 8 million cubic meters or about 44 percent of Malawi's wood consumption could be attributed to agricultural conversion. Lele & Stone 1989 cited in Chidamoyo, 1997, estimated that 24% of the total forested area in Malawi has been converted to arable land. In addition, a huge area of woodland is set aside to provide firewood for curing tobacco and drying coffee: two of the main cash crops in Malawi (Eckholm, et al 1984, Gulhati 1989, and Mwakasungura 1988). Tobacco estates in Malawi account for 21-23 % of the national wood fuel consumption and contribute nearly 47% to deforestation caused by harvesting wood biomass for fuel (Moyo et al 1993 and Lele and Stone as cited in Chidamoyo, 1997). In addition, large estates (commercial farms) monopolize most

of the cash crops. The local farmers and families are left with few acres of land for subsistence farming. As the population grew, land shortages increased and many trees were cut to clear even more land for food production (House and Zimalirana, et al 1992). Scarcity of land has not allowed for shifting cultivation, where a piece of land remains idle for sometime to recover from possible degradation. Lack of a fallow period and over grazing put pressure on the land, and this resulted in environmental degradation and soil erosion (Munslow 1988).

Another aspect of interest to this study is the gap theory's feedback system of supply enhancing and demand-limiting approaches. Supply enhancing approaches include reforestation programs. A household owned woodlot is an example of a wood supply-enhancing strategy. Demand limiting strategies include dissemination of fuelwood efficient stoves. The supply enhancing and demand - limiting approaches are limiting for two reasons. First, the feedback system of increasing supply of forest products ignores the dynamics between supply and distribution of fuelwood during the harvesting period. The households own the woodlots and make their own decisions over the use of the products. Ideally, every household member would get wood and wood products from the household owned woodlot. For instance, women would get fuelwood, and men would get poles to meet household needs. However, the competing uses of woodlot products between men and women may create a paradox of fuelwood shortage amidst plenty. Men as household heads may exert undue influence in determining what, and how much can be harvested for fuelwood. Second, as discussed earlier, the dissemination of woodstoves has not been nearly as successful as the

international and non-governmental organizations anticipated (Bembrdige 1990, Foley et al 1981, Gander 1984, Grace and Arnoux, 1998, Hyman 1994). One of the reasons for the failure was that the programs ignored the household dynamics that affect the adoption of fuel-efficient stoves. Thus, closing the fuelwood gap, alone, may not solve fuelwood problems. The process for dealing with fuelwood scarcity is considerably more complicated and may be better tackled or analyzed by a systems framework (Munslow et al, 1988).

Systems and ecosystems approach

The theoretical base for this study is systems theory. The relevance of a systems approach is that it places problems such as the fuelwood problem, planting of trees, access and utilization of woodlot products in a wider context and looks at fuelwood supply and demand from a broader perspective (Deacon and Firebaugh 1988; FAO 1985; Ham and Theron 1998). A system is an organized unitary whole that consists of interrelated elements (subsystems) characterized by a boundary or a functional unit within a larger system (Dechert 1965, Maloch and Deacon 1966). Systems theory is a holistic approach and is useful to researchers to understand and explain a phenomenon (Berger 1984). Systems theory deals with phenomena that are complex and highly organized, and where there is a strong interaction among parts (Constantine 1986). Systems theory helps explain the relationship between parts of a system, and how the function of the parts serves in the whole system (Constantine 1986). Without knowing the relationships, one cannot understand the system (Gross, Crandall and Knoll 1980). Family and

household owned woodlots are examples of organized complexity for which a systems view is most appropriate.

Family as a system

This study will employ elements from family systems theory in order to describe the dynamics within household owned woodlots. This is based on the isomorphism principal in which objects that may seem different have identical structures consisting of corresponding chains of objects (Berger 1984, Constantine, 1986). Deacon and Firebaugh, 1988; Gross, Crandall and Knoll 1980, Paolucci, Axinn & Hall, 1977, are key professionals in home management theory who subscribe to family systems/ecosystems theory. These key professionals are the major sources of the systems concepts reviewed in the subsequent paragraphs.

A family is an open, dynamic system defined by cultural norms, which has a unique status and special function in fulfilling the needs of its members, and which works to improve family functioning and well being through change in both the family and the environment (Deacon & Firebaugh, 1988; Hook & Paolucci, 1970). A family system consists of members of a household unit who live in the same house and eat together from one "pot". Families/households consist of individuals sharing common goals (Deacon and Firebaugh, 1988; Swanepoel, 1997 and Burkey 1993 as cited in Ham and Theron 1998). A family is a unique, dynamic social entity that is continuously changing and adapting to its

environments. A family/household also interacts within itself, i.e. inside its own boundaries as well as with other households and environments (Swanepoel, 1997 as cited in Ham and Theron, 1998). Systems theory, therefore, provides the necessary framework for conceptualizing multidirectional bonds among family and community relations, the larger systems such as economic, political, physical, technological and social systems (Berger 1984).

A family system is a unique, goal setting entity that aims to meet household needs. A family as a system has two major subsystems, which are the personal subsystem with value components, and the managerial subsystem with planning and implementation as major components. Major family goals are met through the interaction between the personal and managerial subsystem. In the Deacon and Firebaugh (1988) systems model, the personal subsystem emphasizes personal relationships that are affected by multiple social, psychological and spiritual factors. The managerial subsystem emphasizes functional aspects of the system and it is through the managerial (sub) system that individuals and families strive to accomplish goals through the acquisition and use of resources.

Application of systems theory components to the study

Systems theory is applied to this study and views family members as interdependent, sharing a set of common goals. The interrelationship of input, throughput, and output components of the family systems theory are identified and examined in the context of household owned woodlots and fuelwood shortage.

Inputs

Inputs are matter, energy, and information entering the systems in various forms that affect throughput and output. Input is the basis for answers to why, what, and whether. For example, why are resources allocated in a particular way and what resources are allocated (Deacon and Firebaugh 1988)? Inputs consist of demands and resources.

Demands are goals and events that give direction to the managerial activity. Goals are value based objectives or anticipated outcomes, which affect satisfaction and provide direction for standard setting. Events, on the other hand, are pertinent but rare or unpredictable occurrences that require action.

Resources are the means to meet demands and satisfy the systems purpose. Resources may be human and material. Human resources include knowledge, skills, and abilities that have a direct application in meeting demands. Material resources include income, time, energy, land, woodlots, etc (Deacon and Firebaugh 1988; Maloch and Deacon 1966).

In this study, demands are identified as household fuelwood needs, influenced by household size, reasons for planting trees- (motivation to plant trees), and preferred species. Resources include human, such as the proportion of work done by wife and husband, roles in planting, care and harvesting; and material resources include number of trees planted, other sources of fuelwood, ownership of the woodlots/ trees, social economic status and income, and time

taken and distance traveled per trip to get to the woodlot. The overall or combined goal for the household is, therefore, to plant trees in order to meet household needs of fuelwood, fodder, poles, lumber, food, etc.

Demands are both internal and external to the system. Internal demands originate from within the family system while external demands may originate from social, cultural, economic and government conditions (Deacon and Firebaugh 1988; Maloch and Deacon 1966). An example of an internal demand is fuelwood shortage where families/households as a purposive entity respond by planting trees. An example of an external demand would be the Malawi Government Environmental Policy that encourages community re-forestation programs such as the establishment of household owned woodlots.

Goals originate from the personal subsystem. Families may hold a number of goals and this multiplicity complicates the managerial process (Deacon and Firebaugh 1988; Maloch and Deacon 1966). This is also true in a family system as it is related to household owned woodlots for which men and women may hold different and conflicting goals. Individual goals within the family system are seen as reflecting needs or aspirations circumscribed by values or normative views about what is good and desirable, springing from the personal subsystem. In addition, the goals and values subsystem is influenced by the general social and cultural environment, which determines the role individuals are expected to play within a household.

Thus, the overall goals and values of the family system may not correspond exactly to the (often conflicting) personal goals and values held by individuals in the household. (Malawian) women generally are expected to play a small role in major household decisions (McClintock, 1987). Goals and values will, however, be influenced by the goals and values of the main decision maker in the household since significant disharmony would be destructive to the system.

Since within the household there are multiple and conflicting goals, especially between men and women, it is reasonable to hypothesize that the managerial behavior within the household owned woodlots may affect inputs, such as types of trees planted depending on who is the decision maker (head of household). For example, women are likely to prefer trees that meet fuelwood needs while men may prefer trees that would satisfy poles and lumber needs. The attributes men and women look for in trees may influence the type of trees ultimately planted in woodlots (Leach, undated; McClintock, 1987).

Throughput

Throughput is a component within the systems framework that transforms inputs to output. Throughput is essential in explaining the dynamics of a system and in understanding the internal process of how inputs are translated to outputs. Throughput is composed of activities that answer the questions how, how much, how well, when and where (Deacon and Firebaugh 1988). Throughput includes the

managerial subsystem whose components are planning and implementing (Maloch and Deacon 1966, Deacon and Firebaugh 1981).

Planning is comprised of decisions concerning standards and sequence of action. It is through planning that decisions for future actions are made. This includes deciding whether demands can be met by available resources or not . Plans account for action but may or may not be executed by the people who develop the plan (Deacon and Firebaugh 1988). This may be true in household owned woodlots where men may be responsible for planning and decision making while women may be responsible for implementing the plan.

Standard setting and sequencing are part of planning. Standards are a measure of quality and or quantity, which reflects the reconciliation of resources with demands (Maloch and Deacon 1966). Sequencing is the ordering of a task or tasks (Maloch and Deacon 1966). Sequencing is a step-by-step plan, which may or may not include precise timing.

Implementing is the actuating of plans. Some authors have argued that planning may be the managerial component but not the implementation. Implementation has two components, actuating and controlling. Actuating is putting plans into action. Controlling is the process of monitoring and adapting to situational factors while the plan is being actuated. This is usually referred to as checking and adjusting (Deacon and Firebaugh, 1988; Maloch and Deacon 1966).

Maloch and Deacon (1966) identified decision-making as an integral part of home management, mainly in planning and implementing. Decision-making is an

act of selecting the best course of action among a set of alternatives as well as determining the standards and rules to guide conduct. Goals, values, and resources from the personal subsystem together provide content for making decisions (Deacon & Firebaugh, 1988). Three types of decision-making are consensual, accommodation agreement, and defacto decision-making. In consensual decision-making, all members give equal assent and feel equally committed to the decision. In accommodation decision-making, agreement comes through accepting the desire of a dominant person when views are not reconciled. In defacto decision-making, agreement is by absence of dissent rather than by active assent. Defacto decision-making usually follows lack of communication (Deacon & Firebaugh, 1988).

In traditional rural Malawi family systems, the decision-making style is usually characterized by accommodation agreement, or defacto decision-making, where household decisions reflect the decisions of the head of household, and by extension, males in male-headed households. Low or high discrepancies in education, income, sex role differences and expectations, cultural norms, and self-esteem may influence decision-making styles. Decision-making styles include egalitarian, (shared decisions), and traditional decision patterns (Deacon and Firebaugh 1988).

For this study, throughputs are identified as decision-making power and access to woodlot resources. As argued earlier it proposed that this managerial component would also affect inputs and output. The decision-making may affect

how much and what parts of trees women get as fuelwood from the woodlot. Thus, although variables such as amounts of fuelwood harvested, types of fuelwood harvested, and use of other fuels are outputs in their own right, they will be treated as throughputs since they arise from the managerial component of planning and decision making. In addition, the variables are factors that may directly affect the main output (fuelwood sufficiency).

Output

Output is defined as used resources and met demands (Maloch and Deacon 1966). Inputs are transformed to outputs- met or changed demands, changed or met goals, increase or decrease of different resources, changed motivations, satisfaction and dissatisfaction (Gross, Crandall and knoll 1980). Outputs do not imply that demands are met consistently and fully; rather they are, to a greater or lesser degree, contracted and dealt with (Deacon and Firebaugh 1988).

For the study, outputs include fuelwood sufficiency, amount of wood stored for the rainy season, benefits (monetary and non-monetary) from the woodlot, as well as satisfaction with woodlot resources (supplies).

Outputs may be affected by inputs as well as throughputs. It is logical to state that if one plants X amount of trees s/he will get X amount of fuelwood and other products. In addition, if the types of trees planted do not suit one's needs

then the individual will not be able to get what s/he needs. And thus, inputs will directly affect outputs.

It is essential to recognize that outputs may be affected by throughputs within the managerial subsystem as well. Deacon & Firebaugh (1988) describes management as "a series of decisions throughout planning and implementing process, which involves ones value system as choices are made" (p21). It is argued that within male-headed households, outputs may be constrained by household gender dynamics, such as decision-making and power, which will affect access to, amount, and types of fuelwood harvested.

Thus, different goal achievements (multifinality) may exist between male and female-headed households despite having similar resources (woodlots and trees) and similar demands such as fuelwood shortage due to deforestation and household size (Deacon and Firebaugh, 1988).

In summary, using systems theory to guide the study, fuelwood sufficiency may be affected by inputs such as demands and resources as well as throughputs within the managerial subsystem. Figures 1 and 2, present a schematic view of systems theory components and illustrates the proposed relationship. The study aims to investigate socio-cultural factors that are important within this system that determine fuelwood sufficiency as an output. As noted earlier, not all items identified as inputs, throughputs and outputs have direct relevance in explaining shortages.

Feedback and Environment

In addition to the components described above, there are two aspects of systems theory worth noting. First, is the feedback to the system. Feedback is an important part of output. Feedback is the output that re-enters the system as input. Feedback may be positive or negative and influences subsequent throughputs and outputs.

Second is the environment as the context within which a system exists (Benathy, 1973). The family as a life support system is dependent upon the natural environment for physical sustenance and upon social organizations, which are related to man's humanness and give quality and meaning of life. Hook and Paolucci (1970), state that a rapid depletion of essential resources and the necessity to maintain man's humanness forced humankind to reconsider the interdependence of man and its environment. This is true in the case of rural Malawi where, in the past, households depended on natural forests for household fuelwood and other wood products needs.

Environment can also be thought of as a larger system that includes the system under consideration. This larger system is called a suprasystem. Systems within a supra system are peer systems. There are three relationships among peer systems. The first relationship is hierarchical. With this type of system, one system is subordinate to the other system. Second is the centralized system where one subsystem plays a central role and the other systems are arranged around it. The

third is the equalitarian relationship where none of the subsystems has a dominant or central role (Banathy, 1973).

Figures 1 and 2 illustrate the proposed relationship of inputs, throughputs and outputs. Figure 1 shows components of the family systems model adapted from Rice and Tucker, 1986, while Figure 2 shows how the dependent and independent variables in the study have been identified as inputs, outputs, and throughputs in household owned woodlots.

Figure 1 Components of the Family system

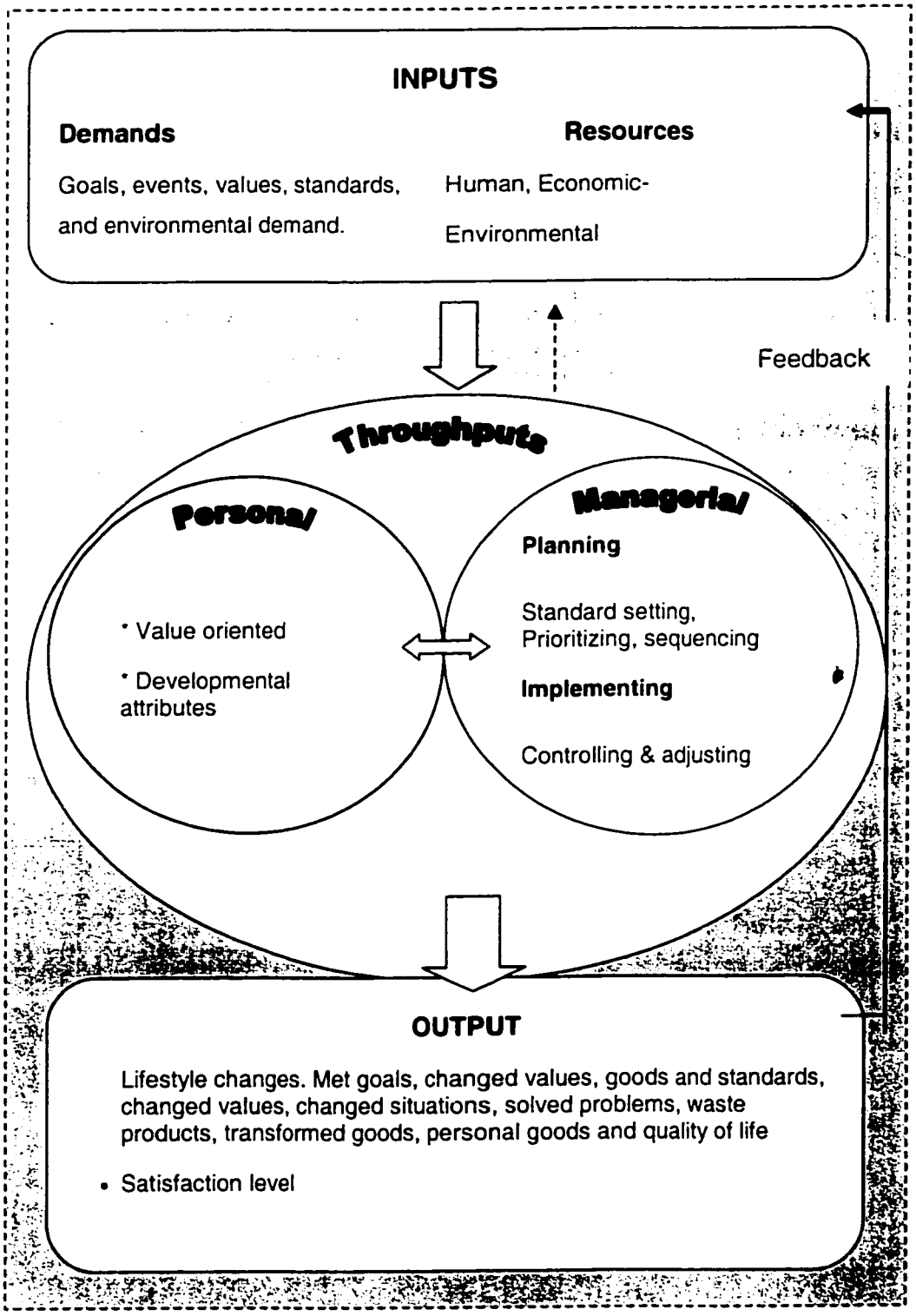
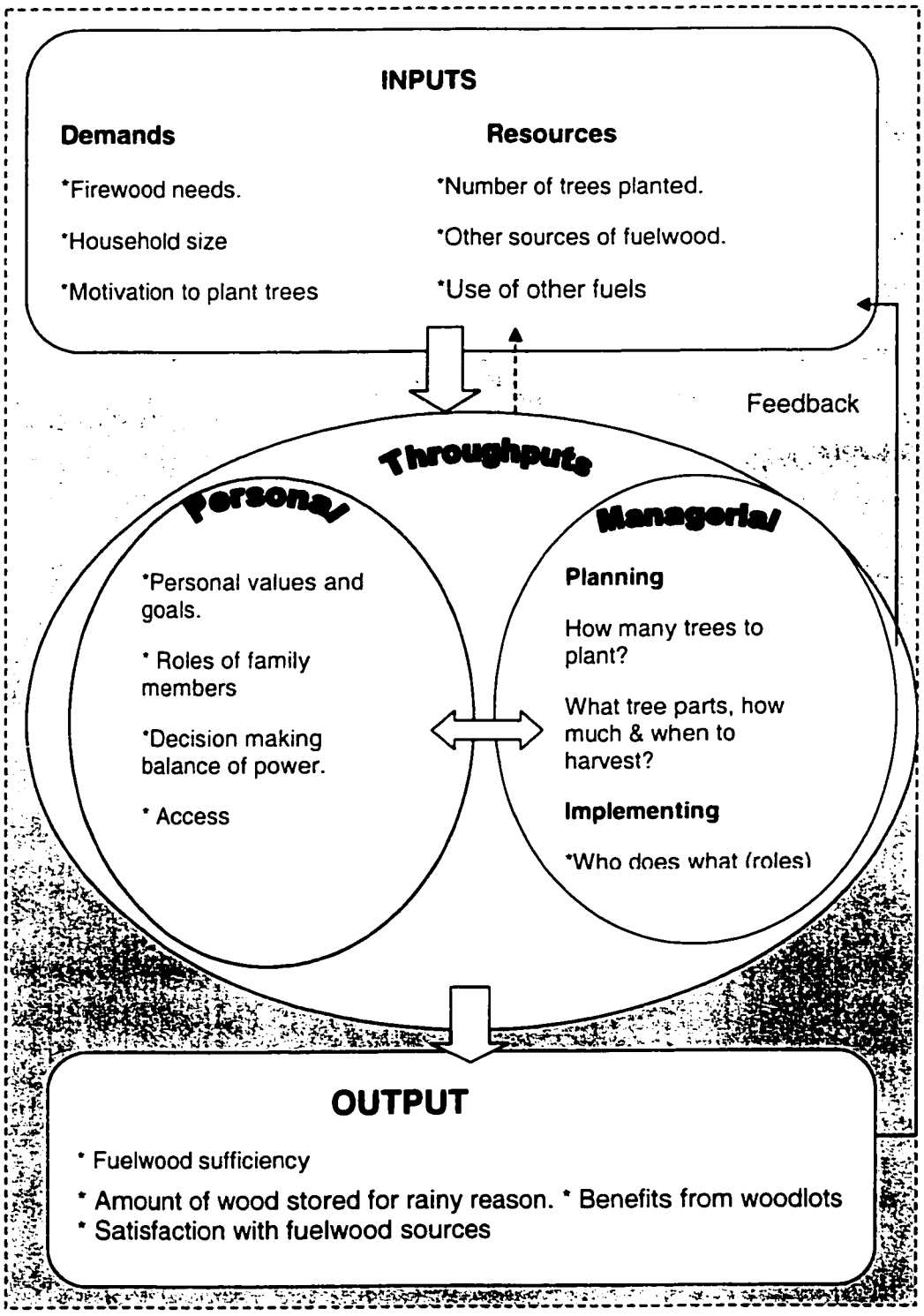


Figure 2 Variables as inputs, throughputs and outputs



Limitations of systems theory

The first limitation of the systems theory is the methodological problem of determining what variables are inputs, throughputs or outputs. For example, some variables may be either input or output to the system, depending on the time in question and focus. This is because any effect of the environment is input to the system and any effects of the system to the environment are output. Thus, inputs and outputs are functional relations between the system and its environment (Maloch and Deacon 1966). For instance, in this study, fuelwood shortage is an output from the larger environment, which serves as input to the family system. This input is in a form of demand (an event requiring action). Such action may include establishing woodlots and planting more trees. At the same time, fuelwood shortage can also be an output in the form of unchanged demands and resources. As seen from this illustration, overtime resources may be input, a throughput or output variable in the systems theory, depending on the point in time an individual is considering (Baker and Nelson 1987; Hogan and Buehler 1983).

The second limitation is that the concept of home management may create a status quo in families and communities. Deacon and Firebaugh (1988) state that management is the basic tool for creative living, for achieving desired goals using resources to our advantage (Deacon and Firebaugh, 1988). Engberg (1996), on the other hand, argues that although tools are necessary, they are not enough to bring about substantive changes in people's lives. The problems experienced by families or women may be faults of the larger system (Engberg, 1996). Women

and men often have different ideas about the distribution of resources and thus, in some cases, gaining access and control of resources may be difficult (Engberg, 1996). Therefore, one must consider strategies that can help marginalized persons (e.g. girls and women) gain access (Engberg, 1996). It is, therefore, imperative to uncover the underlying causes of family and community problems and to reshape macro level policies and programs. Engberg (1996), therefore, proposes the ecological systems approach to family resource management since it is a relevant model for international development (Engberg 1996).

Thus, Engberg (1996) takes the family systems framework further to the critical or emancipatory approach. The emancipatory approach goes beyond the framework in the area of resources and challenges family resource managers

> " to view their work through a normative lens and to give greater recognition to the political and social context within which families function. Deacon and Firebaugh looked at categories, attributes and measurement of resources and their changing availability. In contrast, the perspective proposed by Engberg would ask why resources are distributed the way they are and what would be done to make the distribution equitable" (Engberg 1996, pp 4).

The family systems approach proposed by Deacon and Firebaugh differs from the ecological approach proposed by Engberg, (1996), in that the family system focuses on the interaction within family and looks at family as an environment. An ecosystems approach focuses on the transaction of family

members across the boundaries in a network of environment in addition to the interaction among family members (Hogan and Buehler, 1984; Paolucci et al, 1977).

The third limitation to the family systems framework is that dependent and independent variables, and causes or sets of causative factors are not stated. Variables are instead linked by relationships that act together as interdependent variables (Hogan and Buehler 1984). From this perspective, the researcher has modeled variables as inputs, outputs, and throughputs according to systems theory (See Tables 2 and 3). However, the researcher has further identified independent variables to help explain the dependent variable.

Lastly, it is recognized that a systems approach does not predict behavior but is useful in defining complex situations that are affected by multiple factors (Warren 1992). Critics of a systems approach argue that a systems approach is a perspective rather than a testable theory (Douthitt and Heck 1981.)

CHAPTER 3- METHODOLOGY

SELECTION OF SAMPLE

The data for this study were collected in Malawi from rural communities with acute problems of deforestation and where the government and non-governmental organizations have established household owned woodlots. The sample selection was limited to households that owned woodlots that were five years old and older. These selected households allowed for assessment of factors that affect household fuelwood sufficiency within and between the female-headed and male-headed households.

One hundred and sixteen households: 65 male-headed households and 51 female-headed households participated in the study. In the female-headed households, 28 women were widows, 17 divorced and 8 were married (but the husband had been absent from the household for at least one year). All 65 women from male-headed households were interviewed. In male-headed households, both wife and husband were interviewed. However, only 41 men from these households were available for interviews. The research questions, focused on fuelwood harvesting, use, and fuelwood shortage, and were addressed to women. It was important for men to participate in the study since men are more conversant with woodlot demographics, family's income and other male oriented activities than

their wives: Men and women were interviewed separately, the interviews were confidential, and the responses were not shared with the spouse.

The sample population was from five Traditional Authorities in rural Lilongwe, Malawi. The Traditional Authorities include, Malili, Chadza, Chiseka, Masula and Kalumbu. The ethnic composition of the villages within the six traditional authorities was homogeneous. The Chewa are the predominant tribal group in rural Lilongwe and are matrilineal.

The researcher sought a representative sample of households with individual woodlots that are 5 years or older. However, there was no single list of such a population. In this case, the study used a multistage sampling design. First, the researcher obtained a list of households with individual woodlots from the District Forest Office. From this record, the research identified and made another list of households with woodlots that are at least 5 years old. This ensured that the woodlots were old enough to enable the researcher to ask questions on utilization of forest products. This list was then divided into male-headed and female-headed households, and a random sample was selected to represent the two types of households.

The sample was collected from communities that were representative of most communities in Malawi in terms of their demographics, economic status, etc. However, rural communities in Malawi are not homogenous in the sense that Malawi has different tribes and different family systems. Some tribes are matrilineal and others are patrilineal. This difference may affect the decision

making processes regarding power over possessions, land ownership, etc. In order to control for such differences, and other differences that are not of interest to this study, the researcher selected communities that were similar in other independent variables such as distance to other fuelwood resources as well as family system type (matrilineal or patrilineal). Realizing such limitations, results from this study have been generalized only to the populations that share characteristics similar to the sample.

INSTRUMENTS FOR DATA COLLECTION

The researcher used a questionnaire to collect quantitative data and a focus group protocol to collect qualitative data. The aim of the focus group was to understand, in depth, the intra household dynamics that determine the procurement of fuelwood. The questionnaires were in Chichewa, Malawi's national language. The questionnaire was administered face to face by the research team due to the low literacy level of the participants.

Questionnaire components.

The questionnaire included questions on fuelwood sufficiency and factors that may affect fuelwood sufficiency such as gender of the household head, access to woodlots, decision-making power, number of trees planted, household size, etc. The questionnaire also included questions on socio-economic status, household demographics, work roles, share of work within the woodlot, harvesting

patterns and the contribution of woodlot products in meeting household needs. A copy of the questionnaire is found in Appendix 1.

The research questions variables

The rationale for selecting the variables for testing was based on previous related studies and on intuitive reasoning by the researcher due to unavailability of extensive published data on this specific topic. In addition, the researcher consulted professionals in Malawi, such as experts from the Forest Research Institute of Malawi, and conducted a pilot study to test the instrument for reliability as well as to identify other factors that may affect fuelwood sufficiency in household owned woodlots that are salient but were missed during questionnaire design.

The following are variables used to address the research questions. To measure each variable, the study participants were asked to respond to a question that was either closed-ended or open-ended. The open-ended questions were coded according to the frequency of responses to allow for quantitative data analysis. The variables for research questions 1-8 are exploratory and used primarily used to describe some aspects of household owned woodlots management.

Q-1- Fuelwood harvesting patterns

Most harvested part of tree.

What part of tree did you harvested most in the past 12 months? Responses were coded at nominal level from 1-5 for twigs, branches, trunk/log, stump/root, and whole tree.

Reason for collecting the part of tree

Why do you collect this part? Open ended question and was coded at nominal level according to the pattern of responses.

Preference for part of tree for fuelwood

What part of tree do you prefer to use for fuelwood? Responses were coded at nominal level from 1-5 for twigs, branches, trunk/log, stump/root, and whole tree.

Amount collected

How much fuelwood do you collect per week? This is a reported amount of fuelwood in head-load collected past 6 months.

Frequency of collection

How many trips do you make in a month to collect fuelwood in the past 6 months?

Amounts of wood stored for the rainy season

How much fuelwood did you store for the rainy reason? This was measured in a Mendel (1meter by 1 meter by 1 meter of stack wood) or in head-load.

Q-2 -Fuelwood sufficiency

This question had two items to examine the contribution of household owned woodlots to household fuelwood sufficiency.

Fuelwood shortage

Did you experience fuelwood shortage in the past year? This question looks at household fuelwood shortage in male and female-headed households. This is the respondent's perceived fuelwood shortage in the past year, and this was set up as a categorical variable with response of 'yes' or 'no'.

Use of other fuels

Did you use the following fuels: maize stalks, shelled maize cob, cow dung etc, paraffin, electricity etc, the past year? This question examined whether households supplement fuelwood from the woodlot with other fuels such as maize stalks, shelled maize cob etc.

Q-3- Benefits from the woodlot

There were two parts to this question. These questions focus on monetary and non-monetary benefits gained from the woodlot.

Perceived benefits gained from the woodlot

What is the contribution of household owned woodlots in meeting household needs for fodder, poles, lumber and other woodlot products? Each wood product has its own question. This variable represents non-monetary benefits, and this is the respondent's perceived benefit gained from the woodlot in meeting household needs for poles, lumber, medicine, fodder and food. The responses are on a 5-point likert scale from very beneficial to not very beneficial for each woodlot product harvested.

Income from sale of woodlot products

How much money did you earn from the sale of firewood, trunks, whole tree, poles and sale of tree seedlings? This variable represents monetary benefits from the woodlot, and is the reported amount of money in Malawi Kwacha obtained from sale of all woodlot products (firewood, logs/trunks, whole tree and poles and sale of tree seedlings).

Q-4- Motivation to plant trees

This research question has two items to describe motivation, reasons for establishing the woodlots and planted tree attributes. All the items were closed questions and coded as nominal variables.

Reasons for establishing the woodlot

What was the first, second and third reason for establishing the woodlot? Responses included fuelwood for household use or for sale, for poles for household use or for sale, etc.

Planted tree attributes

What tree attributes were important in the decision to plant the tree species? Responses are coded at a nominal level: burns longer, makes a lot of charcoal, grows straight etc.

Q-5-Role of household members in woodlot management

Who plays the major role in each of the woodlot management activities? This question inquired about roles women, men and family members play in tree planting, care and harvesting in household owned woodlots? Each role has its own question. The responses are coded at a nominal level as 1-5 for wife, husband, both of us, son and daughter.

Q-6-Share of work by household members

What is the proportion of work done by (a) wife, (b) husband (c) other family members in woodlot management activities? This was the respondent's view of his/her input to woodlot work as well as his/her view on the contribution of other family members. This was coded at ordinal level on a scale of 1-5 (5- does all work, 4- does ¾ of the work, 3- ½, 2- ¼, and 1- does no work).

Q-7- Decision-making

Who makes the decision concerning harvesting of fuelwood (twigs, branches, trunks, and whole tree). Each activity is tested and coded individually. This was the respondent's perception on how influential she/he was in making fuelwood-harvesting decisions. This is a 5-point likert scale coded from 1, not very influential, to 5, very influential. A total decision-making power score was calculated by adding up the scores.

Q-8-Access to woodlots

Do you seek permission to harvest twigs, branches, trunk/log, stump/root, and whole tree? This question looks at differences in access to woodlot products between the men and women in male-headed households. This was examined by looking at whether men and women are able to get wood products (twigs, branches, logs, stumps, and w/tree) from the woodlot without seeking permission from the spouse or other individuals. This was assigned a Yes-No response. The researcher created a composite ordinal level from 0-5 from very restricted to full access. 'Yes' had a score of 0 and 'no' a score of 1.

Q-9-Factors explaining fuelwood shortage

Research question 9 is directed towards the major purpose of this study, which is to examine factors that relate directly to fuelwood shortage. This looks at whether fuelwood shortage differs between female-headed households and male-headed households controlling for other variables. Fuelwood shortage was a binary measure (yes/no), based on research question Q-2: Did you experience fuelwood shortage in the past year? Logistic regression addressed this question by testing hypothesis Q-9-1 and Q-9-2.

Hypothesis testing

The study is based on the argument that within household woodlot management there may be gender-based disparities in decision-making, control over woodlot resources, and motivations to plant and manage a woodlot. Men may retain an upper hand in deciding the type of trees grown, the uses and the time when trees are cut, thus influencing fuelwood availability and subsequent sufficiency within a household. In this case, amount and types of fuelwood harvested may be different between male and female-headed households.

This hypothesis is based on the premise that in male-headed households the man is usually the head of the household and is very influential in decision making while in female-headed households the woman may be the sole decision maker. In female-headed households, by definition, the woman is the head of the household (defacto heads where the husband is physically absent from the household, divorcees, widows and never married women) and therefore makes her own decisions. For the purpose of statistical testing differences between household types, research Q1-4 and Q-9 were transformed null hypothesis[4].

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[4] Within household gender differences were analyzed by descriptives only.

Q-1. There are no significant differences in fuelwood harvesting patterns between female and male-headed household as specified in research Q-1.

Q-2 There is no significant difference in fuelwood sufficiency (fuelwood shortage and use of other fuels) between female and male-headed household as specified in research Q-2.

Q-3 There is no significant difference in woodlot benefit (perceived benefit and income) between female and male-headed household as specified in research Q3.

Q-4 There is no significant difference in motivations to plant trees (reasons for woodlot establishment, types of trees planted and tree attributes) between female and male-headed household as specified in research Q4.

Q-9-1 Perceived fuelwood shortage is related to gender of the household head, the number of trees that are five years old and older, use of other fuels (maize stalk), number of persons in the household, and income.

There are other factors that may mediate or suppress the effects of the above variables due to their gendered nature and hence will have more influence in male-headed households than in female-headed households. These factors were incorporated into the second Hypothesis below.

Q-9-2 Perceived fuelwood shortage is related to the number of trees that are five years old and older, use of other fuels (maize stalk), number of persons in the household, income, as well as woman's access to the woodlot, decision making power on fuelwood harvesting, and woodlot ownership.

Definition of variables

Table 1 below describes the dependent and independent variables for Hypotheses Q-9-1 and Q-9-2. Table 2 contains variables used to describe the sample and woodlot demographics. The tables also explain each variable and its measurement.

Table 1. Variables for logistic regression Q 9-1 and 2

Variable	Variable description	Measurement
Dependent variable		
Fuelwood shortage	Did you experience fuelwood shortage in the past year? 1. Yes 2.No	Dichotomous, Recoded as dummy variable. 1.Yes 0.No
Independent variables		
Gender of the household head (Household type)	Married women living with husband past year is male-headed, and all others are female-headed.	Dichotomous, recoded a dummy variable. 1.Male-headed, 0.female-headed
Use of other fuels	Use of other fuels such as maize and tobacco stalks, maize cobs, cow dung etc past year. The response is yes/no.	Dichotomous, recoded dummy variable. 1. Yes 0.No
Number of trees	Number of trees that the household planted that are 5 years and older.	Continuous, actual number treated as continuous
Household size	Total number of people living in the house plus extended family members eating from one pot	Continuous, actual number treated as continuous
Access to woodlots	Does the woman seek permission from husband to collect (a) twigs (b) branches (c) logs (d) Whole tree. Responses 0. Yes, 1. No A composite score of the 4 responses was obtained, 0= no access, 1 very restricted, to 4 Very free.	A composite score at ordinal variable treated as continuous.
Woodlot ownership	The actual owner of the woodlot within the household. Wife, husband, both of us, and other.	Nominal level, coded as dummy- 1 as husband owns and 0- as wife and both of use.

Table 2. Sample and woodlot demographics variables

Variable	Variable description	Measurement
Gender	Reported gender of the respondent	Dichotomous, Dummy variable. 0.Male, 1.female
Age	Actual age of respondent at the time of the interview	Discrete, continuous (nearest year)
Education	Highest level of education attained; adult literacy class, Std 1-4 5-8, form 1-4, university, college, other	Discrete, treated as continuous
Land size	Total land the household owns	Continuous, in hectares
Woodlot size	The numbers of acres/hectares the individual's household owns	Continuous, in hectares
Number of assets	Total number of assets owned; oxcart, bicycle, house	Discrete, measured in actual numbers
Number of animals	Total number of animals owned including cattle and goats	Discrete, actual number
Income	Total income derived from farm, wage, fishing, trade etc	Continuous, measure in Malawi currency (kwacha)
Social status in the community	Any leadership roles in the community. 0 holds a position 1. Holds no position	Dichotomous, Dummy variable. (0,1)

STATISTICAL ANALYSIS.

Data were analyzed by descriptive statistics such as frequencies, cross tabs, chi-square, and t-test for research questions 1-8. The researcher used

logistic regression analysis for research question 9 in order to examine the relationship of the dependent variable, fuelwood shortage according to the models set in the hypotheses. The level of significance for all the analyses was at alpha 0.10, considering the fact that this was a pilot study.

For both Hypothesis 9-1 and 9-2, a logistic regression was appropriate because the dependent variable (fuelwood shortage) had a binary response. All categorical independent variables, as well as the dependent variable, were set up as dummy variables to allow for the regressions (Bobbie, 1990, Keppel and Zedeck 1989).

In addition, the type of data obtained also helped determine the type of models to build. Model building helps to decide what variables are important in explaining the dependent variable. For example, backward elimination in regression was used to determine the best combination of independent variables to predict the dependent variable. In a backward regression, all predictor variables were entered in the first model, and variables that do not contribute to R^2 (or are (statistically non-significant) one at a time. This continued until no more variables were eligible for removal.

The researcher did correlation tests among independent variables to test for multi-colinearity. Variables with high co-linearity (.6 or higher) from the correlation matrix were eliminated.

CHAPTER 4-RESULTS AND DISCUSSION

The purpose of this chapter is to report and analyze the findings from the study. The results presented are based on various statistical analyses of the data obtained from the household woodlot questionnaire. The data analysis had five different stages. The four stages are descriptive analyses of several variables in this study, and stage five is the logistic regression analysis.

The first step in data analysis was descriptive analyses of the sample population, including both men and women from male-headed households, and women from female-headed households. The descriptive analyses include, age, income, years of formal education received, marital status, and household size. The descriptive data were useful in describing the sample population and for comparing parameters of the two household types. In addition, the analyses were useful in identifying important variables that could later predict fuelwood shortage as stated in research question 9.

The next step was to analyze woodlot demographics, in terms of number of trees households have, types of trees planted and patterns of tree planting, as well as woodlot ownership. This was important because some of the variables (e.g. number of trees, woodlot ownership) are important in illustrating differences between the household types and, by extension, predicting fuelwood shortage.

The third and fourth steps were analyses of the first eight research questions. A brief discussion of the results follows each research question addressed in stages 3 and 4. The third step compared the two types of households in the following aspects: fuelwood-harvesting patterns, fuelwood sufficiency, motivations to plant trees, use of other fuels, and fuelwood shortage. Some of the variables from this section entered the logistic regression model as important factors influencing fuelwood shortage.

The fourth step was an analysis of intra-household gender differences pertaining to woodlot management in male-headed households. These variables include decision-making power, access, work roles, and proportion of work done by family members.

The final stage was a logistic regression to answer research question 9: to examine factors that influence fuelwood shortage. Logistic regression predicts the probability of a household experiencing fuelwood shortage, controlling for variables such as number of trees, gender of household head, use of other fuels, etc. The dependent variable, fuelwood shortage, is based on research question 2.

MISSING DATA

Handling missing data is one of the challenges researchers face in a study. In this study, some questions had non-responses, which were considered as missing data. In other cases, some questions were not applicable to some

respondents. For descriptive data analysis, which mostly involved t- tests or Chi-square tests, missing cases were excluded for each bivariate analysis. It is, therefore, important to note that the reported number of responses (referred to as $n=\Sigma_i$) differs in each of the analyses. For the regression analysis, the researcher excluded all missing data 'list wise' in order to have the same number of cases for each partial correlation.

SAMPLE SIZE

The data were obtained from 65 women in male-headed households and 51 women in female-headed households from rural Lilongwe, Malawi. Some questions were also addressed to the 40 men who were available from the male-headed households. The data used to compare the two types of households (female and male-headed) are based mainly on the women's responses, because women are responsible for collecting and using fuelwood. However, it was essential to collect some data from men in male-headed households for two reasons: first, to collect data on woodlot demographics and income, because men are generally more conversant with this information than their wives. The second purpose was to investigate the men's perceptions of access to woodlots, decision-making power, and roles in woodlot management, and also to obtain accurate information on woodlot demographics.

SAMPLE DEMOGRAPHICS

This section describes the characteristics of the sample population in terms of household size, income, the respondents' education, and age. All the data from this section are self-reported by the respondents. In Table 3, see data on education, age, household size and yearly income.

Household size

Male-headed households tended to have larger household sizes than female-headed households. The average number of people in female-headed households was 4.75 with a standard deviation of 2.52. The average number of people in male-headed households was 5.91 with a standard deviation of 2.72. This difference was significant, $t(95) = -2.152$, $p = .034$. The difference could be based on the intuitive reasoning that female-headed households had one less member, and women from female-headed households were older hence less likely to be bearing children.

Education

This variable was a measure of the highest level of formal education (years of education) the respondent attained. Formal education includes primary, secondary, and tertiary education as well as adult literacy courses. Primary school is from standard 1-8, secondary school is from forms 1-4, and tertiary education

represents any number of years spent at the university, college, or technical training centers. Adult literacy is a special program for adults who have never attended any formal school to learn how to read and write.

Most of the women had less than 5 years of education, and many had none. For women in female-headed households who responded to this question (n=46), 21% of them had no formal education[5], 52% had 1-4 years of education (primary school), 17% had 5-8 years of education (primary school), none of them had gone beyond 8 years of education (secondary school), and about 7% of them attended adult literacy classes. For women in male-headed households who responded to this question (n=53), 30% of them had never gone to a formal school, about 42% had 1-4 years of education, 26% had 5-8years of education, 2% of them had gone beyond 8 years of education, and none of them had attended adult literacy classes. A t-test omitting adult literacy (to make level of education an ordinal level variable), showed that the difference in education levels between women from these two household types is not significant, t (97) = -.664, p = .521. Table 3 shows the levels of education attained by women and men and Table 4 shows the results of the t-test between women in the two types of households.

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[5] No formal education excludes respondents who attended adult literacy courses.

Age

Women in female-headed households are older than women in male-headed households. The average age for women in female-headed households was 50.4 years with a standard deviation of 13.72. The average age of women in male-headed households was 44.29 years with a standard deviation of 12.75. The age difference was significant: t (82) = 2.118, p = .037. Many women in female-headed households were widows (n=28). Further analysis showed that the mean age for the widows was 55.91 years with a standard deviation of 14. 4. This demographic helps to explain the observed age difference between women from the two households. The age of the respondents is self-reported in most cases. In a few cases, the researcher estimated the age based on life's milestones such as the year the woman had her first child (since many women would remember their child's birthday if not their own). Other times they estimated the respondent's age by physical appearance.

Income

Men in male-headed households and women in female-headed households reported all income from various sources. The most common source of income was from small scale commercial farming. Other sources included beer brewing for women and brick baking for men. Interestingly, these two sources require much fuelwood. Other sources of income include small-scale businesses (e.g. grocery keeping, piece work, sale of woodlot products). A few other respondents were in

formal employment and therefore received income from wages/salaries or had retired and received a pension. This section reports the sum of yearly income from all sources identified by the respondent. The reported means were significantly different between the two households. Income in female-headed households (mean=MK4, 696.13 and SD= MK6676.82) were significantly lower than the mean income in male-headed households (mean=MK11, 775.00 and SD MK11, 108.26), t (55) = -2.97, p =. 004. The income was reported in Malawi currency: Kwacha (MK). MK 79.00 was equivalent to US$1.00 at the time of interviews. The results from the income reporting may have systematic errors arising from problems with recall, or under and over reporting.

Table 3. Education levels for women and men (%)

Education level (women)	**No formal education**	**1-4 years**	**5-8 years**	**Over 8 years**	**Adult literacy**
Female-headed	21.7	52.2	17.3	0	6.5
Male-headed	30.1	41.5	26.4	1.9	0
Education level (men)					
Male-headed	17.9	30.8	46.1	5.2	0

(n=99* women, 46 from female-headed households and 54 from male-headed households & (n=39 men)

Table 4. Household size, education, age, and income

Household size	**Valid cases**	**Mean**	**Standard deviation**
Female-headed	44	4.75	2.52
Male-headed	53	5.91	2.73
t (95) = -2.15, p = .03.			
Education level (women) In number of years			
Female-headed	45	2.93	2.55
Male-headed	54	3.30	2.98
t (97) = -.66, p = .52.			
Education level (men) In number of years			
Male-headed	39	4.44	3.01
Age of respondents			
Female-headed	39	50.41	13.72
Male-headed	45	44.29	12.75
For widows only.	27	55.91	14.40
t (82) = 2.12, p = .04			
Household Income/ year*			
Female-headed	31	4,696.13	6,676.82
Male-headed	26	11,775.00	11,108.26
t (55) = -2.97, p =. 004			

*Income reported in Malawi currency (kwacha), MK79 =1 US$ at the time of interviews.

WOODLOT DEMOGRAPHICS

This section provides a picture of woodlot demographics for the two household types. This description includes major trees species planted, age of the woodlot, number of trees that were 5 years and older, woodlot and land size, as well as woodlot ownership. All data from this section were self-reported except for number of trees. The researcher physically counted the trees. Table 5 shows the major trees planted by the two household types, and Table 6 has data on age of the woodlot, number of trees, woodlot and land size, and distance to the woodlot.

Tree species planted in the woodlots

There were over 15 different types of trees that are at least 5 years old in the household woodlots. A full list of these trees is in Appendix 2. The most common tree species planted in the woodlots were cassia and blue gum. About 77% of female-headed households had cassia, and 14% of the same households had blue gum as the first major tree species. The remaining 10% of female-headed households had one of the following tree types as the major specie: mango, jacaranda, Toon tree (sendelera), or gmelina (malaina). This is different from male-headed households. About 44% of male-headed households have cassia, 33% blue gum and the remaining 23% have mango, gmelina, jacaranda, Toon tree, or 'other indigenous' trees as their major species.

To facilitate the chi-square test, tree species with expected counts of less than five were combined to reduce the number of cells. All other exotic trees except for blue gum and cassia were combined to create one category, 'other exotic'. Indigenous trees were combined into another category, named other Indigenous.

The chi-square test confirmed that these differences were significant: χ^2 (4 $\underline{n}$ = 112) = 12.90, $\underline{p}$ =0.01. These differences could be attributed to gender differences in motivations to plant trees and differences in end uses of the woodlot products. However, there is a high possibility that these differences were also a function of woodlot age cohort. As observed later in this chapter, male-headed households have woodlots that are older than those of female-headed households.

The study findings show that the most common pattern of tree growing in female-headed households was in home compounds or in a specially designated area for tree planting (38% and 36% respectively). Most male-headed households (53%) planted trees in specially designated areas. About 29% of male-headed households planted trees around the home compound. This difference between households was statistically significant at p=0.065.

Table 5. Major trees species planted in the woodlot (%)

Household type	**Type of trees mentioned (% of responses)**				
	Blue gum	Cassia	Other exotic	Indigenous	Fruit trees
Female	13.7	76.5	9.8	0	0
Male	32.8	44.3	18.0	3.3	1.6
$\chi 2$ (4, n = 112) = 12.901, p =0.012					
(n=114, 51 female-headed households and 61male-headed households)					

Age of the woodlot

The average age of woodlots for female-headed households was 14 years, with a standard deviation of 11.067. For male-headed households, it was 19.50 years with a standard deviation of 13.70. This difference is statistically significant, t (106) = -2.241, p = .027. In female-headed households, the divorced women had the youngest woodlots. This could be because they established the woodlot after divorce.

Number of trees

Female-headed households tended to have fewer trees than male-headed households. Female-headed households had an average of 840.45 trees (s.d = 1719.21) and male-headed households had an average of 1666.10 trees (s.d = 2277.65). This difference is statistically significant t (112) = -2.141, p = .034. The

observed difference could be a function of land ownership since male-headed households have more land in general than female-headed households. This could be due to differences in social status, income and wealth. A high proportion of the men in male-headed households had a position in the village e.g., village headman. In addition, the large standard deviations indicate unequal distribution of number of trees among households. Some households have as few as 81 trees while others have as many as 11, 000. This could be attributed to the same explanations as above.

To determine the number of trees owned, the researcher had to physically count the trees for each household. This was because number of trees was a very important variable for the study, and it was important to get very close estimates. In addition, most of the households had trees planted in more than two places.

Size of the woodlot

Respondents estimated the size of the main area where they planted trees. As we were counting the number of trees, we also estimated the size of the woodlot, which had most trees. This was done to confirm the estimation made by the respondents. The two estimates closely matched. The acreage reported here is from the respondents.

Average size of the main woodlot for female-headed households was .83 acres (s.d =0.69) and 1.56 (s.d =0.21) for male-headed households. The difference in size of the woodlot was significant: t (95) = -2.779, p = .003. This

could be a reflection of total size of land owned, as will be demonstrated in the next section. It is logical to argue that the more land one has, the more likely a larger share of the land will be used for tree planting.

Size of land owned.

Land size excludes woodlot size, as reported previously. Female-headed households tended to have less land than male-headed households. Average land size for female-headed households was 2.71 acres (s.d =1.87) and for male-headed households was 5.5 (s.d = 5.27). The mean land size was significantly different: t (109) = -3.603, p = .0001.

Distance to the woodlot

The woodlots are about .83 km and 1.3 km (female and male-headed households, respectively) away from the households. This distance is substantially shorter than distances reported in other studies. This is because most household-owned woodlots are planted around homestead or nearby farms, unlike in other studies where the study population obtained its fuelwood from government protected reforested areas. There are significant differences between the two household types in the distance women walk to collect fuelwood. This is probably because female-headed household plant trees around the house while male-headed households also plant trees away from the home on a special piece of land.

Table 6. Woodlot age, number of trees, woodlot and land size

	Valid cases	Mean	Standard deviation
Woodlot age (years)			
Female-headed	48	14.00	11.067
Male-headed	58	19.50	13.700
t (106) = -2.241, p = .027.			
Number of trees			
Female-headed	51	840.451	1719.213
Male-headed	63	1666.095	2277.645
T (112) = -2.141, p = .034.			
Woodlot size (acres)			
Female-headed	42	0.839	0.687
Male-headed	55	1.56	1.57
t (95) = -2.779, p = .007.			
Land Size (acres)			
Female-headed	51	2.712	1.871
Male-headed	60	5.512	5.272
t (109) = -3.603, p = .0001.			
Distance to the woodlot			
Female-headed	42	.828	.322
Male-headed	54	1.21	.489
t (94) = -4.36, p = .0001.			

Perception of woodlot ownership

The question: Who owns the woodlot? was asked to both men and women. Most women in female-headed households individually own the woodlot. Only 4.2% of the women in female-headed household said they co-own the woodlot

with a family member. About 61% of women in male-headed households stated that the woodlot is co-owned with the husband, and 30% of them said the husband owns the woodlot. Only 8.1% of the women said they independently own the woodlot. This is an interesting finding in that the perception on ownership by women in male-headed households is very different from the males' perception. About 73% of the men said they individually own the woodlot, while 27% of the men said they co-own the woodlot with the spouse.

RESEARCH QUESTIONS 1-4 (DIFFERENCES BETWEEN HOUSEHOLD TYPES)

This section examines differences between the two household types (female and male-headed) in woodlot management and will answer research questions 1-4. This is based on the premise that fuelwood harvesting patterns, benefits gained from the woodlot, and motivations to plant trees may be different between the two household types due to differences in the gender of the household head. Chi-square and t- tests, where appropriate, were used to examine the differences. All the tests in this section are two tailed tests.

Q-1. Fuelwood harvesting patterns

Questions on firewood harvesting patterns were addressed to women only (n=116) from the two types of households, 51 from female-headed and 65 from male-headed households. Not all the 116 women responded to all six aspects of

fuelwood harvesting patterns. Thus, the sample size differs from question to question.

Preferred part for fuelwood

Women in both households were asked to rank their preferred part of tree for firewood. Of the 114 valid responses, (51 and 63 from female and male-headed households respectively), the part that obtained the highest ranking was the trunk, (65% of the responses in female-headed households, and 46% in male-headed households). Branches ranked second (26% in female-headed households and 38% in male-headed households). Twigs ranked the least, (9.8% and 15.9% of the responses in female and male-headed households respectively).

The observed frequencies between female and male-headed households are similar, determined by a Chi-square test which was not significant at $p < 0.10$; $\chi 2$ (2, N = 114) = 3.976, p= 0.14. We therefore, fail to reject the null hypothesis that tree part preference is different between women from the two household types. Table 7 contains data on the part of tree women prefer to use for firewood.

Table 7. Tree parts women prefer for firewood

Type of household	Preferred part (%)		
	Twigs	Branches	Trunks
Female-headed	9.8	25.5	64.7
Male-headed	15.9	38.1	46.0

Number of valid responses (n=114); 51 female and 63 male-headed.

Chi-square test, χ^2 (2, N = 114) = 3.976, p =0.14

Reasons for tree part preference for fuelwood

This was an open-ended question where women explained the reasons for their preferences. This was then recoded, by themes as quantitative variable. Women (n=113) from both female and male-headed households cited six reasons as explanations for why they prefer to use twigs, branches or logs for cooking. The explanations were highly associated with tree part in question. Thus, the explanations are divided in two categories. Twigs and branches, which are smaller in size, are in one category and trunks and whole tree comprise the other category. Table 8 displays the frequencies of reasons why women from the two household types prefer to harvest twigs, branches, and trunks.

The 52 women from both female-headed households (n=18) and male-headed households (n=34) who favor twigs and branches cited four reasons for their preference. Forty four percent of the female-headed households, and 32% of

male-headed households within this group stated that twigs or branches are already dry or are easy to dry when cut and hence could be used immediately. About 33% and 35% of female and male-headed households, respectively, said they prefer this part because they like to allow the tree to regenerate. Sixteen percent of women in female-headed households and 9% of women in male-headed households said they prefer twigs or branches because they are very small and therefore require no splitting. Six percent and 20% of women in female and male-headed households, respectively, said twigs or branches burn very well and easily.

Table 8. Reasons for women's tree part preference for fuelwood

Household Type	**Reason for tree part preference (%)**					
	Twigs and BRANCHES*				TRUNKS+ TREE**	
	Burns well	Quick drying	Let tree to grow	No splitting	Burns longer & leaves charcoal	Supply lasts longer
Female-headed	5.6	44.4	33.3	16.7	48.5	51.5
Male-headed	20.6	32.4	38.2	8.8	53.6	46.4
	χ^2 (3, $\underline{n}$ = 52) = 2.905, p = .41				χ^2 (1, $\underline{n}$ = 61) = .157, p = .80	

*Women who prefer twigs and branches; n=52, 18 from female-headed households and 34 from male-headed households.

**Women who prefer trunks; n= 61, 33 from female-headed households and 28 from male-headed households

The 61 women from both female-headed households (n=33) and male-headed households (n=28) cited two reasons for their preference for trunks as fuelwood. Most women in this category (49% of the women in female-headed households and 54% of the women in male-headed households) favor trunks for fuelwood because the wood burns for a long time and leaves charcoal behind, hence reducing the need to attend to the fire. About 52% and 46% of the women from female and male-headed households, respectively, said they liked to use trunks because the supply of trunks lasts for a long time and hence reduces the number of trips women have to make to collect fuelwood.

The Chi-square statistic for twigs and branches is $\chi 2$ (3, n = 52) = 2.905, p =0 .41, and the Chi-square statistic for trunks is $\chi 2$ (1, n = 61) = .157, p =445. Therefore, the null hypothesis that reasons for preference between women from the two household types were different cannot be rejected.

Most harvested part of trees

Table 9 shows that a total of 92 women, (42 and 50 from female and male-headed households, respectively), responded to the question: 'What was the part you most harvested in the past year?' The tree parts were twigs, branches, trunks and whole tree. The study findings show that twigs were the most harvested tree part in both household types, with 48% and 44% of the women from female-headed households and male-headed households, respectively, mentioning this. Branches followed, with 31% in female-headed households and 38 % of male-

headed households harvesting branches. Lastly, combined categories of trunks and the whole tree accounted for 21% of responses from women in female-headed households and 18% of responses from women in male-headed households harvesting this part.

Female-headed households demonstrated a slightly higher percentage of harvesting trunks for household use, which may suggest that their harvesting patterns do not compete with demands for other woodlot products. Although there were differences in frequencies between female and male-headed households, the differences were not statistically significant, $\chi 2$ (2, N = 92) = .529, p =0.77. We therefore fail to reject the null hypothesis that household types are the same.

It is important to note that the wood women harvest for fuelwood may also consist of various combinations of tree parts and not necessarily homogenous parts such as twigs and branches. Most women who collect twigs or branches would collect a mixture of the two, with one part sometimes dominating the other. In addition, those who cut down the trees will inevitably use the twigs and branches as well. However, the women who reported cutting trunks or a whole tree for fuelwood most often were categorized as harvesting trunks, and those who collected twigs and braches most of the time were also categorized as such.

Table 9. Most harvested tree parts collected for firewood in the past 12 months

Household type	Part of tree most harvested (%)		
	Twigs	Branches	Trunks*
Female-headed	47.6	31	21.4
Male-headed	44	38	18

χ^2 (2, N = 92) = .529, p = 0.768.

n=92 valid responses from women, 42 and 50 female and male-headed households.

Trunks* (Trunks and whole tree were combined for the chi-square test)

Reasons for collecting this part

The women gave five reasons for why they collect twigs, branches, trunks or a whole tree. These explanations correlate to the size of the part in question. Thus, the explanations are divided in two categories. Twigs and branches, which are smaller in size, share one category and trunks and whole tree share the other category.

Results on Table 10 shows that the 55 women who collected twigs and branches most often in both household types cited four reasons to explain why they collected these parts. But, there are major differences between the two types of households regarding why women collected twigs and branches. Of the 29 women in female-headed households who collected twigs and branches, 41% explained that twigs and branches dry quickly after harvesting, and another 41%

stated that they harvest twigs and branches in order to let the tree regenerate. Another 17% of the women in female-headed households explained that the other parts are for other uses and therefore they could not take them for fuelwood. This is very different from the 29 women in male-headed households who collected twigs and branches. About 41% of these women collected twigs and branches because other parts, such as trunks and the whole tree, are designated for other purposes, 28% of the women collect twigs and branches because they dry quickly and 21% of women in male-headed households collect twigs and branches in order to let the tree regenerate. The remaining 3.4% of the women in male-headed households stated that they collect twigs and branches because there is no need to split the wood, making it suitable for immediate use. The differences between frequencies in the two households on explanations why women collect twigs and branches is statistically significant at an alpha level of 0.10, $\chi 2$ (2, N = 55) =5.535, p =. 063[6] This test resulted in rejecting the null hypothesis that the household types were the same.

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[6] The chi-square statistic is based on the three major reasons. Husband's restriction as a reason was excluded from the analysis because it is only applicable to male-headed households.

Table 10. Reason for collecting tree parts

Household type	**Reason for collecting twigs, branches and logs (%)***				
	Twigs and Branches				Trunks + Tree
	Dries quickly	Let the tree to regenerate	Other parts are for other purpose	Husband restricts	Supply lasts longer
Female-headed	41.4	41.4	17.2	N/A	100
Male-headed	27.6	20.7	41.4	6.9	100
	N=55, 26 male-headed, and 29 female-headed. χ^2 (2, N = 55) = 5.535, p <. 063. **				N=16, 8 & 8 male & female-headed

*This is the % of responses within the sub sample, for example a sub sample of those who collected twigs and branches is n=58, 29 male-headed, and 29 female-headed.

** The chi-square is based on the three major reasons, husbands restriction was omitted from the analysis since it was not applicable to female-headed households

All the 16 women in both female and male-headed households who collected trunks or the whole tree for fuelwood cited longer lasting attributes as the only reason why they collect this part. They explained that collecting trunks reduces the number of visits to the woodlot since one tree can last for more than a month. Table 10 contains data relating the explanations for why women from the two households collect the parts of trees.

The data in Table 7 and Table 9 above show that there is a substantial gap between women's preference and the actual wood they collect for fuelwood. Although most women preferred trunks, they did not generally harvest their preferred part of tree. Of interest are the reasons why women collect twigs and

branches instead of trunks. Women in the two households expressed different reasons for their actions. For female-headed households, their reasons were mostly related to burning qualities of the wood and tree preservation, while for male-headed households competing uses with male oriented products, such as poles, was the major reason why the women did not collect trunks. Another interesting finding is that husband's restriction was not among the first three reasons women cited. Fewer than 7% of the women mentioned husband's restriction as a reason for collecting twigs and branches instead of trunks.

These findings on tree preferences are similar to findings from a study in Ntcheu, Malawi conducted by Brouwer et al. (1993). Brouwer et al. (1993), found that women preferred split wood and branches as fuelwood with little difference between the two. Twigs were the least preferred type of wood. The reason women gave for the preferences in Brouwer's study are similar to this study's findings. An interesting aspect from the Brouwer et al. (1993) study was a finding that cooking with twigs reduced cooking time by 10 minutes and reduced the amount of wood in kg needed to cook a meal in a day by 2.5 kg when compared to split wood. The cooking time experiments found that it took 2.5 hours and 6.3 kg of split wood (from trunks) per day for women to cook meals. However, this study was carried out under experimental conditions where women were always there to attend to the fire. Under normal conditions, twigs may take a longer time to cook food. Women usually do other household work while cooking. Therefore, they may not be able to add twigs in time, as was done in the experiments. Fire from twigs dies down if left unattended. Trunks and some bigger branches are different in that they

produce charcoal, allowing the food to keep on cooking without requiring a great deal of attention to the fire.

In this study, no woman specifically mentioned the cooking duration of trunks, branches or twigs as a reason why they prefer to use the tree parts. At most, women mentioned the general burning qualities of the wood but not in relation to different cooking durations.

Amounts collected

This question examined the average amounts of fuelwood in head loads a household collects per week from all sources. A total of 101 women (47 from female-headed households and 54 from the male-headed households), responded to this question.

A headload is the most common measure of amounts in fuelwood collection. Forest Research Institute of Malawi estimates that the average weight of one headload is 17 kg (Chancellor College-University of Malawi, 1988). The researcher did not weigh the wood. Actual weighing would require conducting the interview on the actual day the household collected fuelwood for all the 116 households, which was beyond the time and financial resources available for the study[7].

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[7] The researchers made use of pictures of standard headloads to help the women identify the actual size of the headload. In addition, where possible, the researcher asked the respondents to show the amount of fuelwood they use for cooking per day if the wood was

There were significant differences in the reported amounts of fuelwood collected between the female and male-headed households. On average, male-headed households collected more wood per week than female-headed households. A t-test demonstrated the difference between the mean of female-headed households (M =1.49, SD= .741) and the mean of male-headed households (M =2.01, SD= 0.898), t (99) = -3.145, p = .002, indicating that male-headed households collected more fuelwood than their female counterparts. Table 11 illustrates these data.

A plausible explanation for the differences in consumption is the relationship between household size and fuelwood consumption. However, there is contradicting evidence on the possible relationship between household size and fuelwood consumption. Two studies reported that there was a significant and positive association between the household size and fuelwood consumption (Sahaputheen and Thangamunthu, 2001, and Kamara, 1986 as cited in Bembridge, 1990), and by extension, of amounts of fuelwood a household collects. On the other hand, another study (Brouwer et. al, 1995) stated that household size is not related to household fuelwood use. This study showed that there were significant differences in household size between the two types of households.

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available. The researcher noted the amount and size (diameter and length), and the part and type of tree. These data are for future use and reference. This also helped the researcher verify to some extent the part and type of fuelwood the women reported earlier in closed ended questions. Further, where available, the women showed the researcher the actual head load.

This may support the relationship between household size and fuelwood consumption, assuming other factors remain constant.

Table 11. Amount of fuelwood in head loads collected per week

Household type	Valid cases	Mean	Standard deviation
Female-headed	47	1.4894	0.741
Male-headed	54	2.009	0.898
t (99) =.-3.145, p = .002, (n=101, 15 missing)			

Frequency of collection

The women reported the average number of trips they make per week in collecting fuelwood. This is directly related to number of trips made per week by a factor of four weeks for most women in both households. A total of 101 women (47 from female-headed households and 54 from the male-headed households), responded to this question.

There were significant differences in the reported number of trips to collect fuelwood per month between the female and male-headed households. On average, male-headed households made more trips per month than female-headed households. A t-test demonstrated this difference between the mean number of trips per month of female-headed households (M =6.00, SD= 2.941)

and the mean of male-headed households (M =7.87, SD= 3. 57, t (99) = -2.85, p = .005. Table 12 illustrates these data.

Table 12. Number of trips per month to collect fuelwood

Household type	Valid cases	Mean	Standard deviation
Female-headed	47	6.00	2.941
Male-headed	54	7.87	3.572

t (99) = 2.846, p = .005,

(n=101, 15 missing responses)

The patterns of fuelwood collection in this study are similar to observed patterns from other studies conducted in Malawi (Brouwer, et.al., 1993, Coote et.al., 1993), where women collected fuelwood an average of 2-3 headloads per week, and by extension made 8-12 trips per month, assuming they collected one headload per trip.

Women's responses, from open-ended questions, provide insight into harvesting patterns that could not have been captured from the close-ended questions. First, as noted earlier, women usually collect various combinations of the fuelwood. Some collected just the twigs, some the branches, and others a mixture of twigs and branches, while others collected just the logs or cut down the whole tree. These collection patterns help to determine the number of visits a

woman would make per week. For example, some women indicated that they would collect wood from the woodlot as need be and may collect just enough for the day, not necessarily a head load. The women were able to do this since the woodlots are close by (around the house or on their farms which are usually located near the village). These women would often report visiting the woodlot more than the average number of visits. In previous studies, women collected fuelwood from government or natural forests, which in most cases are located far from the households, hence, the need for women to collect the maximum size of head load to minimize the number of trips. Due to long distances, women may prefer to collect twigs and branches, which are easy to carry. But this would entail frequent visits since the supply does not last long as would trunks or whole trees. For example, in this study, women who collected trunks and whole tree made very few visits to the woodlots. This is because the trunk would last the women more than a month.

It should also be noted that fuelwood harvesting and use of wood in Malawi varies by the seasons; rainy and dry (Coote et.al., 1993). More wood is needed in the dry season since the wood is drier and hence burns more quickly. However, collecting wood is more difficult in the wet season when the wood is heavier, and difficult to carry since the paths are slippery. The study was conducted at the beginning of the rainy season[8]. In addition, most households (n=86) did store an

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[8] Malawi had late rains and experienced draught in the 2001-2002 seasons. Between November and December the rains were sparse and it was mostly dry, and only started regular rains in January.

average of 44 and 53 headloads (female and male-headed households respectively) of wood for the rainy season, which could have also affected their collection and consumption patterns.

Main source of fuelwood

As indicated in Table 13, the main source of fuelwood supply is the household woodlot. About 84% of women in female-headed households and 85 % of the women in male-headed households stated their woodlot is the main source for fuelwood. About 12% of the female-headed households and about 14% of the male households said they got fuelwood from their own gardens while 4% and 1.5 % of female and male-headed households respectively, said their main source of fuelwood is from other sources. None of the households mentioned buying fuelwood as the main source of wood. Further analysis show that none of the households mentioned buying fuelwood as the second main source. There were no statistically significant differences in the sources of fuelwood between these two household types. Households use fuelwood mainly for cooking, and other activities such as beer brewing, brick baking, and pottery firing and, in some cases, for warmth and lighting.

Table 13. Main sources of fuelwood, poles, fodder etc (%)

Household type	Own woodlot	Own garden farm	Other sources	Buys from market
Fuelwood				
Female-headed	84.3	11.8	3.9	0.0
Male-headed	84.6	13.8	1.5	0.0
(n=116, 51 female and 65 male-headed)				
No significant differences, P>0.10				
Household poles				
Female-headed	96.1	9.8	3.9	0.0
Male-headed	90.3	3.2	6.5	3.2
(n=51 female and 62 male-headed, P=0.10)				
Household lumber				
Female-headed	5.3	10.5	0	84.2
Male-headed	59.0	9.1	4.5*	27.3
(n=41, 19 female and 22 male-headed, 75) not applicable), P=. 003				
Medicine**				
Female-headed	52.5	15.0	30	2.5
Male-headed	68.1	12.8	19.2	0.0
(n=87, 40 female and 47 male-headed households, 29 not applicable)***				

* Other sources are mostly from natural forests in government-protected areas.

** Most of the medicine is from the root of cassia for stomach upset and blue gum to treat colds.

***Most of the non applicable said they do not use herbal medicine or do not know how to make them themselves.

****The number of responses is not the same, since some households do not engage in certain activities.

The woodlot is also the main source of poles for construction for 96% of the female-headed households and 90% of the male-headed households. About 3.9% of female-headed households and 6.5% male-headed households get poles from their gardens. Only 3.2% (2) male-headed households bought poles for household use. Differences between the two households were not significant.

The trend is the same for most of the other tree products such as fodder and food. The woodlot was the major source for fodder and medicine, except for lumber, in female-headed households.

Q-2- Fuelwood sufficiency

Two aspects of fuelwood sufficiency were investigated. The first was to find out if households experienced fuelwood shortage in the past year. Households that did not experience fuelwood shortage could indicate that the woodlot contributed to meeting household fuelwood needs (i.e. was sufficient). The second question looked at whether households supplemented fuelwood from the woodlot with other fuels, including fuelwood, from other sources. Women in female-headed households (51) and women in male-headed households (65) responded to these questions.

Fuelwood shortage

In order to assess fuelwood shortage, women in the two household types (female-headed and male-headed) were asked whether or not they experienced

shortage in the past year. About one third (34%) of all households (n=113), reported that they experienced fuelwood shortage.

For further analysis, a chi-square test was applied to the relationship between household type and fuelwood shortage, and found to be statistically not significant, χ^2 (1, N = 113) = .560, p =0. 546 based on an alpha level of .10. Therefore, the null hypothesis that fuelwood shortage is similar between household types cannot be rejected. The observed frequencies of the two of cells are found in Table 14.

Table 14. Percentage of households who experienced fuelwood shortage

Type of household	**Experienced fuelwood shortage? (%)**	
	Yes	No
Female-headed	37.5	62.5
Male-headed	30.8	69.2
Total valid responses	33.6	66.4

χ^2 (1) N = 113) = .560, p =0. 546

(n=113, 48 and 65 women from female and male-headed households respectively. Women reported the data.

Use of other fuels

Fuelwood is the main cooking fuel in rural households. Fuelwood is also used for beer brewing, brick making and pottery firing. Results from this study

indicate that the majority of women (97%) use fuelwood as the main fuel energy for cooking. Only four women report something else as the main fuel: maize cobs (2 women), maize stalks (1 woman), and 'zigombiro[9] (1 woman). All four women that do not use fuelwood as main cooking reported experiencing fuelwood shortage the past year and all had fewer than one hundred trees. About 41% of women in all household types consider maize cobs their secondary cooking fuel. Frequencies of main and secondary cooking fuels are provided in Table 15 and 16.

A closer examination of Table 17 on patterns of fuelwood use shows that all women had cooked with fuelwood in the past six months, either as the only fuel or with various combinations of other fuels. For example, almost all women (93%) cooked with shelled maize cobs in combination with fuelwood and about 41% of all women had cooked with maize stalks the past six months. About 8.6% (fewer than 10 women) used other fuels: charcoal (6 women), cow dung (3 women), paraffin (1 woman), electricity (1 woman), maize bran (gaga) (5 women), sawdust (1 woman), and tobacco stalks, (8 women).

Although most women use shelled maize cob, fewer than half of them considered shelled maize cobs a secondary main cooking fuel. This is because most households cook with shelled maize cobs for fewer than 3 days a month. In addition, most households use shelled maize cobs as a way of recycling a byproduct of food processing. Maize shelling is an activity that households do

before processing maize into corn flour. Thus, use of shelled maize cobs may be a way of recycling waste and may not necessarily be an indication of fuelwood shortage. However, there is some evidence from the qualitative part of this study that, in some cases, women use shelled maize cobs as a strategy to curtail fuelwood shortage. From open-ended questions and focus group discussions, the women explained that they would make deliberate plans to help other women shell maize so that they could get the shelled cobs. Such women cooked with maize cobs for more than 3 days in a month, and a few others cooked with maize cobs as the main cooking fuel.

Few households use other fuels. Chi-square tests between the two types of households for all these variables were statistically non-significant: all of them had p values of more than 0.10. Low frequency of use of other fuels such as charcoal, cow dung, paraffin, electricity, maize bran, wood dust (sawdust), tobacco stalks is consistent with long term low fuel use patterns in this sample population. Table 17 shows that more than one hundred women (90%) have never used these fuels for cooking.

Use of maize cob is different from the observed use of maize stalks among households. Use of maize stalks may be an indicator of fuelwood shortage. A comparison of women between the two household types, show that more female-headed households (56%) cooked with maize stalk compared to 31% of male-headed households in the past 6 months. The relationship between household

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[9] This is a type of hedge that is sometimes used as fuel in times of fuelwood scarcity

type and use of maize stalk is statistically significant, $\chi 2$ (1) N = 115) = 7.398, p =0.008.

Table 15. Household primary cooking fuel

Household type	**Type of fuels used (%)**				
	Fuelwood	Maize cob	Maize stalk	Other	Charcoal
1st main fuel					
Female-headed	92	4.0	2.0	2.0	0.0
Male-headed	100	0.0	0.0	0.0	0.0
All households combined	96.5	1.7	0.9	0.9	0.0

(n=115, 50 women and 65 women from female and male-headed households respectively).

Table 16. Households secondary cooking

Household type	**Type of fuels used (%)**					
	Fuelwood	Shelled maize cob	Maize stalk	Other	Charcoal	No 2nd fuel
2nd main fuel*						
Female	0	42.0	6	2	0	50.0
Male	0	40.0	1.5	6.2	3.1	49.2
All households combined	0	40.9	3.5	4.3	1.7	5.0

*Percentages based on valid responses of 58 women who have a second main cooking fuel.

Table 17. Percentage of households that cooked with different types of fuels the past 6 months.

Household type	**Individuals who used the fuels ever and past 6-month use (%)**					
	Fuelwood		Maize cob		Maize stalk	
	Ever	Past 6 months	Ever	Past 6 months	Ever	Past 6 months
Female-headed	100	100	94.1	91.1	70.6	56.0
Male headed	100	100	96.1	95.3	47.7	30.7
(n= 116, 51 female-headed and 65 male head						

Table 17 continued

Household type	Tobacco stalk		Charcoal		Electricity	
	Ever	Past 6 months	Ever	Past 6 months	Ever	Past 6 months
Female-headed	4.0	4.0	10	7.8	0.0	0.0
Male headed	10.9	9.2	10.9	3.07	1.6	1.6
(n= 116, 51 female-headed and 65 male head)						

Table 17 Continued

Household type	Fuel use (%)							
	Paraffin		Cow dung		Saw dust		Maize bran	
	Ever	Past 6 months	Ever	Past 6 months	Ever	Past 6 months	Ever	Past 6 months
Female	6.0	1.9	6.0	5.8	2.0	2.0	8.0	5.8
Male	1.6	0.0	4.7	0.0	0	0	1.6	1.6
(n= 116, 51 female-headed and 65 male head)								

Q- 3- Benefits from the woodlot.

There are different ways to measure woodlot benefits. One way is to ask respondents to state perceived benefits gained from the woodlot. Another way is to look at cash income from the sale of woodlot products. This study used both methods to measure benefits. This question addressed all respondents, both male and female, from all 116 households.

As results from the study will later demonstrate, there were significant role differences in woodlot-harvesting activities. Because of this, the data in male-headed households presented in this section for discussion will be from either the men or women depending on whose role it is for harvesting the product. Data for discussion on benefits from fuelwood, medicine and food are from women since they are responsible for collection and use of these products. Data on benefits from poles, lumber and sale of woodlot products are from men as they are responsible for the collection and use of these products. The comparison group of women from female-headed households remains the same, regardless of who is reporting in the male-headed households.

For comparison purposes, Appendix 2 and 3 provides data on the reported benefits on fuelwood, medicine and food from men, and the reported benefits on poles, lumber and sale of woodlot products from women. As results from Appendix 2 and 3 indicate, the mean of women's responses is very similar to the mean reported by the male counterparts in most cases, except for sale of woodlot

products. In addition, the direction of significance (significant or non significant) is not different between the male and female respondents to the same questions, although the level of significance changes slightly.

Perceived benefits.

Respondents from each of the households were asked to rate the benefits gained from the woodlot in meeting fuelwood, pole, fodder, lumber, medicine and food needs on a five-point Likert scale, from very beneficial to not beneficial. Responses for these questions are from households that actually harvested the product the past year. This is based on the argument there are multiple reasons for not using a product and not perceiving the product as beneficial is only one. Other reasons might be that the types of trees planted do not lend themselves to that particular use. For example, one cannot harvest fodder, food or lumber from cassia trees. Because of this, the "not beneficial" category would be biased.

Perceived benefits from fuelwood, fodder, medicine and food as reported by women.

The data on fuelwood, fodder, medicine and food presented below is from the two household types. The sample size for valid responses for each product is presented in Table 18. The Table also shows the results of a t-test and descriptive statistics on reported benefits from firewood, medicines, fodder and food.

Table 18. Benefits from fuelwood, medicine fodder and food

Household type*	Valid responses	Mean**	Standard deviation**
Firewood			
Female-headed	51	4.29	.99
Male-headed	64	4.45	.69
Total valid responses	115	4.38	.883
t (86.097) = -.978, p = .33			
Medicine			
Female-headed	37	3.7	1.08
Male-headed	31	3.71	.97
Total valid responses	68	3.71	1.023
t (66) = -.028, p = .978			
Fodder			
Female-headed	27	1.89	1.01
Male-headed	23	3.04	1.49
Total valid responses	50	2.42	1.372
t (37.74) = -3.145, p=. 003 **			
Food			
Female-headed	28	2.5	1.35
Male-headed	14	3.00	1.66
Total valid responses	42	2.67	1.4
t (40) = -1. 048, p=. 301			

*Women reported the data presented in this table.

** Mean and standard deviations for perceived benefits is based on valid responses of those who actually used the products. Those who did not report using the product the past year were not asked the questions. This is why the number of valid cases is different for each woodlot product, as not every one used the product the past year.

There were no significant differences in reported benefits from collecting fuelwood between female-headed households (M=4.29, SD=. 99) and male-headed households (M = 4.45, SD= .69) from an independent t-test, t (86.097) = -.978, p = .331[10]. There were also no significant differences in reported benefits from collecting woodlot products for medicine between female-headed households (M =3.70, SD=. 1.08) and male-headed households (M = 3.71, SD= .97), from an independent t-test, t (66) = -.028, p = .978. The non-significant chi-square resulted in failing to reject the null hypothesis that the perceived benefits between the household types are similar.

There were significant differences between the two types of households on benefits gained from the use of fodder as a woodlot product. The mean for female-headed households (M =1.89, SD=. 1.01) was different from the mean of male-headed households (M =3.04, SD=. 1.49), according to an independent t-test t (37.74) = -3.145, p=. 003. This suggests that male-headed households benefited most from the use of fodder from the woodlot.

A t-test on the reported means for women in female-headed households (M=2.50, S.D=1.35) and male-headed households (M=3.00, SD=1.66), t (40) = -1.048, p=. 301 resulted in failing to reject the null hypothesis that food benefits from the woodlot are similar between the household types.

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[10] Used a t-test statistic with unequal variance assumption, Levene's test F (5.920)= .017

On average, women from all households reported that the woodlot was beneficial in providing fuelwood to meet household needs. For the other products such as fodder, medicine and food, women rated them in the middle of the scale.

The non-significant t-tests from medicines and food suggest that women benefit equally in these two areas regardless of gender of the household head. This could be due to the fact that women use the leaves and roots as medicine; hence, they may be easily accessible to all women.

The differences in benefits from fodder could be due to the fact that women in female-headed households have fewer animals than do male-headed households, thereby having minimal need for trees for fodder (Household Woodlot Survey 2002). The types of trees planted could also contribute to this differences because some tree species, such as cassia, are not good for animal feed and, if such trees are dominant, women may not use them for fodder as much as they would with other species like Leucaena (Leucaena leucocephala).

Perceived benefits from poles and lumber as reported by men and women from male-headed and female-headed households respectively.

The data presented below are from men in male-headed households, and women in female-headed households. The sample size of valid responses for each product is presented in Table 19. The table also has the descriptive statistics

and t-test results on perceived benefits from poles and lumber, for the two types of households.

There were significant differences between the two types of households on benefits gained from harvesting poles. An independent t-test on mean scores of female-headed households (M =3.78, SD= 1.12) and male-headed households (M =4.41, SD= .832) had a test statistic of t (84) = -2.867, p= .005.

There were also significant differences between the two types of households on benefits gained from harvesting lumber with female-headed households (M =2.06, SD= 1.029) reporting less benefit than male-headed households (M =3.22, SD= 1.577), as indicated by p values of less than 0.10 from an independent t-test, t (43.02) = -3.296, p= .002[11].

In addition, the nature of gendered roles in collection of woodlot products could be attributed to differences in perceived benefits. Lumber and poles are male oriented products since men use them for construction and hence may be harvested more frequently and in large amounts in male-headed households. By the nature of benefits, if people are not using the product, they won't perceive it as a benefit. Furthermore, women usually plant trees that are more suited for fuelwood and sometimes could be used for poles but not for lumber. Hence,

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[11] t-test values are from unequal variance assumption, Levene F test (14.614), p=0001

female-headed households may report having enjoyed fewer benefits than their male-headed counterparts due to minimal use of the product.

Table 19. Perceived benefits from poles and lumber*

Poles*	**Valid responses (n)**	**Mean****	**Standard deviation****
Female-headed (women)	49	3.78	1.12
Male-headed (men)	37	4.4128	.832
t (84) = -2.867, p= .005			
Lumber*** **(Timber)**			
Female-headed (women	33	2.06	1.03
Male-headed (men)	27	3.22	1.577
t (43.02) = -3.296, p= .002***			

*The data in this table was reported by men and women in male and female-headed households respectively

**Mean and standard deviations for perceived benefits is based on valid responses of those who actually harvested the products. Households that did not engage in the activity were not included in the analysis. This is why the number of valid cases is different for each woodlot product.

***t-test values are from unequal variance assumption, Levene F test (14.614), p=0001

Monetary benefits from woodlot products

These data are based on reported income from the sale of woodlot products. Men (n=28) in male-headed households and women (n=25) in female-

headed household reported this income. Thus, a total of 53 households reported having sold, in the past year, at least one or a combination of the following woodlot products; firewood, poles, whole trees and lumber. The income that is reported here is a sum of total income from the sale of all woodlot products for each household. The income is reported in Malawian kwacha (MK). At the time of the interviews, the exchange rate was K79.00 to one US Dollar.

Table 20. Income from sale of products in Malawi currency

Household type*	**Valid responses (n)**	**Mean**	**Standard deviation**
Female-headed	25	408.60	416.29
Male-headed	28	1480.18	1553.30
Total valid responses	53	957.00	1254.57

t (31. 29) =-3.512, p < .001**

*The data in this table were reported by men and women in male and female-headed households respectively

**Used Equal variances not assumed Levene test F=25.877, p=. 000

An independent t-test comparing the mean of sales income of female-headed households (M=MK408, SD=416.29) with that of male-headed households (M =Mk1480.18, SD= 1553.30 was statistically significant, t (31.29) =-3.512, p < .001, indicating that male-headed households earned more money from woodlots

than female-headed households. Table 20 shows income from the sale of woodlot products.

Further analysis of distribution of sales income between the two households provides interesting results. About 76% of the 25 female-headed households earned less than MK 500 compared to 32% of the 28 male-headed households. About 4% of the female-headed households sold woodlot products valuing more than MK1000 compared to 39% of male-headed households. Appendix 5 illustrates this.

In order to gain some insight on the contribution of woodlot products to the household economy, the researcher asked men from male-headed households and women from female-headed households to estimate the proportion of woodlot income to total income. A schematic table (Appendix 6) was provided to aid respondents with low literacy levels.

Reports from women in female-headed households and men in male-headed households who responded to this question indicate that income from the woodlot contributes less than a quarter of total household income, with 60% in female-headed households and 61% male-headed households reporting. About 30% of female-headed households and 39% of male-headed household stated that woodlot income contributes a quarter of the total income. Ten percent of female-headed households and 0% of male-headed households reported that woodlot income contributes about three quarters of the total household income. There are no significant differences on reported woodlot income contribution

between the two household types; as noted from a chi-square test, χ^2 (2, n = 33) = 2.461, p =.292 (Appendix 6).

Computations from total household yearly income and woodlot income show that household woodlots contribute less than 10% (9% for female-headed households and 9.4% for male-headed households) of the total household income.

It is important to note that among women in female-headed households, most income from woodlot products is from the sale of seedlings from tree nurseries (Household woodlot survey, 2002). This is a lucrative business for women as they are able to earn money every year by planting and selling tree seedlings from a very small piece of land.

The difference in monetary benefits between households along gender lines is clear; male-headed households earn more income from the sale of woodlot products than do female-headed households. These differences may be attributed to the number of trees in a woodlot, which is also related to the gender of the household head. Thus, male-headed households may have more than enough trees to meet household needs leaving a surplus for sale. On the other hand, female-headed households may not have enough trees to even meet household needs let alone be able to sell some of the woodlot products. In addition, sale of wood products is a high input job that requires a bicycle or oxcart to transport woodlot products to the nearest urban markets or to major roads. Women in female-headed households may not own bicycles or oxcarts.

Fewer than half of all household types (53 out of 116) sold one or a combination of woodlot products. Three reasons may explain why households do not sell their woodlot products. First is insufficient supply to meet household's needs for fuelwood, poles, fodder, etc., as well as enough for sale. Second, lack of markets within the villages hinders households from selling woodlot products even when households want to. If households plan to sell their products, they would have to go to the nearest urban center. This may entail an investment of time and transport, among other things. Low marginal returns to this economic activity may discourage households from engaging in the sale of woodlot products. In addition, sale of woodlots products was not among the primary and secondary motivations for households to plant trees.

It is important to note that the income is self-reported. Thus, these data are based entirely on respondent's recall and the ability to keep records of sales. In addition, some people may try to hide their incomes while others may over or under report. For instance, one male respondent asked the researcher whether the rumor that the government is planning to impose taxes on sale of trees, as is the case with tobacco, was true. Such fears or rumors may influence respondent's answers. Any conclusions made for this section of the study are based on relative rather than absolute differences.

However, there may be some validity of the reported incomes because of the correlations between men's and women's answers in male-headed households. Women from male-headed households also reported higher incomes

than women from female-headed households. However, the mean incomes were lower than what the men from these households reported. A more detailed examination of average income reported by women in male-headed households and female-headed households is in Appendix 7.

Q-4- Motivations to plant trees

This question addressed heads of households: men in male-headed households and women in female-headed households, in their capacity as main decision makers in a household. The question looked at three items; reasons for establishing a woodlot, tree attributes individuals consider important when making decisions on the type of trees to plant, and the type of trees households intend to plant.

Reasons for establishing the woodlot

Respondents listed, in order of importance, the first three reasons for establishing their woodlots. The data for discussion are from the first and second reasons only. A total of 42 women and 43 men responded to this question.

Seven reasons were given as the most important reason for establishing the woodlot: to provide household fuelwood, household poles, firewood for sale, poles for sale, lumber for sale, lumber for household use, and to prevent soil erosion. Most of the respondents planted trees for multiple uses, with more than

88% of all respondents mentioning more than one reason for woodlot establishment.

The initial Chi-square test had more than 20% of the cells with counts less than 5. In order to resolve this problem, the responses were compressed to create fewer categories. All sales of woodlot products were combined to make one variable. Lumber for household use was also combined with poles for household use for the same reason. The new frequencies for Chi-square therefore had three major categories; to provide fuelwood to meet household needs (74% women and 54% men), to provide poles for household use (19% women and 37% men) and for sale (7.1% women and 9.3% men).

Although more women than men planted trees for fuelwood as the primary reason, a Chi-square test was statistically not significant, χ^2 (2, N =85) =3.983, p =0.14. The chi-square test resulted in failing to reject the null hypothesis of no difference between the two household types. Table 21 shows the reported frequencies of the primary reasons why households had established the woodlot.

The results from the study are contrary to our expectations of gender differentiation of motivations to plant trees, where women were expected to plant trees to meet household fuelwood needs first while men were expected to plant trees for household poles or for sale. In addition, this is contrary to most previous research, which state that households plant trees for multiple uses, with fuelwood as a secondary by product. The study shows that most women as well as men plant trees to meet fuelwood needs.

Co-ownership and women sole ownership in some of the male-headed households may explain why there were no statistically significant differences. If the woodlot is owned by the woman or is co-owned, the woman may have some say in tree planting decisions, hence a substantial number of male-headed households would plant trees to meet fuelwood needs more than anything else.

An important step in future investigations would be to assess motivation for planting trees that have been planted within the last several years in households where the female was already the head at the time of establishment.

Another interesting statistic is that few households (7.1% and 9.3 % of female and male-headed households respectively) planted trees for sale as their primary purpose. Further analysis of the second mentioned reason for woodlot establishment, cash income, still comes second to poles (30% of the responses). This shows that households are far more motivated to plant trees for household needs such as fuelwood and poles than for income. This may also help explain why some households did not engage in the sale of woodlot products in the last year. Table 22 shows the secondary reason for woodlot establishment in the two households.

Table 21. Primary reasons for establishing the woodlot

Household type	**Reason for woodlot establishment (% of the responses)**		
	Household fuelwood	Household poles	Products for sale
Female-headed	73.8	19.0	7.1
Male headed	53.5	37.2	9.3
n= 85; 44 women in female-headed and 43 men from male-headed households			
$\chi 2$ (2, n =85 =3.983, p=0.136			

Table 22. Secondary reasons for establishing the woodlot

Household type	**Reason for woodlot establishment (% of the responses)**			
	Household fuelwood	Household poles	For sale	Other reasons**
Female	15.8	42.1	23.7	18.5
Male	19.0	38.1	35.7	7.2

χ^2 (5, n =80) =8.273, p =. 142

n= 80; 38 women in female-headed and 42 men from male-headed households

**Other reasons include food, prevent soil erosion, and brick baking.

Important trees attributes in tree planting decisions

Men and women in the two household types were asked to rank the relative importance of various tree attributes considered important in deciding on the type of trees to plant. The rankings were from first to third most important. The discussion in this section is based only on frequencies of tree attributes that

received the first ranking. A total of 46 women from female-headed households and 40 men from male-headed households responded to this question.

Table 23. Important tree attributes in tree planting by household type

Household Type	**Tree attributes (% of responses).**				
	Grows fast	Grows straight	Burns well	Produces Charcoal	Other
Female	34.8	19.6	21.7	15.2	8.7
Male	20.0	52.5	0.00	17.5	10.0

χ^2 (4, N =86) =17.131, p 0.002

(n=86, 46 women and 40 men)

Women from female-headed households and men from male-headed households

The following are the attributes women in female-headed households considered important in their choice of trees to plant. Trees that grow fast were ranked first, (34.8% of women), followed by trees with good burning qualities (22%), next was 'trees that grow straight' (20%), and lastly trees that produce a lot of charcoal when cooking (15%). Men, on the other hand, gave different rankings which are as follows: trees that grow straight received the first ranking (53%), followed by trees that grow quickly (20%). Trees that produce charcoal during cooking received the third ranking (18%), and 10% of the men cited other reasons

as why they plant trees. None of the men mentioned burning qualities as the primary attribute, they look for in a tree.

There were significant differences between men's and women's rankings. A chi-square test established the relationship between gender and important tree attributes in tree planting decisions, χ^2 (4, N =86) =17.131, p= 0.002. Table 23 above demonstrates this relationship.

Table 24. Important tree attributes in tree planting decisions by gender within male-headed households

Household head	**Tree attributes (% of responses).**				
	Grows fast	Grows straight	Good burning qualities	Produces Charcoal	Other
Female	31.7	16.7	25.0	20	6.7
Male	20.0	52.5	0.00	17.5	10.0

χ^2 (4, N =100) =20.021, p= 0.0001

(n=100, 60 females and 40 males from female and male-headed households respectively.

These different tree attributes are also evident between men and women within a household. Output in Table 24 demonstrates these differences. The data below are from women in female-headed households (n=60) and men (n=40) in male-headed households only.

The results from this study conform to a study conducted in Malawi by Nguluwe 1999. Nguluwe 1999 found that men rated good poles as the ones that are straight and are from coppices and usually with a diameter of about 5cm dbh.

Types of trees households intend to plant.

The purpose of this question was to investigate how tree attributes translated to choices men and women made on the types of trees to plant. The question, "If you were given a choice to plant trees, what trees would you like to plant, and why would you choose to plant these trees?" was hypothetical. The question measured intentions rather than the actual trees planted for the following reasons. First, intentions are good pointers to future behavior (Ajzen, 1991, and Ajzen & Madden 1986) in the presence of exogenous variables. For example, the observed differences in the actual behavior, as demonstrated by type of trees planted in the woodlots that are five years and older, between male and female-headed households (see Table 5) could be due to the age cohort effect of the woodlots. Male households have older woodlots while female households have newer woodlots. Factors such as seedlings availability at the time of establishment, as well as trends and research during that time would be different. For example, blue gum is believed to dry up the soil, and hence experts are now encouraging individuals to plant blue gum only in dambos as a way of wetland management. Previously, individuals could plant blue gum anywhere they wanted. Such a change would affect the type of trees a household plants. Second, measuring intentions rather than the actual behavior was essential in order to

accommodate respondents (especially women in male-headed households) who have no, or less influence, than men in decision-making. The data reported here are from women (49) in female-headed households and men (40) in male-headed households.

The most common specie that both men and women would like to plant is cassia (Senna siamea and Senna spectabilis), with 77.6 % of the women and 47.5% of the men citing this. Blue gum (Eucalyptus camaldulensis) was the second most cited tree with 10.2 % of the women and 17.5% of the men citing it. Six percent of the women and 15 % of the men would like to plant other exotic trees and another 6 % of the women and 15% of men would like to plant different types of indigenous trees. Only 5% (2 male-headed households) and none in female-headed household mentioned fruit trees as their first choice of trees they would like to plant.

Although cassia was most common choice between men and women in the two household types, a Chi-square test showed statistically significant differences at an alpha level of .10, χ^2 (3, $\underline{N}$ =87) =7.394, $\underline{p}$= 0.060[12]. Table 25 shows frequencies between men and women between the two household types.

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[12] The two individuals that mentioned fruit trees were removed from the chi-square analysis in order to reduce the number of cells that have expected counts of less than five.

Table 26 demonstrates consistency of the observed gender differences between households. A comparison between men and women within male-headed households had similar significant results, χ^2 (3, N =95) =11.677, p =0.009.

Table 25. Types of trees households intend to plant by household type (%)

Between household Type	**Type of trees mentioned (% of responses)**				
	Blue gum	Cassia	Other exotic	Indigenous	Fruit trees*
Female-headed	10.2	77.6	6.1	6.1	0.0
Male-headed	17.5	47.5	15.0	15.0	5.0

X2 (3, N =87) =7.394, p =0.060

(n=89, 49 women and 40 men female and male-headed households respectively)

*Fruit trees was not included in the chi-square test

Table 26. Types of trees men and women intend to plant in male headed households

Within male-headed household	**Type of trees mentioned (% of responses)**				
	Blue gum	**Cassia**	**Other exotic**	**Indigenous**	**Fruit trees***
Women	14.0	77.2	3.5	5.3	0.0
Men	17.5	47.5	15.0	15.0	5.0

χ^2 (3, N =95) =11. 677, p =0.009.

(n=97, 57 and 40 men from female and male-headed households respectively

*Fruit trees was not included in the chi-square test

Cassia is a versatile tree and provides attributes that both women and men desire. Cassia may be popular among households because of its rapid growth and coppicing abilities. Cassia can be used for fuelwood and poles (depending on the size of poles). Cassia burns very well and may produce good amounts of charcoal (especially with trunks or big branches). The glowing charcoal enables women to simmer foods and men to use the charcoal for ironing clothes. Cassia is also popular because it does not produce a great deal of smoke. In addition, cassia has straight branches and trunks suitable for small size poles.

Eucalypts, like Blue gum, are naturally very straight and thus good for poles. Women still use this for fuelwood although it may not be the preferred species. Wood from Blue gum burns well; however, it does not leave much charcoal and hence calls for constant attention

RESEARCH QUESTIONS 5-8 (WITHIN HOUSEHOLD GENDER DIFFERENCES)

The previous analysis dealt with differences that could be influenced by the gender of the household head; female or male. This section looks at within household gender differences in woodlot management to answer research questions 4-7. The data were based on the sample of men and women from male-headed households only, because some aspects of woodlot management such as access to woodlots, and decision-making power are gender-based issues within households. Forty-one men and 65 women responded to these questions. The

data from this section are reported in descriptive statistics only and no statistical tests were done to test for differences. Gender differences will be tested with Logistic Regressions associated with research question9.

Q- 5- Roles in woodlot management

The question; "Who plays the major role in the following activities; harvesting of fuelwood, poles, lumber and charcoal for both household and for sale?" addressed 65 women from male-headed households.

Table 27 and 28 show that there is a very big gender role difference in woodlot management activities within male-headed households. About 97% of the women said they are responsible for collecting firewood for household use, while 3.2 % (2 women) said it was the responsibility of their husbands. One of the two women said that the husband collects the wood because he has to use a bicycle. Because the woodlot is located is very far from their home, the woman cannot manage to carry the wood on her head for such a long distance. The other woman explained that the husband usually cuts down a whole tree and brings the fuelwood home for household use (cutting down trees is usually a man's job). Only 29% of the women in male-headed households receive help from family members; of these, 84% get help from their daughters while 16% receive help from their husbands.

Men mainly undertake fuelwood collection activities for commercial purposes. About 71% of the 42 women who responded to this question stated that

a man is responsible for collecting firewood for sale. The other 21% stated that it is a woman's responsibility. Only 4.8% said they equally share the task with their husband.

In addition to the sale of firewood, men are also responsible for the sale of all other woodlot products such as poles, trees and lumber. More than 82% of the women stated this.

The results are typical because, traditionally, household fuelwood collection is a female domain and male's involvement is a recent phenomenon, strongly tied to income (Nguluwe 1999), except for collection of pole and lumber for household use. Men harvest fuelwood to sell in the nearest urban centers.

Table 27. Role in harvesting woodlot products for household use*

Family member	**Type of product harvested for household use (%)**			
	Firewood	Poles	Lumber	Charcoal
Wife	96.8	14.5	0	33.3
Husband	3.2	79.0	86.6	66.7
Both wife and husband	-	3.2	13.3	-
Son (s)	-	0.0	-	-
Daughter (s)	-	3.2	-	-
Total valid responses (n)	63	62	15	6

*The data in this table was reported by women in male-headed households

Table 28. Roles in harvesting woodlot products for sale

Family member	**Type of product harvested for sale (%)**				
	Firewood	Poles	Whole tree	Lumber	Charcoal
Wife	21.4	16.3	12.8	12.5	-
Husband	71.4	83.7	82.1	87.5	83.3
Both wife & husband	4.8	-	5.1	-	16.7
Son (s)	2.4	-	-	-	-
Daughter (s)	-	-	-	-	-
Total valid responses (n)	42	43	39	8	6

Not all the 65 women responded to all the questions. The responses are from women whose households engage in the activity per se. For example, not many households produce charcoal for sale and hence the number of respondents is only 6.

Although men are responsible for harvesting all products for commercial purposes, this phenomenon may not translate to men's monopoly over cash resources because the non-cash responsibilities of harvesting poles, trees and lumber falls on men as well. For example, 79% of the women stated that pole harvesting for household use is a man's job. However, there is still a need to explain why men undertake harvesting of fuelwood for sale as their responsibility while leaving household fuelwood collection to women.

Q- 6- Share of woodlot work by household members

Sixty-five women in male-headed households were asked to make a self-assessment of their share of work in woodlot management activities such as tree planting, care of seedlings, weeding, and pruning. The women had a choice of five categories (5=I do all the work, 4= ¾, 3= ½, 2= ¼, and 1= none of the work). The women had a chance to use a visual presentation of the concept to help them make the choice. This is in Appendix 6. In addition, the women also stated how they perceived their husband's and other family members' share of work done in woodlot management. For reporting purposes, the five categories are compressed to three; all the work, and three quarters of the work is reported as more than half of the work, half of the work was reported as is (half of the work), and quarter of the work and none of the work is reported as less than half of the work.

Data on Table 29 from women in male-headed households show that 47% of men did more than half of the work in tree planting and 35% of the men did half of the tree planting work. Women did the remaining proportion of work in all households except for 11% of the households in which they also received help from other family members. The family members that were involved in tree planting did between half and less than half of the work.

A few more women than men did most of the work in care of seedlings. About 37% of the women did more than half of the work while 39% of the women

did half of the work. Men did the remainder of the work in all households except for 6 % of the households that also received help from other family members. The family members that were involved in tree planting did between half and less than half of the work.

Weeding demonstrated slight differences in the proportion of work men and women did, with men doing half or more of the work in the majority of the households. The data show that 42% of the men do more than half of the weeding while 44% of the men dc half of the weeding. Women do the rest of the work within the woodlot, except for 9% of the households where other family members do some of the work.

Table 29. Share of woodlot work by family members

Family member	**Types of woodlot management activities (% of responses)**											
	Planting			Care of seedlings			Weeding			Pruning		
	<½	½	>½	<½	½	>½	<½	½	>½	<½	½	>½
Women	48	35	17	24	39	37	44	47	8	73	22	5
Man	19	35	47	34	41	25	13	44	43	6.3	24	70
N=64 , data was reported by women from male-headed households												

Gender demarcation is evident in pruning activities. About 70% of the men did more than half of the work and 24% of the men did half of the work. Pruning has been a man's job because, by tradition, women were not supposed to climb trees. In the past, most of trees were much bigger that they are today. Thus pruning usually involved climbing trees. Although most trees (cassia) today can be pruned without climbing, men continue to prune trees and only a few women are involved.

Q- 7- Decision-making

Both the man and woman from each household were asked to report his or her influence on decisions pertaining to harvesting twigs, branches, trunks, and a whole tree. The total number of male-headed households is 65 and all 65 women were interviewed. However, only 41 men from these households were available for interviews. Thus, the frequencies are based on different sample sizes.

Table 30 shows the percentage of reported decision-making influence for each part of tree from both men and women in male-headed households. As observed from women's responses, women's decision-making power was dependent on the part of tree in question. On a Likert scale of 1-5, from no influence to very influential, women's influence on harvesting decisions decreases as decisions move from twigs to the whole tree. For example, combined frequencies of influential and very influential shows that 67% of women were

influential in making decisions on harvesting twigs, 64% for branches, 57% for trunks and 38% for harvesting the whole tree.

This trend goes in the opposite direction in men's decision-making power. As observed from the men's responses, men's influence goes up as decisions move from twigs to trunks. A combined frequency of very influential and influential illustrates this; 45% of men are influential on twigs harvesting decisions, 43% for branches, 62% for trunks and 72% for the whole tree.

Table 30. Men and women decision making influence on harvesting tree parts

Decision Influence	**Part of tree mentioned**			
	Twigs	**Branches**	**Trunks**	**Whole tree**
Women *	%	%	%	%
1. No influence	4.8	4.8	8.2	7.1
2. Not very influential	17.5	19.0	21.3	32.1
3. Equal Influence	11.1	12.7	13.1	23.2
4. Influential	23.8	27.0	34.4	19.6
5. Very Influential	42.9	36.5	23.0	17.9
Influential + very influential	66.7	63.5	57.4	37.5

Table 30 continued

Decision Influence	Part of tree mentioned			
	Twigs	Branches	Trunks	Whole tree
Men**	%	%	%	%
1. No influence	6.9	7.1	3.8	0
2. Not very influential	24.1	21.4	3.8	12.0
3. Equal Influence	24.1	28.6	30.8	16.0
4. Influential	13.8	10.7	11.5	24.0
5. Very Influential	31.0	32.1	50.0	48.0
Influential + very influential	44.8	42.8	61.5	72

* Women's decision-making power scores are from women's responses (n=65)

**Men's decision-making scores are obtained from men's responses (n=41).

Q- 8 -Access to woodlots

This question pertains to social access- whether men or women need to seek permission from their spouses before harvesting woodlot products. Forty-one men and 65 women responded to this question.

Responses from both the wife and husband show that the majority of men, over 92%, have full, non-restricted access to the woodlot and do not ask permission from their wives to harvest any woodlot product. On the other hand, women's free access to the woodlot is dependent on the part of the tree harvested. More women have autonomy over collecting smaller parts of trees (twigs and branches) without asking for permission from their husbands, while women are

more likely to be required to ask permission from their husbands in order to collect trunks and whole trees. Taking women's responses as a case in point, 75% of women do not ask permission for collecting twigs. This number goes down to 70% with branches, which are bigger in diameter than twigs. This figure further drops to 57% for trunks and then to 46% when harvesting whole trees.

From the men's responses, the 8% of the men (three men) who ask their wife's permission to collect trunks or whole tree gave the following reasons for their actions. The first man's wife owned the woodlot; the second man did it out of 'respect' and 'love' for the wife, and the last man just informed the wife for her information so that she could also keep track of harvesting activities. These responses are similar to women's responses, in addition to other reasons. The additional reasons were; that the woodlot is co-owned hence, the need to ask for permission (3 women); that it was a woman's job to collect twigs and branches so the husband had to inform her (1 woman); and that the women may have other uses for the parts of the tree (1 woman).

Several reasons were given as to why women asked for permissions from their husbands. The reasons men gave are listed in order of frequency from high to low. The reasons were: it is family protocol that a woman should ask the husband as the household head (5 men); the husband may have other plans or uses for the tree (5 men); the woman may cut wrong trees or parts (4 men). Other reasons were: to instruct the women what and where to collect (2 men), to instruct the wife on how much to collect (2 men), for the husband to keep track of

harvesting activities to avoid suspecting that someone has stolen from the woodlot (1 man), she may get friends to the woodlots to collect fuelwood (1 man), she only gets what is left over from harvesting other products (1 man), it's a man's job to cut trunks and trees (1 man).

These explanations are somewhat similar to women's. The reasons women gave listed in order of frequency from high to low, include: family protocol (9 women), the husband may have other plans or uses for the tree and the woman can only get the by-products (6 women), the woman may cut wrong trees/parts (1 women), husband restricts collection (1 women), it is a man's job to cut trunks and trees (2 women).

Table 31 shows that the responses from men and women on access are quite similar and have similar trends. More women are required to ask for permission from their husbands with increasing size of part of tree, regardless of who is responding. However, there are slight differences in frequencies of responses between men and women. One plausible explanation for this is the difference in sample sizes between men and women. Not all men were available to respond to this question.

Another interesting observation is that each gender assumed more power than the spouse allowed. For example, no man reported that he needed to seek permission when collecting twigs while 10% of the women stated that the men are required to ask for permission. This is the same with women, where more 46% of the women stated they do no need to seek permission in order to harvest the

whole trees, while 33% of the men said the women do not need to ask for permission.

Table 31. Percentage of respondents who collect tree parts without asking permission from spouse

Collects without permission	**Part of tree**			
	Twigs	Branches	Trunks	Tree
Husband's response: yes				
Husband	100	100	97.2	91.7
Wife	80	70	42.5	33.3
Wife's response: yes				
Husband	90.3	88.7	84.1	82.3
Wife	75	69.9	57.4	46.3
(n=41 men and 65 women)				

Q-1-8- Summary of the descriptive analyses

To summarize the descriptive analysis, we find that woodlots are contributing substantially to meeting household fuelwood needs as well as other needs such as poles lumber and fodder and, to some extent, household income. However, fuelwood shortage is still a problem in a third of all the households that own individual woodlots.

Contrary to our expectations, a bivirate analysis of fuelwood shortage and type of household did not find statistically significant differences between the two household types. In the next section, we therefore test whether there are statistically significant differences in fuelwood shortage between the two household types controlling for other factors, such as number of trees, use of other fuels, and household size. In addition, other factors such as access to the woodlot and woodlot ownership are important in male-headed household.

RESAERCH QUESTION-9 (FACTORS THAT AFFECT FUELWOOD SHORTAGE)

Q- 9- Regression analysis

Two regression analyses were run to test hypotheses 9-1 and 9-2. Hypothesis 1 tested the effects of gender of the household head on fuelwood shortage controlling for other factors. Data for testing hypothesis 9-1 were from women in the two household types. Hypothesis 9-2 tested the relationship of access and woodlot ownership in addition to variables controlled for in Hypothesis 9-1. Since these additional variables pertain to intra-household gender dynamics, data for hypothesis 9-2 were from women in male-headed households only.

In order to facilitate the logistic regression procedure, all categorical variables were recoded into 'dummy' variables. Table 1 on page 60 shows variable names, how each variable was coded for regression, and the description for each variable.

Hypothesis 9-1.

A sequential logistic regression analysis was performed using SPSS NOMREG to identify the effects of gender of household, number of trees, use of maize stalks as a cooking fuel, household size, and income on fuelwood shortage. The first stage tested a full model with all the variables included. The second model removed the variables that did not significantly contribute to the first model, i.e. income and household size. The third model included all variables in the second model except for maize stalk. Tables 32 and 33 have model fit information and likelihood ratio for all the models.

Table 32. Model fit information for Hypothesis 9-1

	Model	-2 Log Likelihood	Chi-square	df	Sig.	R^2
Model 1	Intercept only Final	74.15 58.63	15.53	5	.008	.32
Model 2a	Intercept only Final	135.45 93.48	41.97	3	.000	.44
Model 2b (With interaction)	Intercept only Final	135.45 79.81	55.64	4	.000	.55
Model 3 (without maize stalk).	Intercept only Final	127.51 98.79	28.72	3	.000	.32

Table 33. Likelihood ratio Tests for hypothesis 9-1

Model	Effect	-2 Log Likelihood of reduced model	Chi-square	df	Sig.
1	Intercept	58.63	.00	0	.
	Number of trees	63.04	4.41	1	.036
	Household size	58.75	.127	1	.722
	Yearly household income	58.66	.034	1	.854
	Female-headed household	60.03	1.41	1	.236
	Hh does not use maize stalk	65.98	7.35	1	.007
	Intercept	93.48	.00	0	.
2a	Number of trees	102.73	9.25	1	.002
	Female-headed household	96.64	3.15	1	.076
	Hh does not use maize stalk	122.93	29.44	1	.000
2b	Intercept	79.81[++]	.00	0	.
	Number of trees	79.81[++]	.00	01	.
	Female-headed household	83.02	3.2	1	.073
	Hh does not use maize stalk	107.58	27.76	1	.000
	Female head*number of trees	93.48	13.67	1	.000
	Intercept	98.88[+=]	.00	0	.
	Number of trees	98.88[+=]	.00	0	.
	Female-headed household	107.20	8.41	1	.004
	Female head*number of trees	114.14	15.35	1	.000

Table 33 continued

The chi-square statistic is the difference between in –2 Log Likelihood between the final model and the reduced model. Omitting an effect from the final model forms the reduced model. The null hypothesis is that the parameters of that effect are 0.

[a] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

[*=] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

The full model (model1), with all the predictors had 59 valid cases for analysis and 55 cases were removed due to missing variables. This model was a good fit, X^2 (5, $\underline{N}$ =59) =15.525, $\underline{p}$ =. 008, Nagelkerke R^2 =. 32, indicating that predictors, as a set, reliably explained fuelwood shortage. However, the likelihood-ratio tests for individual effects of variables in model 1, shows that income, household size, and gender of the household head did not contribute significantly to the model. It seems reasonable to conclude that household size, income, and gender of the household head are not related to fuelwood shortage. However, when interaction effects are added to the model, the interaction term of gender of the household head and number of trees is significant (p=. 089). The interaction effects suggest that the relationship between shortage and number of trees is significant between the two household types.

A second model (model 2a) was built with number of trees, use of maize stalk, and gender of the household head, plus the household head and number of trees interaction effect. Gender of the household head was included in the second

model due to the significant interaction effects; in addition, it is one of the important predictors for this hypothesis. The number of valid cases for this model was 110, and 4 missing cases were removed from the analysis. The number of valid cases increased in the second model since most of the missing cases were from the household income variable. A test of this model with all three predictors is statistically reliable, X^2 (3, N =110) =41.971, p =. 0001, Nagelkerke R^2 =. 44. All variables in this model contribute significantly. Model 2a has a smaller p value and explains more variance than Model 1, and is, thus, a better model than model 1.

An additional model (model 2b) was built with all the variables in model two, plus the Interaction terms. This model with interaction has a good fit as well, X^2 (4, N =110) =55.642, p =. 0001, Nagelkerke R^2 =. 55. The individual effects of the predictor variables with the interaction term are still significant and closely similar to model 2a without interaction. The explained variance, however, is greater than the explained variance of model two without the interaction. This shows that number of trees and gender of the household head when considered together, are significantly related to fuel wood shortage and explain an additional 11% of the variance that could not be explained by model 2a without interactions.

A third model (model 3) was run with all the variables in Hypothesis 1, except for maize stalk. Model 3 was necessary because the direction of the relationship between use of maize stalk and fuelwood shortage is not clear. On one hand, use of maize stalk could be because of a fuelwood shortage and not vise versa. On the other hand, use of maize stalk could be a mediating factor for

the perceived shortage, in that women may not report fuelwood shortage since they were able to substitute with a less desirable fuel. After removing all variables that did not significantly explain shortage, as well as excluding use of maize stalk, model 3, remained with number of trees and gender of the household head as indicator variables for fuelwood shortage. This was a good model as well and each variable contributed significantly to the model, X^2 (3, N =110) = 28.72, P =. 0001, Nagelkerke R^2 =. 32). However, the model explains only 32% of the variance.

This explained variance (32%) of model 3 is smaller than the explained variance (55%) of model 2 with interaction effects included. Thus, maize stalk is a very important indicator in explaining fuelwood shortage and use of maize stalk alone explains 23% of the variance. Therefore, model 2 remains a superior model and the following discussion is based on the results from model 2.

Results from model 2 suggest that gender of the household head is related to fuelwood shortage primarily due to the interaction between gender of the household head and number of trees. Although female-headed households have unrestricted access to the woodlot they have fewer trees to use. In addition, female-headed households may have no competing uses, and all the wood from the few available trees is used for fuelwood. Male-headed households generally have many trees, but there could be a 'paradox of shortage amidst plenty' due to factors such as social access. Hence, women from the two types of households with the same number of trees may report different levels of fuelwood shortage as

will be demonstrated in the next regression analysis. Access to woodlots had a smaller p value than number of trees in male-headed households, suggesting that access (i.e. whether women seek permission or not in order to harvest woodlot products) is an important determinant of fuelwood shortage.

Table 34 shows parameter estimates of the regression co-efficient, Wald statistics, odds ratio for each of the three predictors without the interaction terms[13]. The parameter estimates[14] without interactions and keeping all other variables constant) indicate that, female-headed household are more likely to experience no shortage by a factor of 2.8 (exp (b)). The odds ratio of households reporting a fuelwood shortage increases by a factor of 14.4 when a household uses maize stalk. An increase in the number of trees increases the likelihood of experiencing no shortage by a factor of 1.001. Due to the interaction effects, gender of the household head and number of trees should be considered together when explaining fuelwood shortage.

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[13] The log likelihood of number of trees, gender of household head, and use of maize stalk is similar to the log likelihood ratio of the above plus number of trees and interaction. The reported parameter estimates are from the model without interaction terms, since 'models that include interaction terms are harder to interpret", P 51, SPSS Regression models 10.0

[14] Wald statistics sometimes fail to correctly reject the null hypothesis when the coefficients are large. Log likelihood ratio is a better test for an effect than the Wald statistics. The wald statistics was however used just to give a picture of the relationship between the different independent variables to fuelwood shortage

Table 34. Parameter estimates for model 2-Hypotheis 9-1

Experienced NO shortage	B	Std. Error	wald	Df	Sig.	Exp (B)
Intercept	-1.81	.642	7.97	1	.005	.
Number of trees	.001	.000	5.67	1	.017	1.001
Female head	1.042	.618	2.84	1	.092	2.84
Hh does not use maize stalk	2.67	.568	22.00	1	.000	14.39

Hypothesis 9-2.

A second regression analysis was run for Hypothesis 9-2 to investigate the effects of access to woodlots, (i.e. whether or not a woman seeks permission from husband in order to harvest different parts of the trees), woodlot ownership (whether the woodlot is owned by wife, husband, or is co-owned by wife and husband), in addition to the other variables investigated in the first regression analysis. These data are from women in male-headed households only. Access to woodlots and woodlot ownership are variables that directly relate to intra household gender dynamics, since most women in female-headed households own the woodlot and make their own decisions on when, how much, and what part to harvest from the woodlot. Table 35 and 36 has model fit information and likelihood ratios for all the models.

Table 35. Model fit information for Hypothesis 9-2

	Model	**-2 Log Likelihood**	**Chi-square**	**df**	**Sig.**	**R^2**
Model A	Intercept only Final	74.92 38.41	36.51	6	.00	.64
Model B	Intercept only Final	75.026 37.196	37.83	5	.000	.65
Model C (without maize stalk)	Intercept only Final	70.63 56.19	14.44	2	.001	.29

Table 36. Likelihood ratio Tests for hypothesis 9-2

Model	Effect	-2 Log Likelihood of reduced model	Chi- square	df	Sig.
A	Intercept	38.41++	.00	0	.
	Access to woodlots	44.11	5.70	1	.017
	Number of trees	43.55	5.14	1	.023
	Household size	38.48	.070	1	.791
	Hh. does not use maize stalk	38.41++	.000	0	.
	Ownhubby	38.41++	.000	0	.
	No maize stalk use*Own hubby+	42.87	4.456	1	.035
B	Intercept	37.17	.000	0	.
	Access to woodlots	42.91	5.72	1	.017
	Number of trees	42.29	5.10	1	.024
	Hh does not use maize stalk	37.20	.00	0	.
	No maize stalk use*Own hubby+	41.68	4.48	1	.034
C	Intercept	59.10	2.91	1	.088
	Access to woodlots	65.98	9.79	1	.002
	Number of trees	60.49	4.30	1	.038

Table 36 continued

[+] Ownhubby= 0: Represents either the wife, or, both wife and husband co-owning the woodlot [++] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom. The chi-square statistic is the difference between in –2 Log Likelihood between the final model and the reduced model. Omitting an effect from the final model forms the reduced model. The null hypothesis is that the parameters of that effect are 0.

The first stage tested a full model, which included all variables stated in Hypothesis 2. Second, variables that did not significantly contribute to the first model were removed. These were income and household size. The third model included all variables in the second model except for maize stalk.

The full model (model A) included all five predictors for hypothesis 9-2: number of trees, use of maize stalks, household size, access to woodlots, and woodlot ownership as well as the interaction effects. This model had 60 valid cases for analysis, and 3 cases with missing variables were removed.

Model A was a good model fit, X^2 (5, $\underline{N}$ =60) = 36.51, $\underline{p}$ =. 0001, Nagelkerke R^2 =. 64, indicating that predictors and their interaction effects, as a set, reliably explained 64% of the variance in fuelwood shortages. However, the likelihood-ratio tests on individual effects of the variables show that household size did not significantly contribute to the full model. This suggests lack of a relationship

between numbers of people in the household with fuelwood shortage. Household size was, therefore, removed and a second regression model (B) was run.

Model B included all variable from model A, except for household size. Sixty cases were entered for analysis, after 3 cases with missing data were removed. This was a good model according to model fit information on table 43, X^2 (5, N =60) = 37.83, p =. 0001, Nagelkerke R^2 =. 65. All three variables and the interaction term of maize stalk and woodlot ownership contributed significantly to the model.

As was the case with Hypothesis 9-1, an additional model (model C) was built to test the contribution of use of maize stalk to the explained variance. After removing all variables and interaction terms that contributed more than excluding use of maize stalk, the final model had access to woodlot and number of trees as important variables. The model was reliable, X^2 (2, N =63) = 14.44, p =. 001, Nagelkerke R^2 =. 29. However, this final model explained only 29% of the variance, compared to 65% explained variance in model b, which included maize stalk. This indicates that use of maize stalk is an important indicator of fuelwood shortage and use of maize stalk alone contributes 34% of the explained variance. Thus, the following discussion will be based on model 2 that includes maize stalk, in addition to number of trees and access.

Results from model B, using likelihood ratios, show that access to woodlots is the most important predictor of fuelwood shortage in male-headed households (P=. 017), followed by number of trees (P=0.024) and lastly an interaction between

use of maize stalk and woodlot ownership. Table 37 parameter estimates[15] show the direction of the relation between each of the independent variables to fuelwood shortage. For example, an increase in one unit of access (0, no access to 5, unrestricted access), increases the likelihood of experiencing no shortage by a factor of 1.9 (Exp (B). While a one unit increase in number of trees increases the likelihood of experiencing no shortage by a factor of 1.001.

Table 37. Parameter estimates for model B-Hypothesis 9-2

Experienced NO shortage	**B**	**Std. error**	**wald**	**df**	**Sig.**	**Exp (B)**
Intercept	-2.67	1.26	4.49	1	.034	.
Access to woodlots	.62	.29	4.7	1	.030	1.86
Number of trees	.001	.001	3.09	1	.079	1.001
No maize stalk	1.16	1.21	.92	1	.33	3.20
Ownhubby	-1.32	1.21	1.20	1	.27	.265
No maize stalk* Ownhubby	3.44	1.68	4.18	1	.04	31.32

An interesting observation from all the models in Hypothesis 2 is that there were no interaction effects between number of trees with any of the other

[15] The parameter estimates based on Wald statistics sometimes fail to correctly reject the null hypothesis when the coefficients are large. Log likelihood ratio is a better test for an effect than the Wald statistics. The wald statistics was however used just to give a picture of the relationship between the different independent variables to fuelwood shortage

independent variables. This further strengthens the argument that the two households types experience different levels of fuelwood shortage due to varying number of trees

STUDY LIMITATIONS AND STRENGTHS

Limitations

As with all social science research, there were several limitations to this study. The limitations included both a small sample size and missing data. Missing data affected the number of valid responses. As noted earlier, most of the bivirate analyses had different numbers of valid responses. Small sample size was a problem especially when the data were divided into subsections for further analyses. The small sample size further limited the number of variables entered in the logistic model, hence limiting the ability to control for other factors that could be very important.

Also, the study was limited to one geographical area. The study area was from one district out of the 25 districts in Malawi and restricted to one tribal group with matrilineal cultural practices. This was both a limitation and strength. It was a limitation since results can only be generalized to communities that have similar demographics and cultural backgrounds. It is a strength since limiting the sample population to one cultural group enabled us to at least control one variable, which could be critical to land and property ownership.

This is a one-time cross-sectional study and the results reflect the situation at the time of the interviews. For instance, as noted earlier, day-to-day and seasonal variations in fuelwood harvesting patterns may not have been captured with this study. Use of maize stalk, which was one of the strongest indicators of fuelwood shortage, is seasonal as well.

The primary data collection method for this study was a questionnaire. Questionnaires rely on recall data, and hence are subject to error due to inaccurate recall of facts. For example, most of the quantities measured, except for the number of trees, are based entirely on respondents' recall. In such cases, data from a recall activity may not be reliable, especially when the recall activity did not follow a regular pattern and when the recall activity was beyond three months. However, individuals may remember some milestone activities such as cutting down a whole tree. The ideal methods to understand some aspects of this study, mainly fuelwood harvesting and consumption patterns and income, would be direct monitoring and weighing techniques (Abbot and Homewood 1999, and McElwee, June 2001).

Concepts such as proportion may be hard to explain to individuals with low literacy levels. However, the researcher used visual representations of standard measures (a pictorial representation of proportion, a standard head load and Mendel) to estimate size and quantities.

Therefore, conclusions from the present study are focused more on relative differences than absolute levels of fuelwood shortage between households.

However, most of the results for the study are comparable to previous studies. In addition, there was a very good level of agreement between husbands' and wives' responses in male-headed households to the same question, demonstrated by a higher correlation of responses, ascertaining some reliability of the data collection instruments.

The translation from English to Chichewa, Malawi's national language, may also have introduced some systematic error. Some concepts may have been lost in the process since some English words do not have direct translation to Chichewa. Finally, the data are based on the assumption that respondents were truthful in their responses.

Strengths

We were able to administer the survey face to face, increasing the response rate. The investigation involved a triangulation procedure and included several instruments to gather the data, which were the questionnaire, a focus group and a field trip. In addition, respondents showed us the actual amounts of wood and types where applicable. Within the questionnaire, several questions were asked in different ways to investigate a similar concept. There was a high level of agreement of the responses from respondents. The same level of agreement was observed when men and women from male-headed households responded to similar questions.

CHAPTER 5- RECOMMENDATIONS AND CONCLUSIONS

The purpose of this chapter is to draw together various components of the research process, to provide a summary of the study results, to discuss implications of the study findings, and to offer recommendations on policy issues and future research.

THE RESEARCH PROCESS

The effects of the gender of the household head (male and female-headed households) on fuelwood sufficiency, motivations to plant trees, and benefits gained from the woodlot were investigated, and gender differences in woodlot management within male-headed households were explored. Variables that are important in explaining fuelwood shortage in households that have established household owned woodlots were also identified.

Literature related to deforestation, woodlot management, fuelwood use, and harvesting patterns were discussed to provide a brief background to the problem of fuelwood in Malawi. The most important of these was the Malawi government's strategies to deal with the fuelwood problem. The government adopted supply enhancing and demand limiting approaches of reforestation programs and fuelwood efficient stove projects, respectively. The literature review also included a discussion of previous research related to deforestation and

fuelwood problems in order to identify gaps between research and practice. Possible alternatives to fuelwood were also discussed. Important socio- economic variables to be considered in this research were also highlighted.

A systems framework provided a theoretical background within which woodlot use and fuelwood sufficiency could be addressed. The researcher used elements from family systems theory in order to describe the dynamics of household owned woodlots. Systems theory in family resource management examines the interrelationship of input, throughput and output. In this study, inputs were identified as demands, such as household fuelwood needs influenced by household size, number of woodlot trees, and preferred species and parts of trees for harvest. Outputs included fuelwood sufficiency, the amount of wood stored for the rainy season, benefits (monetary and non-monetary) from the woodlot, as well as satisfaction with woodlot supplies. Throughputs for the study were identified as decision-making power and access, i.e. managerial components of households.

The test instrument (Appendix 1) was administered to women from female and male-headed households. Questions from some sections of the survey addressed men from male-headed households as well. In addition, qualitative data were collected through focus groups with some of the women participants.

Questions on the survey were read to the participants due to low literacy levels. A total of 116 households (51 female-headed and 65 male-headed), participated in the study. These households were from five Traditional Authorities in rural Lilongwe, Malawi.

RESULTS FROM THE STUDY

The primary objective of this study was to identify variables that are important in explaining fuelwood shortage in households that have established household owned woodlots. In order to achieve this, the study sought to answer nine research questions. The first eight questions provide descriptions of differences between the two household types (research question 1-4) as well as gender differences within male-headed household types (research question 5-8) in woodlot management. The analyses also described some of the variables that would address research question 9: factors that affect fuelwood shortage.

Sample demographics

The study participants included women (51 and 65 from female and male-headed households, respectively). In female-headed households, 28 were widows, 17 were divorced and 8 were married but the husband was absent from the households for at least one year. Forty men from male-headed household also participated in the study. These men responded to selected questions pertaining to male roles in the household woodlot management.

The average household sizes were 4.8 and 5.9 members (female-headed and male-headed households respectively). Most of the women in both households had about three years of formal education. Women from female-headed households were significantly older (mean=50.4) years than women from

male-headed households (mean 44.3) years. Female-headed households had significantly less income (mean=MK 4,696) than male-headed households (mean=11,775). Men in male-headed households were responsible for the sale of woodlot products.

Woodlot demographics

The main source of fuelwood for the study population was household owned woodlots. The main use of fuelwood is for cooking food. Secondary uses of fuelwood include beer brewing and brick making, for some households, as well as for lighting and heating.

The major tree species in these woodlots included cassia (for female-headed households) and blue gum for male-headed household. These woodlots had 13 other tree species planted as well. Female-headed households had a mean of 840 (median =250) trees that are 5 years and older with a standard deviation of 1719 and male-headed households have an average of 1666 (median=700) trees with a standard deviation of 2277 trees. The large standard deviations and difference between mean and median indicate that trees were neither equally nor normally distributed among households in both household types. Households tree ownership ranged from 85 trees to 11,000 trees, for all household types.

Research questions 1- 8

Table 38 and 39 provides a summary of findings from the research questions 1-8. Research questions 1-4 described differences between male-headed and female-headed households and research questions, 5-8, looked at gender differences between men and women within male-headed households.

Table 38. Summary table between household type differences- Q1-4

Q-1- Fuelwood harvesting patterns	
Preferred part of fuel wood.	No difference –both household types preferred trunks for fuelwood.
Most harvested part of tree	No difference- BUT the reasons for harvesting twigs were different.
Amount of fuelwood collected	Different**. Male-headed households collected more
Frequency of collection	Different**. Male-headed households made more trips per month to collect fuelwood
Main source of fuelwood	No difference. Household woodlots were the major source fuelwood and poles.
Q-2- Fuelwood shortage	
	No difference
Q-3- Benefits from the woodlot	
Perceived benefits	No difference in fuelwood, medicine, food. A difference** in poles, timber and fodder
Income from sale of woodlot products	Different***. Male-headed households earn more income from woodlot products sales
Q-4- Motivation to plant trees	
Reasons for establishing woodlots.	No difference. Both household types planted trees for fuelwood as the primary reason. No difference. Both household types planted trees for poles as the secondary reason.
Type of trees to plant	Different *, cassia for female-headed and blue gum for male-headed households
Important trees attributes	Different***. Female-headed household had fuelwood oriented attributes and male-headed households had pole oriented attributes
*** Significant at <01, ** significant at, <05, * significant at <.10 level	

Table 39. Summary table for male- headed household gender analysis Q5-8

Q-5-Roles in woodlot management	
	Women collect fuelwood. Men harvest poles and lumber (Timber) Men are responsible for harvesting all woodlot products for sale.
Q-6- Share of woodlot work	
	Men did most of the tree planting Seedling care was shared between men and women although more women than men did most of the work Weeding was shared between men and women although more men than women did most of the work. Pruning was predominantly a man's task.
Q- 7-Decision making	
	Men made most of the decisions in fuelwood harvesting Decision making power of men increased with increasing size of tree part.
Q-8- Access to woodlots	
	Men did not ask for permission from their wives in order to harvest any tree part Women asked for permission from their husband in order to harvest tree parts. The number of women who asked for permission went up with increasing size of tree part.

Q-1- Fuelwood harvesting patterns

Most women preferred tree trunks for cooking because fuelwood from trunks burns for a long time and produces large amounts of charcoal. Fire from trunks requires less attention, thereby enabling women to carry out other activities

simultaneously. In addition, most women liked trunks because wood supplies last a long time. A few women prefer twigs and branches because they dry quickly or are already dry when harvested, while others preferred twigs and branches in order to allow the tree to regenerate. In addition, twigs and branches require no splitting.

These finding were fascinating in that most women in both households did not usually harvest trunks, even though this was their preference. One would expect that women would collect the parts they prefer. Thus, tree preferences do not translate to the actual part of the tree harvested. Most women collected twigs first, followed by branches, and a few collected trunks. Usually the women collected each tree part with a combination of other parts.

Several reasons were given as to why women collected twigs and branches instead of trunks. Interestingly, these reasons differ significantly by the household type. Competing uses of trunks, such as poles for construction, was the main reason why women from male-headed households did not collect trunks. Surprisingly, the husband's "restriction" was the least mentioned by women, with only 7% of the responses. On the other hand, in female-headed households, tree regeneration and the quick drying attributes of twigs were the two equally important reasons why the women collected twigs instead of trunks. This behavior may be reasonable given the small size of their woodlots.

The women collected between 1.5 to 2 headloads of wood per week as cooking fuel only. Male-headed households collected significantly more than

female-headed households, probably because they had larger woodlots and had somewhat larger families. Most women made 6-7 trips per month to collect fuelwood. On average, women in female-headed household made fewer trips than women from male-headed households. In addition, collection patterns varied among women; some women collected fuelwood daily or as needed, and others stockpiled their fuelwood. This probably affected the frequency of collection. Frequency of collection is also a function of distance to the woodlot; the part of the tree harvested, and, probably, different management styles. People who traveled shorter distances collected on a daily basis; with those harvesting trunks or whole trees making fewer visits. This study did not determine how much time women spent in fuelwood collection for comparison to various fuelwood collection patterns.

Q-2 - Fuelwood sufficiency

Fuelwood shortage

Fuelwood shortage was a problem in a third of the households that own woodlots. A chi-square test showed that there were no differences between female and male-headed households. However, a difference in shortage of fuelwood by gender of the household head became apparent when controlling for other variables such as number of trees (see research Q9).

Use of other fuels

Most households in both female and male-headed households used fuelwood as the main energy source for cooking. Some households used fuelwood with various combinations of other fuels, mostly with shelled maize cobs. The use of shelled maize cob however, is also a way of recycling a by-product of maize processing. Use of shelled maize cob is limited to 3 days per month on average. Focus group discussions revealed that, in some households, women reported going to other households to help shell maize so that they could obtain the cobs for cooking fuel.

Some households used maize stalks either as the main fuel or in combination with other fuels. Most of the households that cooked with maize stalks reported having experienced fuelwood shortage in the past year. Women avoided the use of maize stalks as cooking fuel as much as possible. This is because maize stalks produce a great deal of smoke, and burn very quickly, hence demanding constant attention. Maize stalk use may, therefore, be an indicator of severe fuelwood scarcity and desperation. Few households use cow dung or tobacco stalks.

Q-3- Benefits from the woodlot

Perceived benefits gained from the woodlot

Most households benefited from the woodlot in the past year. Women from both households reported to have benefited equally from the woodlot in terms of fuelwood, medicine and food such as mango fruits. However, there were variations between reported benefits from the use of poles, lumber, and fodder. Male-headed households reported more benefits than female-headed households. This could be due to the low use of poles and lumber, (generally male oriented products), in female-headed households.

Income from sale of woodlot products

Some households were involved in the sale of woodlot products on a small-scale. These households sold one, or a combination, of the following woodlot products: fuelwood, poles, whole tree and lumber. The study showed major disparities in total sales between the two types of households. Female-headed households sold less than male households. This could be a function of the overall number of woodlot trees and other enabling factors such as having a bicycle to transport woodlot products to the nearest markets. Of the few households that sold woodlot products, the respondents reported that sales were less than one quarter of total household income. In fact, computations showed that

household woodlots contribute less than 10% of total household income for those who engage in sales.

Q-4-Motivations to plant trees

Households planted trees for many reasons and uses. Planting trees for fuelwood was the primary purpose in both household types. This was a surprising finding for two reasons. First, factors such as gender division of tree planting roles, competing uses of woodlots for poles or lumber, and the need to derive income were overridden by the stated need for fuelwood. The lack of difference between household types may be because most female-headed households were male-headed households at some point in the past, and perhaps at the time of woodlot establishment. In addition, some women in male-headed households individually owned or co-owned the woodlots, hence they may have had some influence in establishing the woodlots. Second, these findings are contrary to previous studies and recommendations where researcher stated that households plant trees for multiple uses, with fuelwood as a secondary byproduct. However, the gender of the household respondent was generally not identified in prior studies.

The special characteristics women look for in trees to plant, in order of importance, include: trees that grow very quickly, whose wood burns well, and those which produce charcoal. On the other hand, men look first for trees that grow straight, followed by trees that grow very quickly, and trees whose wood produces charcoal.

An interesting observation is that, although preference for tree attributes between men and women differ, cassia was a popular species with both men and women. However, more women than men mentioned cassia as the type of tree they would want to plant. Less than half of the men mentioned cassia and with over half splitting their choices among blue gum and other exotic and indigenous trees. It is worth noting that cassia is a versatile tree. Its wood can be used as fuelwood as well as poles depending upon the desired size of the poles. Blue gum also has multiple purposes such as for poles, fuelwood and medicine. However, women prefer cassia since it has superior burning qualities, and dries more quickly than blue gum.

Q-5- Roles in woodlot management

Both men and women play important roles in managing the woodlots. However, these roles are differentiated by gender. Women collected fuelwood for household use with assistance from children, mainly girls. Sometimes the women received help from their husbands, generally when collection involved cutting down a whole tree and traveling very long distances requiring the use of bicycles. Men were responsible for harvesting all woodlot products for commercial purposes and also for harvesting poles, lumber and whole trees.

Q-6- Share of woodlot work by household members

Men and women shared the work pertaining to woodlot tasks. However, the proportion of labor input to specific woodlot management tasks differed between

men and women. For example, men did most of the work in tree planting, weeding, and pruning, while women did most of the work in the care of tree seedlings. Only a few households (fewer than 10%) received help from other family members mostly girls.

Q-7- Decision-making

Overall, men made the decisions on harvesting parts of tree for fuelwood. The differences in power relations between men and women were most apparent when it came to decisions to harvest bigger parts of the tree such as trunks or the whole tree. For example, from women's responses, the number of men who were influential in harvest decisions increased from 45% for twigs to 72% for trunks.

Q-8- Access to woodlots

Most of the men had free access to the woodlot and did not ask their wives for permission to harvest twigs, branches, trunks, or the whole tree. This was different for women. Many women asked permission from their husbands in order to harvest tree parts. This requirement to ask for permission increased with increasing size of the tree part harvested. For example, most women asked permission to collect trunks and whole trees while few women asked for permission when harvesting twigs. This suggests that, within the households, husbands have more power than wives. However, we do not know, from this study, how often husbands may have refused access when the wives requested it.

Q-9-Factors that affects fuelwood shortage

Results from the logistic regression with all household types, show that number of woodlot trees, use of maize stalk, and gender of household head were important variables in explaining fuelwood shortage. Its is important to note there was a significant interaction between number of trees and gender of the household head, suggesting that female-headed households and male-headed households experience varied levels of fuelwood shortage. Women from female-headed households were less likely to experience shortage with increasing number of trees while this was not necessarily true with women from male-headed households.

Results from logistic regression 9-2 showed that women's access to woodlots in male-headed households was the more important predictor of fuelwood shortages followed by number of trees and the interaction between use of maize stalk and who owned the woodlot.

APPLICATION OF SYSTEMS THEORY TO STUDY FINDINGS

This study drew upon a systems framework to identify factors that affect fuelwood shortage. Figure 2 on page 45 identified several variables as inputs and throughputs that would affect output (fuelwood shortage).

Inputs and throughput variables that had a plausible relationship were entered into the regression analysis for research questions 9. Variables identified

in figure 3 and 4 were deemed as important variables to explain fuelwood shortage. Number of trees, income, use of maize stalk and household size were identified as inputs and gender of the household head representing the decision maker variable was identified as a throughput for regression analysis with all household types. For regression analysis with male-headed households only, number of trees, income, use of maize stalk, and household size were identified as inputs and access to woodlots as a throughput.

Logistic regression results suggest household size and income were not important inputs that would affect the output; fuelwood shortage. However, number of trees and use of maize stalk were important inputs that affected fuelwood shortage. Use of maize stalk is proposed to be a feedback mechanism of fuelwood shortage that re-enters the system as input. An interesting observation is that when access to woodlots, which is identified as a throughput, enters the regression model in male-headed households, access to woodlots overtakes number of trees and becomes the most important variable to explaining fuelwood shortage.

The results from the regression analysis in male-headed households show that throughputs are essential in explaining and understanding the internal process of how inputs are translated to outputs (Deacon and Firebaugh 1988). In addition, the results agree with an earlier discussion on systems theory (pages 29-44) where by it was assumed that similar inputs could lead to different outputs (multifinality), because of differences in managerial behavior between male and

female-headed households. This is based on the premise that goals between men and women may be different, and that men make most of the fuelwood harvesting decisions.

Figure 3. Between household input, throughput and outputs analysis

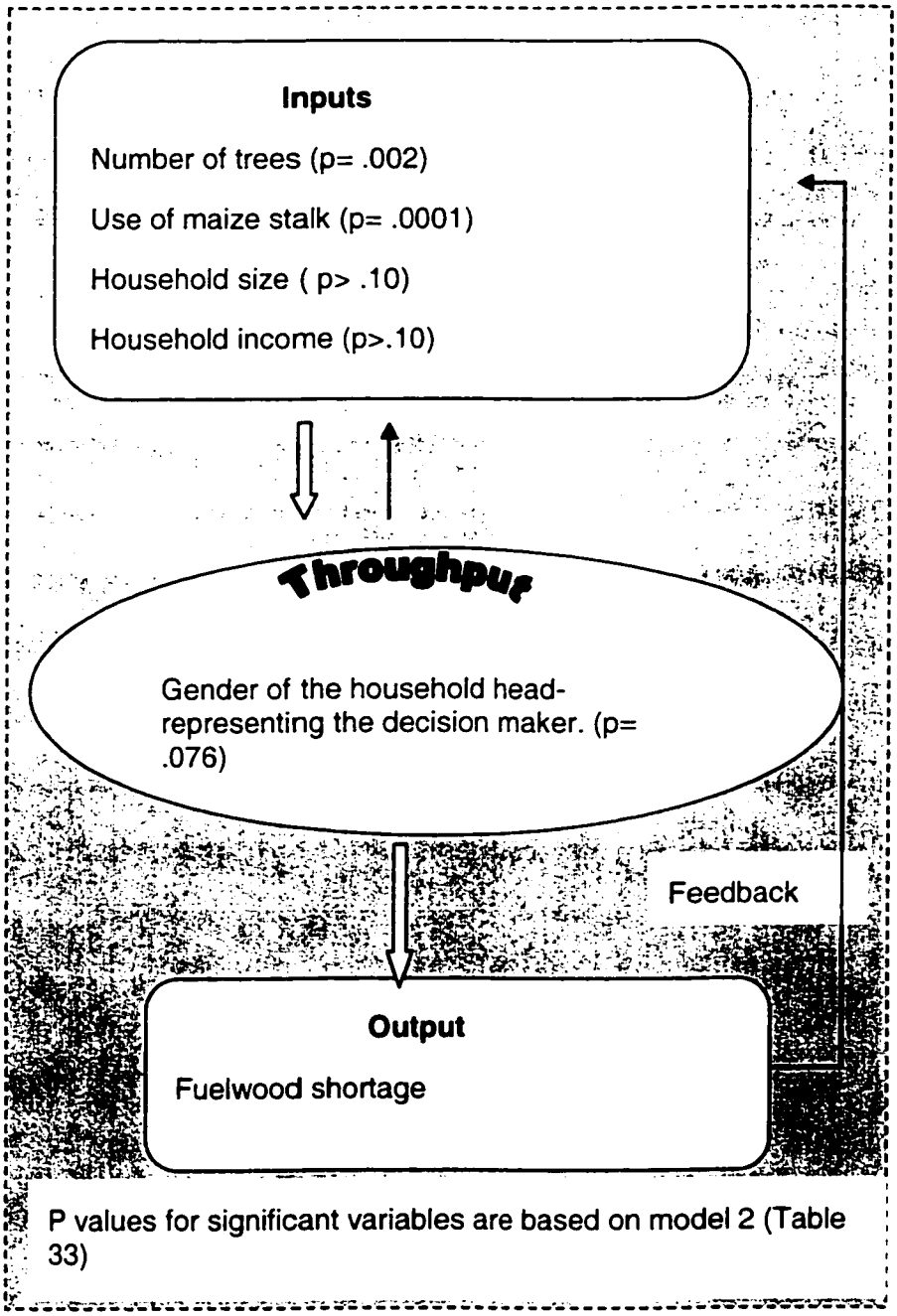
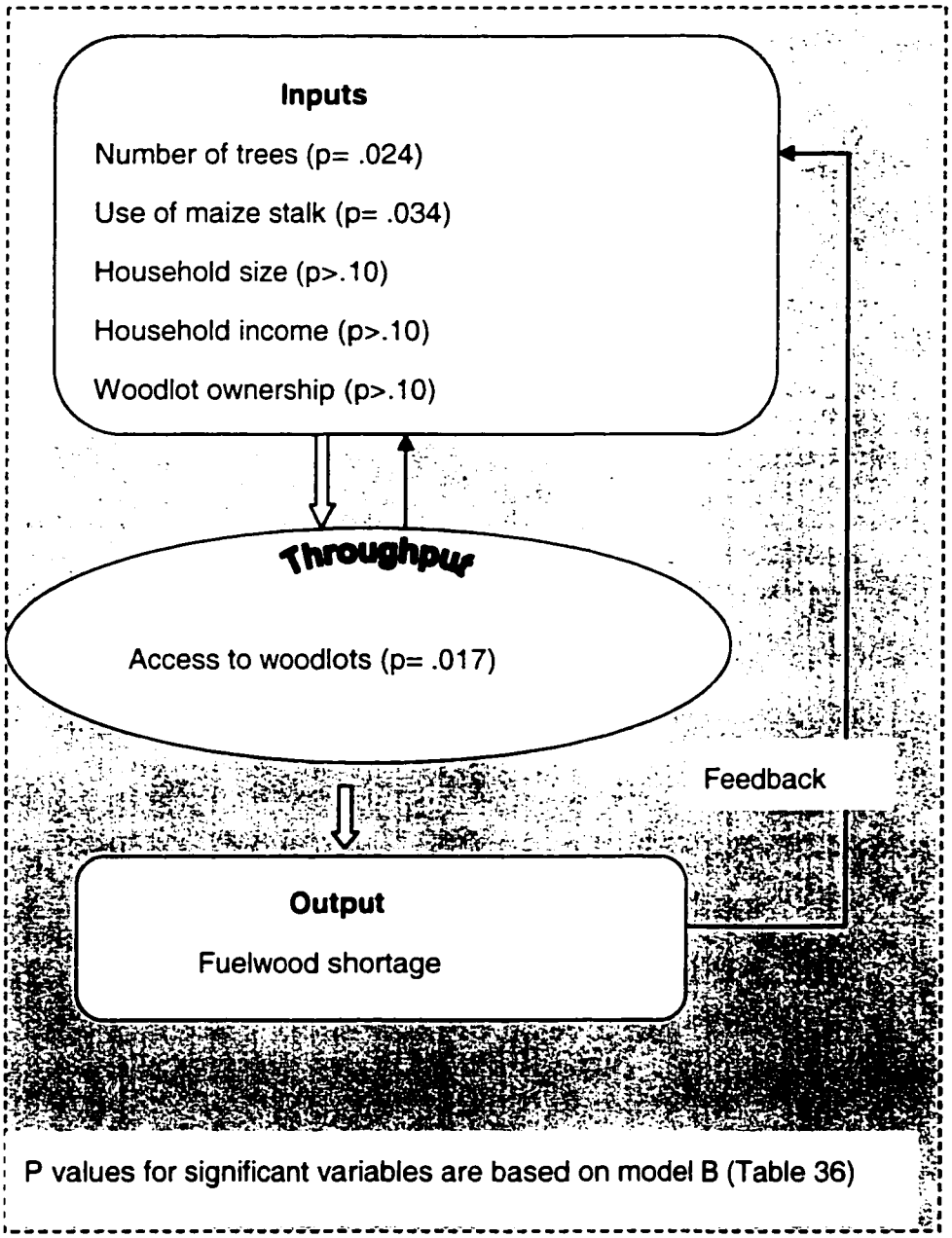


Figure 4 Within male-headed household input, throughput and outputs analysis



STUDY IMPLICATIONS AND RECOMMENDATIONS

This section provides implications of the study and recommendations for policy and future research.

Household woodlot success story

Household owned woodlots are the most important source of fuelwood for most of the households in this sample population. About 84% of the sample households depend on woodlot fuelwood as their major source. Apart from trees planted in some respondents' gardens[16], there are no other sources of fuelwood in these villages due to deforestation. In areas where forests exist, most of these forests are government-protected areas where it is illegal to cut down trees. In addition, some of the forests that exist are community owned woodlots, planted by community members composed of multiple households. Ideally, these woodlots are for community use. However, anecdotal evidence shows that households do not harvest any of these woodlot products for household use (Household Woodlot Study, 2002, and pilot study)[17].

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[16] Most households have mango trees in their gardens for a source of fruit. Women will sometimes cut off branches to use for fuelwood.

[17] This information was collected from the household woodlot questionnaire and focus group study. However, the analysis of this information is beyond the scope of this dissertation. In addition, an earlier pilot study by the researcher showed that in 9 out of 10 community woodlots in Dedza district and 8 out of 9 community woodlots in Lilongwe district woodlot products e.g. fuelwood, were not harvested for individual household use.

Household woodlots produce multiple benefits for households in terms of providing the household with fuelwood, poles, lumber, fodder, medicine and food. In addition, these findings show that women who have woodlots walk shorter distances to collect wood when compared to women without woodlots as reported in previous studies where households did not own woodlots (Culler, Peterson, & Matenje, 1990). This is a positive outcome, as this probably frees some of the women's time for development work such as involvement in income generating activities.

Further, household woodlots produce various benefits for the environment and, to some extent, the wider community. Household woodlots have helped the environment through reforestation in two ways. First, woodlots have reduced the need to cut down natural woodlands, hence preserving some of the special indigenous trees. Second, woodlots have slowed down the rate of deforestation as some households with woodlots now have alternative sources of fuelwood.

Less successful stories

Woodlot economic contribution to the household

Despite the benefits, woodlots may offer to the household economy, 54% of the households in this study did not engage in sale of any woodlot products. In addition, for the 46% of the households that sold woodlot products, income from

the sale of woodlot products contributed less than 10% of their total yearly income. Research and program efforts should therefore, focus on households that have not been profiting and encouraging others to maximize profits from the woodlot.

In addition to increasing biomass and providing ground cover, the sale of woodlot products has substantial potential to raise household income and hence reduce poverty. Earnings from sales of woodlot products may add diversity to household incomes and can provide a buffer against drought and crop failure due to changing weather patterns. Woodlots are important because harvesting can be deferred or brought forward to provide income when it is most needed.

However, these woodlots can only bring economic value to households if households have enough trees to first meet household needs. As observed from the study, many households (mainly female-headed households) have very few trees. Reforestation projects must encourage households to plant enough trees in order to meet this objective as well.

Fuelwood shortage

It is apparent that the woodlots have not provided a total solution to the problem of fuelwood shortage since a third of the households reported experiencing fuelwood shortage in the past year. Fuelwood shortages apparently have multiple and interacting causes. Direct causes of fuelwood shortages differ by type of household. Nevertheless, the fuelwood problem has emerged as part of

an overall problem of gender as it influences distribution of resources and decision-making power.

As observed from female-headed households, number of trees was the most important factor in fuelwood shortage. The number of trees in a household woodlot may be a function of the amount of land devoted to woodlots. Female-headed households had smaller land sizes than their male counterparts due to socio-legal problems of land ownership. Customary laws discriminate against female land ownership in that women's access to land is generally through a male relative (kandodo, 2001). Within male-headed households, women who experienced fuelwood shortages had limited access to woodlots. Access to woodlots is determined by power dynamics and contributed to fuelwood shortages in spite of the number of trees a household had. Thus, reducing fuelwood shortage should therefore include a mix of measures, such as increase in number of trees planted, addressing fuelwood efficient methods of cooking such as fuelwood efficient stoves and fuel-efficient cooking practices, as well as addressing social cultural determinants. Households that are experiencing fuelwood shortage should receive special attention in order to address their problems.

Tree planting

The study findings affirm the notion of planting multi-purpose trees to meet different household needs. Tree planting at the household level should continue to be a priority in forestry programs. This is because there is no immediate substitute

for fuelwood. Only 3% of the rural population has access to hydroelectricity, either because the Electricity Supply Corporation of Malawi (ESCOM) does not provide most rural households with the service, or rural households cannot afford to pay for it. Electricity in Malawi is expensive even for an average Malawian let alone the rural poor. Other forms of energy such as biogas and solar energy need large capital investments which most of the rural households cannot afford.

There are two major limitations when advocating for an increase in number of trees per household. First, increase in number of trees is limited by land, especially in female-headed households. One way to override this limitation is to encourage tree planting around homes, along farm boundaries, and inter cropping with other crops in the farms[18] as well as planting trees that have great coppicing abilities in order to increase output per small area of land.

The second limitation is that trees need more than 5 years before they are ready for use. Hence, tree planting is a long-term solution. This calls for short-term remedies of demand management, e.g. through the implementation of fuel-efficient stoves.

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[18] With the right tree species intercropping can help in increasing soil fertility, which is most needed in rural households as fertilizers are expensive and may be bad for the soil in the long run.

Fuelwood efficient stoves

Past experience is one of the best guides to future policy and technology intervention. Malawi and other African countries have a long history of promotion of fuel-efficient stoves. For example, in Malawi mud stoves were promoted in the 1970s and 1980s but had limited success. Designers of fuelwood efficient stoves may have ignored the needs of women and their cooking styles, as the stoves were reported to be very inconvenient (Energy Division, 1991). Mud stoves were built on a permanent location hence rendering them immobile. This was different from the traditional cooking on open fire[19]. With an open fire, women are able to move the cooking place from indoors to outdoors and vice versa. In hot weather, women usually cook outside the kitchen while in cold weather or during the rainy season, women cook inside the house. Another impediment to the adoption of woodstoves was the fact that it could not replace the open fire in other many respects, such as space heating and lighting.

However, despite these problems, improved cook stoves have an important role to play in solving fuelwood shortage as they offer an immediate remedy. In addition, fuelwood efficient stoves offer many benefits to the household. For example, improved cook stoves can reduce the amount of wood required for cooking and, to some extent, conserve the heat. In addition, improved fuelwood

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[19] In the traditional method of cooking, a saucepan rests on 3 stones based in a triangle formation. Firewood is put underneath the saucepan. See appendix for picture.

efficient stoves reduce cooking times, which can be beneficial for women's labor availability. Further, fuel-efficient stoves prevent the release of smoke into the kitchen, as is the case with open fire cooking, hence preventing lung related illnesses. In addition, the traditional open fire method of cooking wastes energy as the heat escapes easily.

Learning from the past failures of fuelwood efficient stoves, the introduction of fuelwood efficient stoves should, therefore, be accompanied by adaptive research, and an intensive educational campaign. For effective programs, beneficiaries should be involved as much as possible in the project design and implementation, to ensure that the designs are culturally appropriate and take into account women's cooking patterns and preferences. Male involvement is also critical since men make most household decisions and are a valuable support in the adoption of new technologies.

Redressing social cultural factors

The fuelwood issue is a gender-based issue; men plant trees and make decisions over harvesting, while women gather and use the fuelwood. The importance of full participation of both men and women in the development and implementation of projects cannot be over emphasized.

The key task for successful implementation of fuel-efficient stoves and reforestation programs is to understand the socio-economic aspects of rural households and design suitable programs to ensure that woodlots benefit both men and women. In addition, fuelwood shortage problem can be solved by encouraging the establishment of woodlots where women have an equitable voice in decision-making by addressing gender-specific priorities as they relate to the use of woodlots. This can be done through gender sensitization on needs of women. Gender sensitization should target program planners as well as men who are heads of households and decision makers.

All three recommendations above call for the government and non-governmental organizations to work together to address the provision of fuelwood. Once these measures are in place there is need for frequent monitoring and evaluation of the projects.

FURTHER RESEARCH

The study results provide a starting point for looking at interrelationship around household woodlots, fuelwood supplies and gender dynamics; factors that affect the distribution and utilization of woodlot products with a focus on fuelwood shortage. However, there is in need for further research in order to:

- Determine an optimal number of trees for each household in order to meet minimal needs as well as to determine the optimal number of trees

to encourage the sale of woodlot products. This should be done in the context of land, labor and other economic resources of the household.

- Replicate the study in other geographical areas and during other seasons, as well as socio- cultural groups within Malawi in order to verify the study findings and to capture day-to-day and seasonal variability of fuelwood supplies and use. Additionally, further studies should capture the interactions of fuelwood shortage and famine.

- Replicate the study with a larger sample size in order to increase statistical power of the study and include other variables not included in this study that may also be important. These variables may include measures of land holdings; better measure of income and wealth, increased information about when or under what circumstances the woodlots were formed.

- Households without their woodlots need to be factored into future study as an element that helps one to see the magnitude of the fuelwood shortage problem.

CONCLUSION

The study adds to the growing body of literature concerning community forest programs in general, and household woodlots in particular. It was unique in the sense that it addressed the gender dynamics of power and decision making

that may affect planting, management and use of trees. The study also provides a different perspective of family systems theory in looking at household resources important to developing countries such as fuelwood and woodlots.

The results from the study have demonstrated that the solutions to fuelwood shortage are not simply a function of increasing supply and reducing demand as a third of woodlot owners in the sample area continue to report fuelwood shortage. As observed in the male-headed households, access to woodlots, i.e. whether or not a woman must seek permission to harvest woodlot products, is also a major determinant of fuelwood shortages. Female-headed households are an important segment of Malawi's family structure and thus we need to address their needs.

Fuelwood shortage problems can be improved by encouraging the establishment of woodlots where women have an equitable voice in decision-making by addressing gender-specific priorities as they relate to the use of woodlots. This can be done through gender sensitization on women's needs that target program planners as well as male household heads who hold decision-making power. Another important strategy to redress fuelwood shortage could be the implementation of fuelwood efficient stoves in order to reduce the amount of wood needed for cooking. For successful programs, men and women should participate in both program planning and implementation to ensure that the programs are culturally appropriate and meet the needs of the target beneficiaries.

It is hoped that the findings from this study will improve the understanding of gender dynamics in household owned woodlots management. It is also hoped that professionals and policy makers will become more sensitive to gender differences as they encourage households to establish woodlots that have multi purpose trees.

Epilogue.

This dissertation is part of a comprehensive data set collected from households that owned woodlots. Other variables remain to be analyzed, such as a focus group study on community owned woodlots. Other aspects of this study investigated cooking practices, and knowledge and trends in use of fuel-efficient stoves for a project the researcher will implement with funding from American Association of University Women (AAUW).

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APPENDICES

Appendix 1. Household Woodlot Questionnaire 2002

The questions included in this copy of the questionnaire relate to the dissertation only. Other questions, which were asked to the respondents, are not included

Codes,	**11= other, 55= Don't know**	**99= not applicable, 66= no answer**

	Type of household	1 Female-headed	2. Male-headed
	Sex of the respondent	1. Female.	2. Male.

Household fuelwood availability- ASK all women and men

Responses					
	1. Own woodlot.	6. Buys from the market.			
	2. Around homestead.	7. Government protected forests.			
	3. Own Farm/garden.	11. Other sources (explain)			
	4. Other people's farms/gardens	55, 66, 99.			
	5. Community woodlots.				
What is the major source of the following?	Most important source				
	1st	2nd	3rd	4th	5th
Firewood for cooking					
Why is this the most important source of firewood? (Please give all the reasons).					
Firewood for sale. Poles for household use. Poles for sale. Lumber Medicine. Other.....					

Perceived fuel wood problem- ASK women only

The following questions relate to the fuelwood situation in your household.

Did you experience fuel wood shortages during the past twelve months?	1. Yes. ***(Please ask Q? 18-22)*** 2. No. ***(go to Q? 23)***
How would you describe the problem of fuelwood availability during the past 12 months (since January 2001)?	1. Severe problem. 2. A problem. 3. Not a problem. 4. Not a severe problem. 55- Don't know 60- No answer
Why is this a problem?	
How often did experience this problem of fuelwood availability? ***(Please leave open ended, but ensure the responses are in number of days, or weeks)***	
What would you suggest as a possible solution to this problem? (Go to question 23)	

Purchase of fuelwood

	Ever bought the following ?		Last 3 months (Nov 01-Jan 02)	past year (Jan 01- sept 01) (Make sure you exclude last 3 months)
		1.Yes, ⟶ 2, No	1.Yes, ⟶ 2, No	1.Yes, 2, No
	A, Firewood			
	B, poles			
	C, Lumber			
	D. Charcoal			
	E, whole tree			

(If ever BOUGHT in the past 3 and 12 months please ask according to the period specified above)

	How much did you spend last 3 and 12 months?	1, Amount of $	50, Don't know
	A, Firewood		
	B, poles		
	C, Lumber		
	D. Charcoal		
	E, whole tree		

Cooking fuels

	Responses	1, Firewood 2, shelled maize cob, 3,charcoal, 4, Cow dung 5, paraffin, 6, electricity, 7, gaga, 8, utuchi, 11 other
	What is your main cooking fuel?	1,2,3,4,5,6,7,8, 11
	What is your second main cooking fuel	1,2,3,4,5,6,7,8, 11

Use of other fuels

	Have you ever used the following fuels?		Did use the following fuels for cooking in the past Four months (Since May 2001)?	What proportion does this fuel take among all fuels you use for cooking? All, ¾, ½, ¼, <¼. 11, 55, (Show visual aid) →	How many times per week did you use this fuel (e.g. 1x, 2x, 3 Per week, etc *(Leave open ended)*, →
		1, Yes 2, NO	1, Yes 2, NO		
	Firewood				
	Shelled maize cob				
	Maize stalks				
	Charcoal				
	Cow dung				
	Paraffin				
	Electricity				
	Maize bra				
	Saw dust				
	-Tobacco --stalks				
	If Zitsononkho is mentioned, ask the amount collected per ' tsoskwe'[20]? (Grain milling)				
	How often is the' tsokwe' done per month?				

[20] Tsokwe= pounding maize to remove the bran. This is done by hand with a mortar and pestle or by a mill.

Preferred species and parts of a tree

	Which of the following do you use for cooking? ***{Please circle only one choice}.***	1, 3 stone hearth (Open fire place). 2, traditional metal stove (Mbaula). 3, Ceramic stove ((Mbaula). 4, Paraffin stove. 5, Stove range (Gas, electricity). 6,Other (Please explain) 11, 55, 60

Marital status (to determine if woman is female head)- Ask all women

	Are you married? A, Yes ⟶ B, No ***(please ask status below)*** ***(Go to Q? 47b)***		Has your husband been living in your home for the past eight months? 1. Yes. (Husband present) 2. No. (De-facto female head) 3, Divorced. 4, Never got Married. 5, Widow. ***(Go to Q? 47b)***
	Household head. 1= male head, 2= De-facto female head, 3-5 = female head (Please fill in the type of household head here.		
	Were you living with your husband when the woodlot was established	1. Yes. 2. NO	
	Who owns the woodlot?	wife, husband, Both of us, Other (explain)	

The following questions, ask male heads, Female heads, and women whose husbands were not available)

	How old is the woodlot?	
	When did you start harvesting the following from the woodlot? (Year)	
	Twigs	
	Branches.	
	Logs.	
	Roots/Stamps.	
	Whole tree.	

How big is the woodlot? In acres

	Why did you establish the woodlot? Please state the first, second up to the fifth reason if applicable		
	Reasons	Responses	
	1st	1, Household firewood	7, Lumber for home use
	2nd	2, Firewood for sale	8, Lumber for sale
	3rd	3,poles for household use	9, prevent soil erosion
	4th	4, poles for sale	10, medicine
	5th	5, charcoal for household use	11, food
		6 charcoal for sale	12, fodder

How many trees are five years or older?

	What are the major species planted? ***(Please list all that major types of trees)*** →		Where did you plant the trees →	Number of trees planted
	1st major			
	2nd major			
	3 rd major			
	4th major			
	5th major			

	What year did you last plant trees	
	Is your family intending to plant more trees	1. Yes. 2. No. 3. I don't know.
	If the answer is NO, please ask, why? →	
	If the answer is YES, please ask, what tree species are you intending to plant?	
	What's the intended use for these trees?	

Woodlot collection activities- (Females only- *Please ask ASK all women)*

These questions relate to firewood collection activities from your woodlot

	What parts of the tree do you usually collect for firewood for cooking from:	Responses	
		1. Twigs. 2. Branches 3, trunk 4, Stump 5. Whole tree. 11, other	
		Source	Tree part
	The 1st most important source.		
	Why did you collect this part		
	The 2nd most important source.		
	Why did you collect this part		

	How far is the main source of fuelwood from your household?	..... Km.
	How far is the woodlot from your household? (If NB source is not the woodlot	..... Km.
	How long does it take you to get there?	.....Hours.
	How do you rate your freedom to get the following from the woodlot?	1. Very free. 2, Free. 3. Neutral. 4. Not free 5. Not very free, 55, 60
	Please explain your answer	
	What measure do you usually use when collecting firewood?	1, Head load 2, stacks, 3, Mendel 4, oxcart, 5, bicycle, 6, other (explain)

	How many trips do you make in a week/ month to collect firewood? (From all sources). N/A please ask why	.....
	How much firewood do you consume in a week? (Please describe size. Show picture of sizes).	....Head loads .....Stacks
	In the past year, how much firewood did you store in preparation for the rainy season?	....Head loads .....Stacks
	How many meals do you prepare in a day?	.....
	Please show me the amount of firewood, which represents a typical day's amount of firewood consumption. ***(Please describe in 3D, type of tree and part used)***	

The following questions relate to the last trip you made to collect fuelwood (from all sources).

	When did you last collect firewood for household use?		
	How much did you collect? In stacks, head loads. ***(Use a measure that applies)***	.....	
	Where did you collect this?		
	For how long did this firewood last? ***(Leave open ended Give the exact time the respondent gave you)***	Scale 1. 1,2,3....13 days 2,1, 1.5 weeks	2, 2.5, 3, 3.5 wks etc
	Did you supplement this with firewood from other sources?	1, yes → 2.No	From where?
	Did you supplement this firewood with fuels such as crop residual, cattle dung, charcoal etc	1, yes → 2. No	What fuels?

Access questions- Ask both men and women

	Is it necessary for YOU to seek permission before harvesting products from the woodlot?		Who give the permission	
		1.Yes 2, No	My husband/wife	Other (please explain
	Twigs			
	Branches			
	Logs/trunks			
	Whole tree			

Benefits from the woodlot- Ask both men and women

	In the past year, how beneficial was the woodlot in meeting the following needs (at household level)	Scale of responses	
		1.Very beneficial 2.Beneficial 3.Neither beneficial nor not beneficial 4.Not beneficial	5.Not very beneficial 55, 99.
	Firewood	1 2 3 4 5 99	
	Poles	1 2 3 4 5 99	
	Lumber	1 2 3 4 5 99	
	Fodder	1 2 3 4 5 99	
	Medicine	1 2 3 4 5 99	
	Food	1 2 3 4 5 99	

Roles in wood lot harvesting

	Who is mainly responsible for the collection of the following?	***Responses*** 1. Wife. 2. Husband. 3. Both of us.	4. Son(s). 5. Daughter(s). 11, Other (explain) 99, N/a
	Poles for household/community use.		
	Making charcoal.		
	Firewood for household use.		
	I, does she/he get any help?		
	Ii, who helps her/him		
	Ii, How much help does s/he get?		
	Who is mainly responsible for the sale of the following:		
	Firewood.		
	Poles.		
	Charcoal.		
	Whole tree.		
	Lumber		
	Other (please explain)		

Participation in wood lot activities

This section is designed to identify your response about participation in woodlot activities. Please indicate how many times you did the following activities mentioned below. If you did not take part in any activities of the woodlot, please say so.

	Overall, how much would you say a) you, b) your spouse c) and other contributed the following activities in the past year, would you say you did 1, none of the work, 2-¼,3-½,4- ¾, or 5-all work? ***(Show the visual aid).***			
	Tree planting	Wife	Hubby	Others
	Taking care of seedlings			
	Pruning trees			
	Weeding within the woodlot			
	For female heads please ask who helps her			

Decision-making influence

This section is designed to understand your participation in decision-making process. Please indicate how much influence you yourself had, and how much influence your spouse and others had. Please circle the appropriate numbers below. For example, if s/he believes that s/he personally has a lot of influence in deciding what trees to plant, circle number "1" in the corresponding box in the table. If s/he believes that s/he personally has no influence in a decision, please circle "5" in the corresponding box in the table. Please make sure you circle a number for each set of columns for each decision situation. If a decision was made when she was not around,' please write down 99 (not applicable).

Ask this question even if the h/h is female head. There might be someone who still decides for them

	How much influence do you, your spouse, and others have on the following decisions	1. Extremely influential 2.Very influential 3. Influential	4. Not very influential 5. No influence 55, 99, 88	
		Self	Spouse	Other
	Harvesting the following for household use			
	Twigs.			
	Branches.			
	Trunks/logs			
	Stumps.			
	Whole tree.			

For all women, ASK a hypothetical Question

	If you were given a chance to establish a woodlot as an independent self, what would be the most important need, you would want a woodlot to fulfil? What would be the 2nd, 3rd, 4th, and 5th important need?		
	Reasons		Responses
	1st		1, Household fuelwood / 7, Lumber for home use
	2nd		2, Firewood for sale / 8, Lumber for sale
	3rd		3, poles for household use / 9, prevent soil erosion
	4th		4, poles for sale / 10, medicine
	5th		5, charcoal for household use / 11, food
			6, charcoal for sale / 12, fodder

	What species would you like to grow? (Start with the most important?	***List***....., ..., ..., ...
	Please explain why you have chosen these species? (List 5 reasons, staring with the most NB reason)	**Responses** 1, Grow straight 2, Fast growing 3, Makes a lot of charcoal 4, Burns longer 5, Does not emit a lot of smoke 6, Need less attending when cooking 11, other
	1st	
	2nd	
	3rd	
	4th	
	5th	

DEMOGRAPHICS -ASK all women and men

	Educational level — Standard 1,2,3,4,5,6,7,8, Form 1, 2, 3, 4 Adult literacy class, Other (please explain)	
	What is the highest level of education you attained?	
	What level of education did your husband attain?	
	How old are you? (If not sure ask year of birth	

Ask male heads and female heads, and wives whose husbands are not available to answer questions.

	What type of dwelling structure you have??	
	Wall	Brick, sun dried. Brick, burnt. Concrete plastered. Mud. 11, other (explain)
	Floors	Cement, Mud
	Roofing	1 Grass Thatched, 2. Iron sheets, 3, Tiles, 11, other (explain)

	How many people live in this household?	.....
	How many children under 15 live in the household?	.....
	How many adult females over 15 live in this household?	

		Responses	
	What is your primary occupation?	Regular paid employment (please specify) Trade (please specify e.g. fishing, carpenter, shop keeping, basket weaving etc) Subsistence farming Commercial farming Don't work 11, Other please specify, 55, 60	
	Is there another job that you do?	1, yes, 2, No	What Job?
	What does your husband do for a living?	***Not for divorced women and widows)***	

Income- ask all women and men

	Please list all sources of income	How much per year from each source
	If woodlot is mentioned as source of income, please indicate the proportion to this to the total income? (Please show the aid)	< ¼, ¼, ½, ¾ 4/4 of total income

Assets- ask men only and women from female-headed households

	Do you have the following assets in your household?		(If yes then ask) How many? .....
203	Oxcart	1. Yes 2. No	
204	Cattle	1. Yes 2. No	
205	Goats	1. Yes 2. No	
206	Chickens	1. Yes 2. No	
207	Ducks	1. Yes 2. No	
208	Pigs	1. Yes 2. No	
209	Bike	1. Yes 2. No	
210	Other, please specify	1. Yes 2. No	
211	Do you own a house?	1. Yes 2. No	
212	Do you own land?	1. Yes 2. No	
213	How much land do you own? (Note 1 ha = 2. 47 acres)	.....Acres or .....hectares	

These questions relate to a community woodlot- ask women only.

	Do you have a tree nursery		At household level		Group/ community level
	Do you sell tree seedlings		1, yes 2, NO		1, yes 2, NO
	How much did you get from the sales in the past year		1, yes 2, NO		1, yes 2, NO
	Do you have a community woodlot in your village?				1, yes, (go to Q? 2, No. (Go to Q?
	Do you take part in the activities of the community woodlot?				1. Yes 2. No, Why not? ...
	Have you ever-harvested firewood from the community woodlot?				

Alternative fuels- ASK women only

	What other sources of heat do you know besides the following fuels, firewood, charcoal, paraffin, electricity and gas?	
	Have you ever seen these types of stoves? ***(Show a picture of the stove)***	1, Yes 2, No
	If yes, please explain what you know about these stoves?	
	If no: ***(explain to the client what they are)*** *and then ask if they have ever heard of such stoves?*	
	What do you like most about fuel-efficient stoves?	1, saves time 3, other 2, saves wood,

Alternative fuels- continued

	What do you not like about fuel-efficient stoves?	1, does bring a lot of light to the house, 2, does not warm the room, 3, other
	Would you be able to live with such disadvantages?	

Would you like to comment on what we have discussed so far?
Thank you for taking time to answer these questions.
IMPORTANT: Enumerator, please write down your observations,
1. What type of wood are they using for cooking? Was this wood mentioned?
2. Other critical observations, anomalies etc

Appendix 2. Benefits from the woodlot reported by men and women in the two household types

Woodlot benefit by product type	Household Type	N	Mean	Std deviation	Test for equality of means	
					P value	df
Firewood	Female	51	4.3	.99	.17	85
	Male	36	4.6	.70		
Poles	Female	49	3.8	1.1	.005	84
	Male	37	4.4	.8		
Lumber	Female	33	2.1	1.0	.001	58
	Male	27	3.2	1.6		
Fodder	Female	27	1.9	1.0	.008	40
	Male	15	2.9	1.4		
Medicine	Female	37	3.7	1.1	.42	53
	Male	18	3.4	1.2		
food	Female	28	2.5	1.3	.22	39
	Male	13	3.1	1.4		

Appendix 3. Benefits from the woodlot reported by women in two household types

Woodlot benefit by product type	Household Type	N	mean	Std deviation	Test for equality of means	
					P value	df
Firewood	Female	51	4.29	.99	.31	113
	Male	64	4.45	.69		
Poles	Female	49	3.78	1.12	.003	108
	Male	61	4.48	.55		
Lumber	Female	33	2.06	1.03	.0001	67
	Male	36	3.47	1.34		
Fodder	Female	27	1.89	1.01	.002	48
	Male	23	3.04	1.49		
Medicine	Female	37	3.70	1.08	.98	66
	Male	31	3.71	.97		
Food	Female	28	2.50	1.35	.30	40
	Male	14	3.00	1.66		

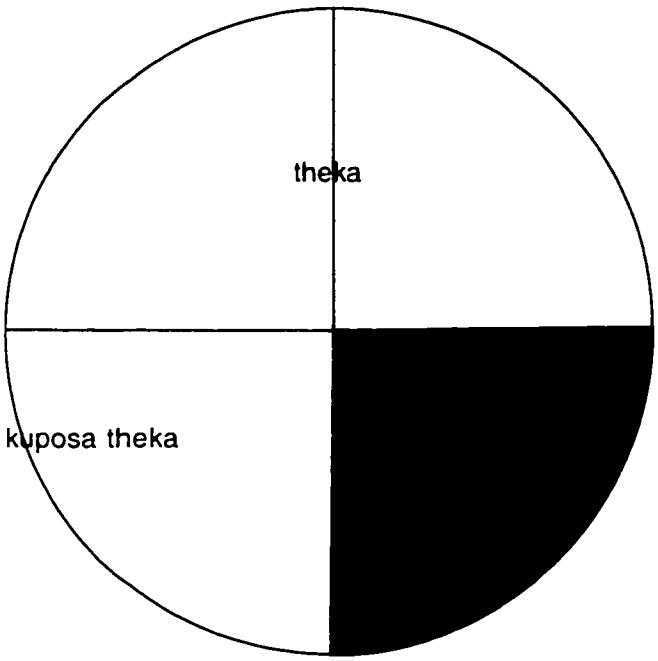
Appendix 4. Distribution of income

	Household type	n	mean	Std deviation	% of households
All households that sold woodlot products question	Female-headed	25	408*	416	100
	Male-headed	28	1480**	1553	100
Households that sold <500	Female-headed	19	206	139	76
	Male-headed	9	221	163	32
Households that sold 501-1000	Female-headed	5	-	-	20
	Male-headed	8	-	-	29
Households that sold >1000	Female-headed	1	1700	-	4
	Male-headed	11	3074	1328	39

Given in the nearest Kwacha with no units

Amounts quoted in Malawi currency-Kwacha

Appendix 5. Sample of proportions



Appendix 6. Proportion of woodlot income to total income-

		Woodlot proportion to total income % of respondents					
		n	< ¼	¼	½	¾	4/4
Gender of the respondent	Female	10	60	30	10	0	0
	Male	23	60.9	31.1	0	0	0
X^2 (2, N = 33) =2.46, p =.292							

Appendix 7. Income from sale of woodlot products reported by women from both households-107

Household Type	N	mean	Std deviation	Test for equality of means	
				P value	df
Female	25	408	416	.36	43
Male	20	537	514	.37	

Appendix 8. Traditional 3 stone fire place.

Appendix 9. Institutional Review Board Approval Document

OREGON STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
REPORT OF REVIEW

TO: Geraldine Olson
Human Development and Family Sciences

RE: Intra-Household Gender Analysis of Individual Woodlots: Access to and Use of Woodlot Products

Protocol No 1737

The referenced project was reviewed under the guidelines of Oregon State University's Institutional Review Board (IRB) and the U.S. Department of Health and Human Services The IRB has **approved** your application. The approval of this application expires upon the completion of the project or one year from the approval date, whichever is sooner. The informed consent form obtained from each subject should be retained in program/project's files for three years beyond the end date of the project

Enclosed with this letter please find the original informed consent document for this project, which has received the IRB stamp. All participants are to receive the information contained in the enclosed IRB stamped informed consent document, translated into the local language.

Any proposed change to the protocol, the informed consent form, or testing instrument(s) that is not included in the approved application must be submitted using the MODIFICATION REQUEST FORM. Allow sufficient time for review and approval by the committee before any changes are implemented. Immediate action may be taken where necessary to eliminate apparent hazards to subjects, but this modification to the approved project must be reported immediately to the IRB Any happening not connected with routine expected outcomes that result in bodily injury and/or psychological, emotional, or physical harm or stress must be reported to the IRB within three days of the occurrence using the ADVERSE EVENT FORM. Please use the included forms as needed.

If you have any questions, please contact the IRB Coordinator at IRB@orst.edu or by phone at (541) 737-3437.

Laura K. Ziemer for Date 1/28/02

Anthony Wilcox, IRB Chair
Langton Hall 214
Anthony.Wilcox@orst.edu, 737-6799

cc: IRB Coordinator

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A letter of introduction and informed consent document. (For questionnaire participants)

Sponsoring Dept letterhead.

Research title: Intra-household gender analysis of individual woodlots on access to and use of woodlot products.

Investigators: Dr Gerry Olson- Principal Investigator and Mercy G. Chikoko

OSU IRB Approval Date: 1/28/02
Approval Expiration Date: 1/27/03

Dear Sir/madam,

My name is Mercy Chikoko and I am a graduate student at Oregon State University in the United States. I am conducting a study for my Ph.D. on homestead/individual woodlot management and utilization of woodlot products. This information, when collected, will provide homestead woodlot owners, government and non- governmental organizations with useful information for enhancing community forestry projects and the well being of households and communities.

I am asking for your help in obtaining this information. My colleagues and I would appreciate if you could take some time to respond to the questions that we will ask you. We will use your responses together with others for the purposes of this study only. Your participation is very vital to this study and it will help in developing community forestry programs for the well being of both men and women.

Your participation in this study is completely voluntary. You may decline to respond any questions or withdraw from the study at any time. The questionnaire will take about one hour to administer. One of our team members will ask you questions from this questionnaire and write down your responses.

The discussion is strictly confidential and we will not share the information with anyone outside this study. We will not discuss this interview session with your spouse.' Your

name or any information obtained from this study will not be linked to you. The research team will remove any labels/ names from the questionnaire that would link the responses/questionnaire to you. No one else apart from the research team will have access to the completed questionnaires. We will ensure that your questionnaire is kept safe under lock and key at all times. We will destroy the questionnaire at the end of the study, and we will keep it confidential until that time.

If you have any questions about the study, please contact the Village Forest Officer (state his/her name),[a] or you may contact Mercy Chikoko, at chikoko@africaonline.co.zw, or on cell phone number 942113.

Thank you for your cooperation.

Yours truly,

Mercy Chikoko.
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX,

If you agree to participate in this study please sign/ fingerprint the following.

My signature/finger print below indicates that I understand the procedures described to me and I give my informed consent. I understand my participation is voluntary and may refuse to participate or chose to discontinue my participation at any time.

Signature/thumbprint of subject	Name of the subject	Date Signed
Subject present address		Subjects Telephone number
Witness name and signature		Date signed

OSU IRB Approval Date: 1/28/02
Approval Expiration Date: [illegible]