OPERATIONALIZING INTEGRATED HOUSEHOLD ENERGY PLANNING: THE CASE OF MALAWI

Bernhard Paul Romahn

Thesis presented for the degree of
Doctor of Philosophy
in the Energy and Development Research Centre
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Abstract

Recognition since the 1970s of the adverse consequences in developing countries of deforestation on the livelihood of farmers and the poorer segments of urban households, and on the environment, has led to extensive investments in energy research and household energy projects. Poor performance and failures of woodfuel projects and other policy interventions have led to a radical reconsideration and criticism of the woodfuel scarcity paradigm and associated methodologies and assumptions. Recent research has been focussing on developing a new methodological framework for integrated fuelwood and household energy policies. Against this background, the main objective of this research consists in exploring and evaluating concepts and hypotheses which may be used for developing an effective analytical planning and policy framework for household energy policy. Empirical research has been conducted by the author over several years in Malawi. At the macro level, the often poorly-understood and contentious relationship between population growth, land tenure and land-use changes, fuelwood use and deforestation is examined. Another major methodological theme in household energy policy formation is the conceptualization of farm household decision behaviour and their responses to fuelwood pressures. Relationships between fuelwood and agricultural policies are examined. A range of rural and urban policy interventions are studied in depth. The empirical evidence from Malawi shows that there is no universal set of policy prescriptions which neatly apply to all household energy issues in developing countries. Nevertheless, the complexity of the inter-linkages between factors impacting on household energy production, distribution and use points to the need for a coherent conceptual framework. Integrated Household Energy Planning provides this, not in a simple step-by-step set of procedures, but rather in terms of an approach which is sensitive to the range of factors which need to be analyzed and understood before policies are formulated and implemented.

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Table of contents

List of figures

List of tables

List of annexes

Abbreviations and acronyms used

ADD	Agricultural Development Division
ADMARC	Agricultural Development and Marketing Corporation
AIDS	acquired immune deficiency syndrome
ASA	Annual Survey of Agriculture
BADD	Blantyre Agricultural Development District
BCFP	Blantyre City Fuelwood Project
CBA	cost-benefit analysis
CLDA	Customary Land Development Act
cu.m	cubic metres
C/W ratio	consumer/worker ratio
DEMPROJ	Demographic Projection Model
DEPD	Department of Economic Planning and Development
DEVPOL	Statement of Development Policies 1987-1996
DOF	Department of Forestry
DTT	demographic transition theory
EEST	Estate Extension Service Trust
EIRR	economic internal rates of return
EMP	Energy Master Plan
EPA	Extension Planning Area
EPU	Energy Planning Unit
ESCOM	Electricity Supply Commission of Malawi
ESMAP	Energy Sector Management Assistance Programme
ESU	Energy Studies Unit
FAO	Food and Agriculture Organization
FBE	forest-based enterprise
FHH	female-headed household
FRIM	Forestry Research Institute of Malawi
FRMBA	Forest Resources Mapping and Biomass Assessment for Malawi
FSNM	Food Security and Nutrition Monitoring Report
FWEP	First Wood Energy Project
GDP	Gross Domestic Product
GJ	gigajoule
GNP	Gross National Product
GOM	Government of Malawi
ha	hectare
HEM	new home economics model
HIV	human immune deficiency virus
ICRAF	International Council for Research in Agroforestry
IDA	International Development Agency
IFI	informal financial institutions
IHEP	Integrated Household Energy Planning
IHESS	Integrated Household Energy Strategy Studies
INEP	Integrated National Energy Planning
KADD	Kasungu Agricultural Development District
km^2	square kilometres
KRADD	Karonga Agricultural Development District
kWh	kilowatt-hours
LADD	Lilongwe Agricultura Development District
LBA	Local Boards Act
LFP	Lilongwe Forestry Project
LLDP	Lilongwe Land Development Programme
LPG	liquefied petroleum gas

LPM	linear programming models
LREP	Land Resources Evaluation Project
LRMC	long-run marginal cost
LWADD	Liwonde Agricultural Development District
MAI	mean annual increment
MAS	Malawi Agricultural Statistics
MFNR	Ministry of Forestry and Natural Resources
MHH	male-headed household
MJ	Megajoule
MK	Malawi Kwacha
MMF	Malawi Mudzi Fund
MOA	Ministry of Agriculture
MOF	Ministry of Forestry
MOL	Ministry of Labour
MPT	multipurpose tree
MSB	Monthly Statistical Bulletin
MSME	medium- and small-scale enterprises
MUES	Malawi Urban Energy Survey
MUHES	Malawi Urban Household Energy Survey
MZADD	Mzuzu Agricultural Development District
NADD	Ngabu Agricultural Development District
NCSP	National Child Spacing Programme
NDP	Net Domestic Product
NEP	National Energy Plan
NNP	Net National Product
NSO	National Statistics Office
NSSA	National Sample Survey of Agriculture
NTPD	National Tree Planting Day
PJ	Petajoule
RDP	Rural Development Project
RE	Rural Electrification
RLA	Registered Land Act
RSMW	rural statutory minimum wage
SACA	Smallholder Agricultural Credit Administration
SADC	Southern African Development Community
SADCC	Southern African Development Coordinating Conference
SAL	structural adjustment loan
SAP	structural adjustment programme
SFC	specific fuel consumption
SMW	statutory minimum wage
SNA	system of national accounts
SSDC	sub-Saharan developing countries
SWEP	Second Wood Energy Project
TIES	tea industry energy survey
TFR	total fertility rate
TRIM	Tobacco Research Institute of Malawi
TWh	Terawatt hours
UNDP	United Nations Development Programme
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development
VFA	Village Forest Area
WEC	Wood Energy Component
WEC1	Wood Energy Component of the Malawi Energy I Project
WHO	World Health Organization
ZK	Zambian Kwacha
ZUHES	Zambia Urban Household Energy Strategy

Chapter One

INTRODUCTION

The energy problems of low-income households in developing countries have received a great deal of attention over the past 20 years. Despite the focus on issues such as fuelwood scarcity and deforestation and on costly imported hydro-carbon fuels, there have been few marked successes in implementing policies to secure sustainable, affordable and accessible energy services for the vast majority of the poor. Rather, the literature abounds with accounts of projects which have failed - whether they be tree-planting initiatives, fuel-substitution measures, demand-side management interventions or direct controls. The cumulative costs of these failed policy interventions are enormous. Clearly there is a need to understand better what has being going wrong, and to develop a conceptual framework and methodology for developing workable policies which have a greater chance of success because they are based on better diagnoses of the problems and desirable solutions. This dissertation seeks to do just that.

1.1 BACKGROUND AND RESEARCH OBJECTIVES

The interpretation of the nature, dynamics and interrelationships between the factors influencing energy supply and demand in rural and urban households in developing countries, has undergone significant changes since the need to address emerging household energy issues began to be recognized as an essential part of the overall economic development and policy agenda. The Integrated National Energy Planning (INEP) methodology was developed in response to the shortcomings of the conventional industrial sector oriented and supply-side oriented energy planning approach.

As each energy sub-sector has unique technical, economic, financial and other characteristics, specific INEP methodologies are required to analyze sub-sectoral energy planning issues within the overall planning context. While the general methodology of INEP may be considered to have reached the status of maturity, the development of an adequate methodology for Integrated Household Energy Planning (IHEP), and thus for analyzing household energy planning issues, has been regarded by many policy analysts as still inadequate.[1] This relative methodological underdevelopment, especially in connection with rural household energy policy and woodfuel policy, has been associated, for example,

1 See the discussion of methodological issues in later sections of this chapter.

with insufficient financial support and investment as well as inadequate research (see, for example, Katerere 1992: 138-39).

The analysis of widespread failures of household energy policies and woodfuel and woodstove projects throughout the 1980s, notably in rural areas, gave rise to serious criticism in the mid-80s about the suitability of the previous conceptual framework of analyzing household energy policy issues, and thus of the approaches used for designing and implementing household related energy policies and programmes. The first step in challenging conventional wisdom in the area of rural household energy policy started in the second half of the 1980s with the criticism of the main assumptions and methodological perspectives of what has been labelled in the literature as the 'fuelwood gap theory'. The fuelwood gap theory marked the beginning of viewing household energy issues from the perspective and decision-making rationale of the actors, whom policy analysts and decision-makers intended to reach and expected to respond favourably to their policy proposals and measures. The tenets of the woodfuel gap theory represented not only a radical departure from the tendency of perceiving energy problems as both an energy problem *per se* and as a major problem of rural households, but opened the perspective of focusing *inter alia* on the importance of involving local communities and people in resource management, and on the question of how households make decisions in their specific economic, legal, social and resource environment.

This perspective broadened the scope and complexity of issues which have to be integrated in the formulation and implementation of rural household energy policy. It has also important methodological implications. First, the interpretation of the linkages and degree of interdependence between household energy policy issues and other policy areas has become much closer. This underpins the necessity for pursuing an integrated household energy policy. Secondly, the scope of changes in the conceptual framework for household energy policy is not just incremental. Rather, the dimensions of change in rethinking rural household energy policy is considered by many researchers[2] to be a radical departure from the texture of conventional thinking. In other words, the discussion of rural household energy policy is perceived as a paradigm change.

Compared to developments concerning rural household energy policy, no comparable development exists in the area of urban household energy policy analysis. This is mainly due to the fact that the fuel consumption and interfuel substitution decisions of urban

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2 See, for example, O'Keefe and Munslow (1988), Foley (1988), Leach and Mearns (1988a) and Eberhard (1992).

households are more amenable to the traditional tools of statistical and micro-economic analysis. The main development in analyzing the central research question in this area – that is, the question of which factors influence fuel choice and interfuel substitution – is that the important concept of the 'energy transition', which incorporates the notion of an 'ideal fuel preference ladder' of households, has been challenged. Still, there is only limited knowledge about the scope and relative importance of factors which influence fuel choices, and the interfuel substitution process in urban households. This applies to processes involving the substitution of traditional fuels (woodfuels and agricultural residues) by modern fuels (petroleum products and electricity), but particularly to reverse interfuel substitutions (backward substitution).

With regard to household energy sector planning and policy in developing countries, no generally accepted conceptual framework has been developed yet in the context of INEP. However, intensive empirical research in developing countries has produced growing general knowledge as to the key methodological issues and relationships which should be addressed in IHEP. Empirical evidence about key relationships between macro- and micro-variables on which household energy policy could rely to become more effective, varies from being fairly well established to being scanty or unproven. Despite the manifold policy failures experienced and substantial research which has been carried out in this area, it appears as if more is known about existing uncertainties and information gaps than about a clear conceptual framework.

Against this background, the main objective of this dissertation is to explore and evaluate the established knowledge and hypotheses concerning key relationships and associated specific methodologies which have been formulated towards the development of an integrated planning approach for the household energy sector in developing countries; this will be attempted in relation to a case study in Malawi. The second, related, objective of the research consists of an analysis of household energy policy options for rural and urban households, by analyzing the performance of projects and policies which were implemented in Malawi since about 1980. With regard to these research objectives, it has to be pointed out that that not all relevant issues and facets which are under discussion in the literature are addressed, or are addressed in every detail. This limitation is for two reasons: first, the complexity of the issues and linkages involved in INEP and household energy policy required the scope of the analysis to be limited; secondly, the scope and level of detail of discussing the pertinent methodological and policy issues had to be limited to those which could be reasonably analyzed, given the availability, accessibility and quality of data and other information in Malawi, during the period when the research was conducted.[3]

Malawi was chosen as a case study mainly because of five characteristics which are of importance from the point of view of the objectives of this research. First, its economic status as being among the ten poorest countries in the world in terms of Gross National Product (GNP) per capita[4] allows the exploration, *inter alia,* of poverty-energy interrelationships. Secondly, the country's household energy sector is still at the early stages of the 'energy transition', that is rural and urban households rely mainly on woodfuels. Thirdly, a high population growth rate and a rapidly declining per capita availability of arable land has created intense pressure on the utilization of agricultural land and on woody biomass resources, resulting in a fairly high deforestation rate during the past two decades. Fourthly, rural and urban household energy policies were pursued, the results of which allow the drawing of conclusions concerning methodological and policy issues which are discussed in the mainstream of IHEP. Finally, several energy studies and surveys were previously conducted to explore various issues related to urban and rural household energy planning. However, to the knowledge of the author, no comprehensive attempt has yet been made to integrate the results of the energy research conducted and of relevant research findings from other research disciplines and policy areas, to analyze household energy policy issues and to draw conclusions with regard to the existing knowledge in this area.

1.2 CONVENTIONAL ENERGY PLANNING AND ECONOMIC DEVELOPMENT

Prior to the occurrence of the first 'oil crisis' in 1973, energy investment planning and energy policy in developing countries were characterized by three features. First, there was

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[3] The author was employed as Energy Advisor by the Government of Malawi in the Department of Economic Development and Planning, Office of the President and Cabinet, from March 1989 to September 1991. Because of the fiduciary duty of the author, information obtained through participation in official intra-governmental meetings and access to government-internal material information associated with debates about (energy) policy issues which are relevant to this research, is not quoted or otherwise directly referred to in this research. Use of this knowledge is, by virtue of fact, entirely contextual. It is emphasized that this limitation is mainly relevant to the dynamics of discourse among government departments, with regard to the division of responsibilities for energy and forestry matters, and aspects of policy design and implementation. It has especially to be noted that leading officials and other staff members of the Ministries and Departments of the Government of Malawi have made available information in all areas which are relevant to this research, to the author. In comparison to a number of other countries in which the author has worked, the governmental support in obtaining information was exceptional. Due to the pervasive data problems with which researchers are confronted in empirical studies of this nature, it appears that this research could not have been undertaken without this support.

[4] With a per capita income of US$180.0 (in 1989 prices), Malawi was ranked as the fifth-poorest country in the world, together with three other countries (see World Development Report 1991: 204).

virtually no planning effort directed at non-commercial or biomass fuels. Secondly, investment planning for commercial energy supplies was exclusively supply-oriented, that is the prime occupation of energy planners was to find a least-cost solution to projected final energy demand. This implied that no recognition was given to an integrated least-cost investment planning approach that addresses simultaneously the economic efficiency of investment in energy supply and end-use efficiency and demand management options. Thirdly, energy planning was carried out on a project-by-project or, at best, sub-sector basis whereby little coordination, if any, existed among the coal, oil, electricity and woody biomass sub-sectors.

The implicit theoretical background of the supply-oriented approach was that the energy sector's role was simply to meet market demand (de Oliveira & Girod 1990: 532). Furthermore supply cost minimization involved *sui generis* a focus on cost and technical solutions.

The macroeconomic implications of increased oil prices in terms of imported inflation, growth, employment and balance-of-payments effects were experienced by developed and developing countries alike. However, the latter, particularly the lower-income oil importing developing countries, were worst affected because they were faced with a drain on foreign exchange resources accompanied by deteriorating terms of trade for their commodity exports. Due to the short-run inflexibility to accommodate these changes, sub-Saharan developing countries (SSDC) responded through oil product supply rationing – but most relied on debt financing (Davidson & Karekezi 1992: 11). The second 'oil crisis' in 1979/80 led to similar short-term adverse macro-economic impacts in developing countries. However, the ability of SSDCs to deal with these impacts was heavily constrained by their accumulated external debt. The ensuing debt crisis of developing countries in the 1980s brought in its wake the structural adjustment programmes spearheaded by the World Bank and the International Monetary Fund.

The implications of the oil price shock on the conceived development policies of the SSDCs were fundamental, as articulated by Davidson and Karekezi (1992: 11):

> The first oil shock completely wiped out the validity of our countries' development plans for the 1970s which were based on the rapid growth experienced in the 1960s. Our preparedness left us no choice but to move from planning for future development to struggling for survival.

The response to the end of the era of cheap commercial energy in developed countries was to revise energy strategies towards diversification and enhancement of non-oil commercial energy supplies, and to foster energy conservation and energy efficiency. The latter entailed an integration of energy demand into the preview of energy planning, which essentially involved viewing energy demand in terms of the energy services demanded, rather than as quantities of final energy to be delivered. The demand-management or 'end-use approach', as de Oliveira and Girod (1990: 531) have called it, represents, according to these authors, a radical departure from the conventional supply-oriented approach in two respects. First, and most important, it led to the insight that 'all the multiple facets of energy (physical, economic, technical, financial, social) and its links with the social and economic environment should be studied and integrated into energy policies'.

As a result of the increased complexity of the interactions between the facets of the energy system with other sectors and society at large, new variables have been introduced in the planning process. Therefore the transition from the conventional energy planning approach to the end-use approach, also involved a broadening of the spectrum of energy policy tools, from the narrow focus on energy pricing policy.

Coinciding with the need to cope with the impacts of the 'oil crisis', the attention of development planners and decision-makers was drawn by Eckholm (1975) to the development and household energy problems involved in the depletion of forest stocks in the rural areas of developing countries. This process was dubbed the 'fuelwood crisis'. The notion of a crisis reflected the concern that, if the perceived rapid depletion rates of woody biomass resources in excess of replenishment rates were to continue unabated, a possibly irreversible resource degradation process would be triggered in the rural areas, with disastrous long-term environmental and socio-economic impacts.[5] Thus the 'oil crisis', which had already dampened expectations of a fast pace of the transition from biomass fuels to commercial fuels in the urban household energy sector, was suddenly accompanied by serious concerns about the development implications of the perceived, and largely unknown,[6] 'woodfuel crisis' in the rural sector. The challenges involved in the latter led to a more serious consideration of traditional fuels by some governments in oil-poor developing countries, after the second oil price hike in 1979 triggered a backward energy substitution to woodfuels in many end-use sectors. This development led to a flurry

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5 The article by Rady (1992: 582-583) provides a stylized presentation of the relationships between variables and processes which are involved and interact in producing what he calls a 'vicious cycle of biomass crisis in rural areas of developing countries'.

6 See Openshaw (1978) for a discussion of the fact that hardly any information was available about woodfuel problems in developing countries in the early 1970s.

of woodfuel and rural energy surveys (Bernardini 1983: 90), and initiated numerous donor-sponsored woodfuel and other renewable energy projects. However, in spite of these efforts, rather limited progress had been achieved until the early 1980s by developing countries to effectively integrate rural energy problems into their planning and policy framework. The state of affairs in this respect was pointedly portrayed by Foley (1983: 11):

> Few governments in the poorer developing countries have national energy policies; fewer still have policies which are realistic and effective; and even fewer have any energy policies at all for their rural areas. Such initiatives as have taken place have, therefore, lacked a policy framework and tended to be sporadic and uncoordinated.

In summary, a host of coinciding and interdependent adverse changes in the key development parameters created the need in developing countries to replace the conventional energy planning approach by an integrated national energy planning methodology. These adverse changes include:

- the growth constraint imposed by the accumulation of external debt;
- the increased vulnerability of economic growth and social development objectives in developing countries, subject to developments in the international energy markets;
- the necessity to cope with a hitherto largely unknown 'fuelwood crisis' with potentially severe repercussions on long-term growth prospects;
- the need to develop and implement a viable long-term energy strategy; and
- the virtual absence of an adequate planning and policy framework to integrate these energy-related problems effectively and consistently into the realm of overall development planning efforts.

1.3 THE METHODOLOGICAL FRAMEWORK FOR INTEGRATED HOUSEHOLD ENERGY PLANNING

In response to the developments discussed above, the concept and methodology of INEP was developed from the late 1970s. In this respect it is difficult to trace precisely the origin of the approach because simultaneously, and very rapidly, INEP methodologies were developed and applied in different versions and with different degrees of technical modelling sophistication of the subsystems involved, both for applications in developing and developed countries. For example, analytical methods under the umbrella of INEP were specifically developed at the Brookhaven National Laboratory, USA, for application in the International Energy Development Programme initiated by the Carter administration in 1977.[7] The further development of the general INEP methodology, as well as its applications to specific energy sub-sectors, has been documented in numerous articles, books and consulting reports. [8]

INEP provides the general methodological framework for this research. As pointed out in Section 1.1, the general methodology of INEP provides the overall framework for the integrated analysis of the energy system. Therefore the main components, methodological issues and concepts of INEP are discussed first.[9] This overview leads to the question of what steps have been undertaken since the inception of INEP, in developing countries, and what problems are involved in institutionalizing INEP. These considerations will be discussed later in the context of activities conducted in some SSDCs.[10] Based on this discussion, issues concerning the integration of the household energy sector into INEP need to be discussed. This involves a discussion of the leading methodological issues and problems related to an IHEP approach, combined with the question to what extent IHEP has been practically integrated into the INEP framework.

1.3.1 Planning levels and their integration in integrated national energy planning

INEP is structured as a hierarchical and interactive framework that integrates three levels of planning:

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7 See Mubayi et al (1979: 1) as an example of one of the earliest attempts of developing the INEP methodology for both developing and developed countries and its application to a developing country (Peru).

8 See, for example, Munasinghe (1980) for a discussion of aspects of the general approach and methodology involved in INEP. Numerous researchers have contributed to the development of the INEP approach. Perhaps the most comprehensive overview of the basic concepts and methodologies involved in INEP is provided in *Integrated Energy Planning - A Manual* (APDC 1985). A number of researchers spearheading the development of INEP contributed to the development of the manual. See the discussion in Munasinghe (1992) as an example of how electricity sub-sector planning and decision-making can be integrated within INEP. As an example of an early conceptualization of the rural and urban dimension of household energy planning and integration into INEP, see Bernardini (1983), who refers to INEP as an 'integrated systems approach to national energy planning'.

9 An extended and separate theoretical review of the development of general methodological issues and refinements in the INEP approach that occurred after its inception, is beyond the scope of this research. As noted in the introduction, the discussion of relevant methodological issues and research results will be drawn into the analysis of IHEP issues, to the extent that they are relevant for the situation in Malawi, or that inferences as to such issues can be made on the basis of this research.

10 Though every country has a unique constellation of factors and policies which are addressed in INEP, many similarities exist among the SSDCs. Therefore throughout this research, special emphasis is placed on comparisons with relevant aspects of planning and policy issues in Malawi and other SSDCs, notably with neighbouring countries. It should be noted that this emphasis does not intend to limit the scope of research material which has been drawn into this research, to sources or situations in any particular world region.

- the macroeconomic level;
- the energy sector level;
- the energy sub-sector level; and
- the international level.

The macroeconomic level

The analysis at the national or macro level involves both the objectives underlying the overall development strategy, and its translation into macroeconomic and sectoral development objectives and policies. In this context energy planning is part of national economic planning in the same way as are, for example, population planning or agricultural development planning. Consequently, the formulation of an energy strategy requires consistency with the objectives and constraints of the overall economic policy (that is, the macro level) and the rest of the economy, which refers to the other non-energy sub-sectors such as transport, agriculture, and so on. As part of the economy, the input-output linkages between the energy sector and the rest of the economy are of prime interest to policy analysis and decision-making. The main interactions and linkages that have to be considered in the energy sector-macroeconomic integration within the framework of INEP, may be summarized as follows.

Financial linkages

The financial resource claims of the energy sector include capital requirements and recurrent cost for imported materials and fuels. In most developing countries the capital needs of the power sector constitute a major share of domestic capital formation, which competes with other capital-intensive energy sub-sector investments and investments in other economic sectors. The power sector is a key component of the economic infrastructure. Power failures create outage costs which amount typically to a multiple of the economic cost of power supply (Sanghvi 1991: 433). The sector's capital requirements have to be carefully balanced against the investment needs of other sectors, to avoid crowding out effects in the capital markets, and thus adverse impacts on economic growth and employment.

The foreign exchange component of power sector investment is typically in the range of 50% (Barnett 1992: 327), but the actual share of foreign financing is usually higher, depending on the capacity of the domestic electric utility to generate funds internally and the potential of resource mobilization in domestic capital markets. All capital-intensive programmes and projects in the energy sector have therefore to be evaluated in terms of their long-term impacts on external debt and the balance of payments. This involves also a recognition of their recurrent foreign exchange requirements. A further important planning consideration applies to financing arrangements which are typical for some SSDCs (for example Zimbabwe and Malawi), where the government both guarantees energy sector debt (most typically for power sector investments) and assumes the foreign exchange risk. In these instances public finances are exposed, and therefore vulnerable, to unexpected shortfalls of their revenue base which may require fiscal austerity measures.[11]

Important direct and indirect financial linkages exist between the energy sector and the financial sector. The main direct linkage which has to be taken into consideration refers to the structure of the domestic capital markets. The main function of the capital markets is to mobilize financial savings and to allocate them efficiently to the most productive investment opportunities. This role of financial intermediation is crucial for the interaction between the energy sector and the financial sector in three respects. First, a competitive financial market can provide long-term risk capital for energy sector investments. Churchill and Saunders (1989: 2) have pointed out that the mobilization of finances for infrastructure developments in developed countries has been instrumental for the development of their capital markets. However, to emulate such a strategy is not primarily an issue of developing long-term debt instruments in the financial market. A precondition for energy sector companies, particularly those involved in supplying the domestic market, to raise at least some portion of their financing requirements from domestic sources, is to meet criteria of long-term financial solvency and profitability. In this respect many publicly owned electric utilities (and to some extent domestic coal producers) in developing countries have exhibited deteriorating financial performance between the mid-1960s and the mid-1980s (Munasinghe 1992: 100). This was due to a host of factors including government interference in operations management, poorly designed pricing policy, lack of managerial accountability and poor system maintenance and technical losses (Churchill & Saunders 1989: 2-3; Barnett 1992: 326-31).

A second, rather indirect but vital, interaction relates to the access of small-scale producers to short- and medium-term financing for productive inputs. This issue is of particular importance to smallholders in the agricultural sector because constraints to the financing of productive inputs have a strong bearing on income growth and thus on the pace of the transition from traditional to modern fuels.

A third financial issue which has to be considered in the energy sector-macroeconomic

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11 The political and economic crisis which occurred in 1992/93 in Malawi is a vivid example of structural problems embedded in government finance and expenditure.

integration relates to the energy sector as a source of government revenue through taxation of fuels. This issue is intimately related to the objectives of energy pricing policies in developing countries.

Employment effects

Employment objectives also play a role. Energy strategies, however, are not usually heavily influenced by employment considerations. More of interest are the employment and income effects of the collection and trading of woodfuels which are among the most labour-intensive operations in the energy sector.

Forward and backward linkages

Forward linkages of the energy sector are constituted through the sector's role as part of the economic infrastructure. This crucial link is exerted through the economic impacts of the energy sector's outputs on production and consumption in terms of energy supply availability, reliability and supply-cost characteristics. Substantial deficiencies in the supply security of fuels and, for example, the quality of power supplied may create substantial production losses or additional costs for energy appliances of households. Limited access to, and availability of, fuels are an important issue for urban, but particularly rural households, because they influence fuel substitution and the end-user cost of useful energy, and create income-related and rural-urban equity issues in energy policy. This link is influenced by energy pricing and energy policy objectives, which have to be considered both in relation to the macroeconomic level and at the level of integrating energy sub-sectors. Backward linkages of the energy sector include the impacts of energy sector development through the use of environmental resources and the demand for goods and services in other sectors.

The energy sector level

The intermediate or energy sector level of INEP focuses on the energy sector as a composite of sub-sectors including the oil and gas, coal, power, woodfuel and renewable energy sub-sectors. The analytical focus at this level is concerned with the interactions between the sub-sectors by taking into accounts the mutual impacts which are exerted through developments in each single sub-sector. The scope of linkages which have to be considered in a country-specific context is mainly determined by the degree of competition of fuels in the energy markets, both for energy conversion and end-uses. Thus the scope of analysis is largely related to interfuel substitution issues and therefore addresses the consistency of sub-sector policies and regulations.

A wide range of sometimes complex policy conflicts are addressed at this level, many of which are often difficult to resolve because of their diverse implications for different policy considerations at each of the three planning levels. For example, the continuation of subsidizing locally produced coal consumed by industry was supported in Malawi by some proponents for the following reasons: enhancement of energy supply security; foreign exchange savings; employment effects of coal mining; and avoidance of the detrimental impacts of losing demand from some major industrial coal customers on the financial viability of a parastatal coal mining company. The latter had produced substantial financial losses which were absorbed by government since it started operation. This option had to be compared by the decision-makers with a proposal for a feasible coal import strategy characterized by supply security, slightly higher foreign exchange cost, absence of comparable employment effects, but substantial cost savings to industrial end-users in manufacturing industries. Choices between these different objectives had to be made in a macroeconomic policy environment where one of the government's main macroeconomic concerns was to lower the high level of inflation. This example demonstrates some of the trade-offs between macroeconomic policy objectives (employment creation, reduction of inflation, saving foreign exchange), energy sub-sector objectives (financial viability, supply security) and least-cost energy supply (economic efficiency).

The sub-sector level

The third level of INEP, the sub-sector level, addresses the specific sectoral planning issues. Energy sub-sector planning generally includes the analysis of energy resource assessment, valuation of externalities associated with energy supplies, supply and demand analysis, analysis of interfuel substitution, including energy pricing and taxation and fiscal regimes, regulatory issues related to fuel supply and pricing, technical and allocative efficiency of energy market structures, and policy and project analysis.

Even though this analytical spectrum applies specifically to the sub-sector level, some areas such as energy sector regulation and supply and demand analysis are also important for higher levels of INEP. For example, an aggregate supply-demand analysis of commercial fuels coupled with fuel price scenarios will provide an estimate of the future fuel import bill. In turn, the latter, combined with estimates of the total capital requirements for energy sector development over a certain planning period, will provide an input to economic policy analysis at the macro level. The macroeconomic analysis will then address the issues of whether the capital requirements of the proposed energy sector development is consistent with, for example, the soundness of the projected balance of payments, or can be realistically expected to be financed through international funding sources or domestic capital markets.[12] Depending on the availability of foreign exchange and external financing possibilities, the projected supply-demand scenario may either be feasible or may, otherwise, have to be scrutinized for necessary and suitable policy adjustments at either of the three planning levels, or a combination of them.

The international level

The analysis at the macro-economic level already incorporates the linkage of the national economy to the external economic environment. There are three major issues and possible developments which may have implications for domestic energy strategy and policies.

First, the likelihood of a recurrence of large oil price increases in real terms within the planning horizon of the next one to two decades has somewhat subsided. Secondly, changes in the demand for capital for energy sector and other infrastructure development, and changes in international financial markets, may impose either much tighter external constraints or increase the capacity of some developing countries to finance their future energy sector investments. This will depend on the outlook for their macroeconomic performance, the adequacy of energy pricing policy, financial viability of energy sector companies as well as the legal and regulatory framework.

SSDCs which have limited access to international capital markets, and which normally represent higher sovereign risks, are less likely to attract private investments in the energy sector, particularly in the power sector. Given the bleak outlook for financing power sector investments in a number of developing countries (see, for example, Barnett 1992: 328-32), governments may either have to increase electricity tariffs considerably (which may negatively impact upon the possibility of cross-subsidizing electricity) or use additional budget funds to finance power sector development. The latter may perhaps have adverse implications on the financing of investments in other energy sub-sectors, notably on the woodfuel sector. The general implication of the capital intensity of the energy sector and perceived long-term financing constraints of a number of developing countries is perhaps that the latter may have to adapt to this situation, by developing as O'Keefe et al (1992: 36) have suggested, 'a policy framework that enables them to seek less energy-intensive development paths'.

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12 A more detailed description of the scope of application of the analytic areas mentioned above and the challenges facing the energy economist in the context of sustainable development policies, is discussed by Watkins (1992).

Thirdly, the concern about the impact of greenhouse emissions on global warming, particularly of carbon dioxide emissions, which are related to energy production and use, may create financial opportunities for developing countries through carbon taxes and the trading of pollution licences. However, the outlook for the introduction of carbon dioxide reducing options, which have a bearing on woodfuel and household energy strategies,[13] is rather uncertain.

1.3.2 Policy objectives, instruments and constraints

The ultimate objective of INEP is to develop a set of consistent policies that meet the often conflicting national and sectoral objectives. Within the multitude of specific objectives, INEP has to consider in the policy-making and implementation process several general objectives that pervade all levels of planning: economic efficiency, social and intergenerational equity, environmental considerations and financial viability. In the analytical process of INEP, that is the analysis of energy issues, strategy formulation and policy-making, the trade-offs between these objectives are of key interest. Therefore, as a minimum requirement, professionally sound policy analysis and advice to decision-makers has to clarify and evaluate these trade-offs clearly, in addition to the consistency requirement with all other objectives involved in this process. However, difficulties arise in the context of INEP because the general objectives are related to theoretical concepts and methodologies which are beset with a number of theoretical and normative issues and explicit and implicit assumptions, as well as theoretical and practical problems of implementing specific methodologies. A number of the latter problems, discussions and concepts are relevant to the analysis in this thesis both in terms of the applied energy-economic methods and policy considerations, and the theoretical concepts on which they are based or to which they are related. The latter are discussed in Annex 1-1. Key issues in this respect are related to the interpretation of the role of INEP with regard to market and planning; the analytic role of the concepts of technical and allocative efficiency; market

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[13] As biomass is a main CO_2 sink, energy conversion of wood resources and deforestation contribute to the enhanced release of CO_2. To reduce CO_2 emissions, two biomass related options are of interest in the context of a woodfuel strategy (see Rosillo-Calle & Hall 1992: 131). The first option, reforestation, sequesters CO_2 and implies a one-time benefit which accumulates until trees have grown to maturity. The second option, substitution of fossil fuels by biomass produced on a sustainable basis, involves a recurrent annual benefit equivalent to the amount of carbon not burnt in the substituted fuel. The second strategy is clearly more favourable because it has additive benefits: it captures carbon benefits both during the growth period plus an annual recurrent benefit. Similarly, for any woodland management option involving incremental wood production, agroforestry options and efficiency increasing measures (more efficient stoves and charcoal kilns), carbon benefits can be accounted for. Hence there is a large coincidence between supply- and demand-side options which may be considered as part of a woodfuel and household energy strategy as well as a country-specific CO_2 abatement strategy.

failures and externalities; policy approaches to deal with market failures; relationships between cost-benefit analysis; equity and environmental considerations; the integration of major objectives within INEP; and institutional problems associated with developing INEP capacity and policy implementation.

1.4 INTEGRATED HOUSEHOLD ENERGY PLANNING: RESEARCH ISSUES

The constraints to which the building of INEP capacity at the national level have been subject also represent constraints to integrate effectively rural and urban household energy policy, and the development of a household energy strategy within INEP. As mentioned above, integrated energy planning methodology has been developed in the literature and through the implementation of INEP studies and projects, during the past 10 to 15 years. Major attempts to develop INEP have been made by the general energy sector assessment studies of the World Bank and the United Nations Development Programme (UNDP) as part of the Energy Sector Management Assistant Programme (ESMAP), and by a number of National Energy Plans or Energy Master Plans which were heavily funded by the latter institutions, as well as bilateral donor organizations. In the SSDCs, INEP projects have been carried out, for example, in Kenya (1983-84), Zimbabwe (1984-85), Botswana (1985-87) and Lesotho (1985-88).[14] All these studies integrated urban household energy aspects. More recently, the integration of household energy issues into INEP has been made, for example, in a series of about 70 ESMAP-funded studies under the umbrella of the Integrated Household Energy Strategy Studies (IHESS). In the SSDCs such studies have been conducted, for example, in Zambia and Zimbabwe as well as in Tanzania in the form of the Tanzania Household Energy Project. Studies of the latter type may be regarded, in the terminology chosen above, as examples of IHEP studies.

1.4.1 Methodological problems and issues

Attempts at tackling household energy issues through energy programmes and projects focusing on the development of renewable energy technologies, large-scale reforestation programmes, natural woodland management, government fuelwood plantations, community forestry, agroforestry and farm forestry and the introduction of improved woodfuel stoves both in urban and rural areas, have met with mixed success or have been,

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[14] The studies in Kenya and Zimbabwe are documented in O'Keefe et al (1984) and Hosier et al (1986) respectively. The National Energy Plans for Lesotho and Botswana are documented in a series of reports which were produced by the consultants implementing these studies; see Lahmeyer International (1987) for Botswana and Lahmeyer International (1989) for Lesotho.

An account of the mixed successes and the lessons which can be learnt from integrated energy plans which have been produced in African countries, is given in Hosier (1992).

in some instances, outright failures. The overall rather disappointing results have given rise to a complete rethinking of the conventional conceptual and methodological framework for analyzing household energy issues in terms of its underlying assumptions, the perception of the nature of energy problems, the required scope of the analysis, the relative importance of macro policies and energy sub-sector policies, as well as methodological issues. Foley (1988: 78), for example, stresses the need for establishing a new household energy paradigm:

> It is now clear that a new intellectual framework is required for the discussion on household energy. The notion of an 'energy gap' needs to be replaced by a new paradigm which takes into account the knowledge which has been accumulated in the past decade.

Similarly, Eberhard (1992: 19) judges the new research findings which have come about as a result of the fundamental criticisms of traditional conceptualizations concerning the 'fuelwood crisis' to be the emergence of a new paradigm.

Most of these programmes and projects have been directed at rural communities and households to alleviate the perceived shortages of woodfuels.

1.4.2 Criticisms of the fuelwood gap model

Conventional planning approaches and woodfuel policies were based on a set of assumptions which have been summarily treated in the literature as the fuelwood 'gap model', because the fuelwood crisis was conceptualized in terms of a gap between growing fuelwood demand and decreasing supplies. Thus criticisms of this model provide an appropriate starting point for a discussion of the changed conceptualization of the scope and nature of the key problems, and the implications for research directions and questions which have emerged in the area of integrated household energy planning and policy. An overview of some central issues of the debate provides the background of this research and is discussed in what follows. More specific issues are abstracted from the literature and are discussed in their appropriate context in subsequent chapters.

Fuelwood gap models conceptualized the fuelwood problem as a supply-demand problem which gave rise to favouring policy interventions addressing a gap problem. The basic problem associated with the 'closing-the-gap' policy perspective was to give answers to the basic questions of where the gaps are, how severe they are, how quickly they widen and who causes them. Gap models are criticized in this respect for several simplifying assumptions about key relationships between the involved variables on the supply and demand side and the interaction of supply and demand.[15]

A general flaw of the gap model consists in the assumptions of the supply gap projection methodology. The typical gap model has assumed a linear relationship between population growth, household size, fuelwood demand and deforestation.[16] This assumption has been challenged with regards to the dynamics on the woodfuel supply and demand side.

The main criticism of the population growth/fuelwood consumption relationship is that rural households adapt to diminishing supplies of woodfuel through a number of possible responses, including the increased consumption of lower quality woody biomass and other biomass fuels, changes in cooking practices, food selection and processing, woodfuel conservation measures, social survival strategies, and supply responses (tree planting). In this respect, indicators of fuelwood stress or shortage may provide guidance as to the severity of problems in particular areas or localities. A key issue in this context, however, is to distinguish whether, and to what extent, the observation of certain types of adjustments reflect indeed a response to an energy problem. Other reasons such as food shortages or seasonal labour constraints may be more important factors. A second major issue is that there is no firm empirical evidence available as to the typical sequence or sequences in which such adjustments take place, and the conditions under which they occur. It is, in particular, unclear how substitution moves from woodfuels to inferior fuels, or are complemented, delayed or substituted by direct fuelwood conservation measures and other adaptive strategies. A third major issue which is linked to this complex is under which conditions rural households resort to the purchase of woodfuels or the on-farm or off-farm growing of trees. It is obvious that an understanding of the factors influencing such patterns and household decisions is a prerequisite for identifying, prioritizing and designing principle household energy policy options.

A second criticism of gap models relates to their assumption that household woodfuel consumption is the principal cause of deforestation. This assumption about the biofuel-deforestation link has been challenged by some authors and studies who found that this link is by no means universal and that deforestation may be primarily driven by agricultural extensification (land clearing), rather than by household woodfuel use. This issue remains contentious, however, according to Teplitz-Sembitzky and Schramm, and

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15 This section draws on the summary articles of criticisms of 'gap' models by Leach and Mearns (1988a) and Eberhard (1992).

16 One example for the application of a fairly pure form of the gap model are the wood supply and demand projections which have been made in the National Energy Plan of Malawi (see NEP 1990).

`there is some controversy about what combination of factors is the driving force behind the depletion of biomass resources' (1989: 123).

A clarification of the question as to which consumers or processes are mainly responsible for deforestation and forest resource depletion clearly has strategic implications for woodfuel policies: a cause-effect analysis is always required for determining in which consumption sectors corrective measures need to be taken or whether the process is governed by other factors, as suggested by the notion that land clearing is a major contributor to deforestation. Linked to this issue are the questions of which externalities are induced by deforestation, what the role of woodland products is for production and consumption activities of rural households, and which groups bear the costs of deforestation and forest depletion. Depending on the answers, important equity implications may be involved.

A third major criticism of gap models addresses an issue which is central to the entire research and policy debate related to IHEP. Gap models are criticized for deriving policy conclusions and prescriptions for intervention measures on the basis of extremely weak data, resulting typically in the projection of broad national or regional supply-demand gaps of woody biomass which conceal large variations and deficits at the local level. Combined with other linearity assumptions and deficiencies of the gap conceptualization of the fuelwood problem, weak data are fraught with uncertainties concerning the physical availability of woody biomass resources, leading to large uncertainties and deviations in estimating supply-demand gaps, even at disaggregate levels. This naturally has led to proposals to pursue the assessment of woodfuel supply at a much more disaggregated level (Eberhard 1992: 19) to cope with what is ultimately perceived, for example, by O'Keefe and Munslow as the most important level of policy interventions:

> [I]t is impossible to plan for fuelwood interventions as a national strategy based on a national shortfall. The problem is one of identifying sites, not general situations, for intervention. The fuelwood problem is critically a local problem. (1988: 26)

Hence, one may realistically expect that the tension between defining what data are adequate to devise effective energy policy decisions and programmes, and the need for action, will remain a major issue and challenge for IHEP from a policy perspective. The data-policy trade-off relates not just to the question of comparing the costs of additional information with the potential benefits that can be reaped from better policies; it has also the broad methodological implication that structured and efficient data collection needs should be considered from the perspective of a specific model of the household energy system (Foley 1988: 79).

Criticisms of the fuelwood gap model and issues related to adaptive strategies to fuelwood scarcity are, of course, part of the general issue of which factors influence rural household fuel consumption levels and interfuel substitution, including the switch from woodfuels to liquid fuels and electricity.

1.4.3 Elements of a new framework for rural household energy policy analysis

Microeconomic decision behaviour of farm households

The perception of fuelwood problems in terms of a growing gap implied a strong notion of physical scarcity and therefore lent itself to policy interventions of this type. The widespread failure of typical rural energy programmes, such as fuelwood plantations and more efficient cookstove dissemination programmes, has shown that the underlying assumptions about the role of energy needs, and their importance relative to other basic household needs and problems, have been grossly overestimated. This implies serious deficiencies in conceptualizing the objectives and the rationale of the decision-making behaviour of rural households with regard to all aspects of on-farm and off-farm resource management and use, including woodfuels. The need to conceptualize the decision-making behaviour of farm households emerges from the simple fact that almost every intervention involves a decision about reallocating existing, or mobilizing additional, household resources – land, labour and capital. Thus policy options and their perceived benefits have to be evaluated in the context of the farm, to answer the crucial questions of how different types of households are likely to take which decisions, and under what circumstances. Therefore, theorizing about farm household behaviour is an important first step which has to be operationalized towards the practical requirements of household energy policy.

For example, the decision to plant trees always involves the need to divert all three major resources available. The question then arises of whether farm households plant trees to meet their home consumption needs, for example, or whether they view trees as a commercial crop for sale, with a certain amount of wood being retained for home consumption. If the latter decision perspective was more important, the relative producer prices and financial returns for fuelwood and other crops would be major decision variables. These prices in turn depend on the efficiency of fuelwood and crop markets.

The role of market failures and macro-policy variables

Research dealing with the complexity of rural households' decision-making has focused on particular resource constraints such as women's labour or farmers' specific risk considerations in production decisions. Such approaches are valuable in that they have provided insight into some microeconomic factors involved in household decision-making, but they are by themselves too narrow and selective to gain a comprehensive understanding of which factors influence the production and consumption decisions of farm households. Other researchers have stressed the need to conceptualize the production and use of biomass fuels in connection with macro-variables and processes which have an impact on the dynamics of resource management and fuelwood stresses. This approach is advocated *inter alia* by Soussan et al:

> The causes of these (fuelwood) stresses are rooted in more fundamental failures in rural land, labour and capital markets. They also reflect the failure of local and national governments (often in collusion with donor agencies) to establish the conditions which would allow efficient and sustainable allocation of land and resources between woods and cropland, food and wood production. (1992: 140)

This view primarily addresses the efficiency of markets with which rural households interact. In the same perspective, Eberhard stresses the importance of additional macro-policy issues to address household fuelwood problems:

> Effective policies cannot thus be produced by energy or even forestry ministries in isolation, but have to be developed within the framework of agricultural and rural development policy, taking into account macro-policy issues, such as population, land distribution, tenure rights, and land management (ecological) issues....
>
> The new fuelwood paradigm seeks to address causes and not symptoms of fuelwood scarcity. In many cases, indirect macro-policy or broader rural development initiatives may be more effective in alleviating the fuel burden of the poor. In all cases, it is important that the livelihood systems of rural communities are understood. (Eberhard 1992: 20-24)

Rural household energy policy and farm household decision behaviour

A central issue for effective policy design relates to the explicit and implicit assumptions made concerning the economic behaviour of the economic agents, and hence their anticipated responses to changes in the decision variables that policy approaches and instruments intend to influence.

The above discussion shows that the discourse about which factors should be integrated into a new conceptual framework for rural household energy policy goes in two interrelated directions. The first stresses the need to integrate the analysis of macro-processes, including the main markets farm households are interacting with, and macro-policy as well as sub-sector policy issues, notably of the agricultural sector. This macro perspective is complemented in the second direction by (implicitly) emphasizing the need to overcome the deficiencies in understanding the decision-making behaviour of households under changes in macro parameters and markets.

To the extent that the microeconomic behaviour of economic agents can be approximately characterized in all material respects in terms of the assumption of the utility-maximizing individual or the profit-maximizing firm (because farm households are producers), the likely impacts of policies on certain target groups are more predictable compared to situations where the underlying restrictive assumptions do not hold. The former assumption may be, with certain qualifications, more applicable to certain groups of urban households, but may be only partially applicable to the majority of rural farm households.

In the preview of integrated energy, and particularly household energy policy, the decision-making behaviour of rural households assumes a central role. The assumption of the profit-maximizing farm household represents, by and large, a model which has few empirical equivalents. The notion of a profit-maximizing farm enterprise is especially hardly ever fulfilled in SSDCs, where most of the farmers produce mainly for subsistence, and are, to a different extent, involved in cash crop production. Farm households more typically operate under one or more objectives and are subject to specific constraints, the relative importance of which may vary widely according to country, region or community, depending on their relative resource endowments and the degree to which they are integrated into the economy through labour, credit and agricultural goods markets (Ellis 1988). This diversity poses a challenge to the conceptualization of farm household decision behaviour from a planning, methodological and policy viewpoint.[17]

The role of markets, farm household decision-making and their relationships are some of the main elements which are considered as relevant in developing a new conceptual framework for developing rural household energy policies and, of course, fuelwood policies. Such relationships are discussed systematically in the literature about theories and concepts of farm and peasant households. Yet the potential contribution of the latter to conceptualizing and interpreting a whole range of contentious issues related to the economic and social determinants of decision-making of farm or peasant households, has

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[17] These issues, and their relevance for IHEP, are further discussed and applied throughout this research, particularly in Chapter 4.

hitherto been only partially explored and operationalized within the context of household energy policy analysis.[18] Their potential contribution to the understanding of relevant aspects of household decision-making in connection with decision variables which are crucial for the successful design of household-related fuelwood policies, as well as aspects of the adaptive behaviour of households in response to fuelwood scarcities, are an important theme of this research.

1.4.4 Urban household energy policy

In the area of urban household energy policy in developing countries, certain issues and linkages have attracted most research. First, the macroeconomic implications of a rapid substitution of traditional fuels by modern fuels (petroleum products and electricity) have been an issue. Secondly, and most important, the factors determining the pattern, direction and speed of this process of fuel choice and interfuel substitution are diverse and not well understood. A central concept for explaining this process is the 'energy transition' which assumes that income is a major influencing factor and in which the notion of a 'fuel preference ladder' is embedded. According to the latter, households aspire to climb an energy ladder, from traditional fuels to cleaner and more convenient modern fuels. However, the intuitively appealing energy transition concept has been challenged on account of empirical evidence which has shown that a number of other factors may also strongly influence fuel choices, and thus interfuel substitution. The analysis of the relative importance of factors influencing this process remains an important research area for integrated household energy policy.

Thirdly, with growing urbanization and stagnating (or even strongly declining) real incomes in a number of developing countries in the 1980s, the switch to modern fuels did not advance as rapidly as anticipated and even resulted in backward fuel substitutions. This has put the important question on the policy agenda as to what extent the woodfuel consumption of urban households contributes to deforestation. Because of the possible impacts of deforestation and forest depletion on rural users of forest resources, this link establishes one important dimension of rural-urban equity considerations for the conduct of household energy strategy and policy. However, little systematic knowledge is available

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[18] This issue is further discussed in Chapter 4. However, it is emphasized that, as mentioned above, selected theoretical concepts (such as risk aversity) are often explicitly or implicitly used in the literature in explaining rural household decision behaviour with regard to aspects of energy-related decisions. These are often only generally referred to, not operationalized or put into a more comprehensive context of households' objectives, rationale and constraints. Some of the few authors which have introduced more elements of household decision-making aspects are for example, Leach and Mearns (1988a), Bradley (1991) and Bradley et al (1993).

concerning the economic valuation of deforestation-induced externalities, and particularly of forest produce.

Fourthly, stagnant incomes combined with the anticipation of strongly increasing woodfuel prices as a result of the 'fuelwood crisis', has given rise to the concern that the social welfare and the meeting of the basic energy needs of the urban poor may be adversely affected. As a result, different household energy policy intervention measures have been tried to alleviate such consequences. Among these, large-scale fuelwood plantations, which were usually operated by government departments or agencies, have met with mixed success, because of the cost inefficiency of such plantations, competition of cheap woodfuels from customary woodlands, or a combination of both factors. In order to make government fuelwood supplies and supplies from rural farm households competitive in comparison to woodfuels from customary lands, governments have also intervened in different forms in woodfuel markets. Such interventions involved attempts to make woodfuel markets more efficient and to control woodfuel flows into cities. The feasibility of the latter option is especially contentious. Other commonly used measures include attempts at controlling woodfuel prices and of directly subsidizing fuels or of implementing cross-subsidization pricing structures. In these areas, energy policy research is directed at the question of how such measures can be efficiently structured to meet equity objectives by avoiding disproportionate leakages.

1.5 RESEARCH METHODOLOGY

The information used in this research was partly based on information which was collected in Malawi from March 1989 to September 1991. Most of the information, however, was compiled from literature searches in Malawi and Germany. During four field visits to Malawi which were carried out from 1992 to 1994, literature and information searches were conducted in the libraries of international organizations (FAO, UNDP, UNHCR, WHO and the World Bank) and of several ministries and government departments in Malawi. In addition, much unpublished information was directly obtained from government officials in Malawi. Field visits were also used to discuss research issues and data problems with government officials and consultants involved in household energy policy research, implementation of household energy and forestry projects, land-use planning and agricultural extension.

1.6 OVERVIEW OF CHAPTERS

Chapter 2 is an introductory chapter which mainly compiles information used in subsequent chapters. It is subdivided into three sections. Section 1 outlines the geographic and administrative set-up of Malawi. This information is important for an understanding of the survey data which are used in this research. In Section 2, aspects of past and future demographic developments relevant to household energy policy are discussed, including the trends and determinants of migration patterns, population growth trends and population policy, and the linkage between population growth and environmental degradation. Population data are used in subsequent chapters, notably for the discussion of macro relationships between population growth and land-use changes and deforestation. The third section discusses the economic development policies, structural growth constraints and past performances of the Malawi economy. Emphasis is on the role of agricultural policies, which had a strong influence on the income development of the smallholders and on land-use changes affecting their access to forest resources. Section 2.4 introduces briefly the structure of the energy sector and the household energy sector. This is followed by a discussion of linkages between the economy and the household energy sector. Embedded in this discussion is an overview of the household energy policy objectives of the government of Malawi (GOM) and their rationalization with regard to long-term macroeconomic issues.

The main themes discussed in Chapter 3 are the relationships between population growth and changes in land tenure systems and deforestation, and aspects of on-farm resource management. Section 3.1 discusses findings in the literature concerning the macro relationships between population growth, deforestation, household fuelwood shortages and land-use changes. The conclusion of this discussion is that some of these relationships differ by country so that empirical analysis of country-specific conditions and developments is needed. In Section 3.2, hypotheses concerning the linkages between land and tree tenure security and resource management, both on farms and for open access resources (woodlands), are analyzed. An understanding of these linkages is important on account of their influence on smallholder household decision-making and the designing of farm forestry and agroforestry interventions. Section 3.3 explores long-term relationships between population growth and land extensification and fragmentation. The purpose of this discussion is twofold. First, changes in both dimensions of land use have implications both for strategic decisions of fuelwood policy formulation and for policy design and implementation. Secondly, the extent to which different social groups are able to participate in the utilization of local resources is hypothesized in the literature to have implications for their attitudes towards the resource management of common property resources. This hypothesis is addressed in this context.

In Chapter 4 methodological issues concerning the connection between rural household energy policy and the conceptualization of farm household decision behaviour, empirical analysis of smallholder decision-making in Malawi, and an analysis of smallholder income, are discussed. In Section 4.1, the discussion starts with a description of why a number of rural household energy policies have failed, what conclusions have been drawn concerning the enlarged scope of analysis, and of specific interactions which have to be considered between households' decision-making and various markets. A major shortcoming of formulating rural household energy strategies and policies is that the decision behaviour of rural households has not been sufficiently analyzed, even though farm and peasant household energy models and concepts have long been used for the design of agricultural policy. Therefore, selected farm household models and concepts are discussed to analyze their usefulness and implications for explaining farm household resource allocation decisions and, where applicable, their direct relationship to household energy policy issues.

A key consideration for this analysis is that each household and farm intervention or policy option offered to rural households implies the utilization of land, labour or cash resources. These models serve as the background for the explanation of decision-making aspects in smallholder households in Malawi. Section 4.2 discusses the relevance of characteristics of broad types of rural household groups and their differences for rural household energy policy analysis. As a result, the further analysis of rural household energy policy is confined to the group of smallholders which constitute the majority of rural households. Section 4.3 analyzes household decision behaviour and constraints of smallholders in Malawi with reference to the farm household theories and concepts which were discussed in the previous section. This analysis incorporates the interdependence between aspects of agricultural policy, land fragmentation and the differential access and participation of households in credit, labour and goods markets. The analysis in this section also draws conclusions with regard to the possibility of stratifying rural households for household energy policy targeting purposes. Section 4.4 discusses the real income development and composition of income of smallholder households since 1980. This serves the analysis of linkages between the level and structure of household incomes and energy consumption in Chapter 5. Section 4.5 summarizes the discussion and draws conclusions and implications for household energy policy.

The main topic in Chapter 5 is relationships between woodfuel supply and demand and deforestation in Malawi. The chapter is structured into six sections. In Section 5.1, estimates of woody biomass supply and deforestation on a district level are discussed, together with the question of what contribution agricultural land-clearing has made to deforestation. Section 5.2 analyzes the past woodfuel demand of rural village industries and the woodfuel supply and demand of agricultural sub-sectors, in order to determine to what extent these consumer groups have contributed to deforestation in Malawi. The discussion then proceeds in Section 5.3 with an analysis of patterns, determinants and changes of energy demand in rural households. A primary objective here is to test the available empirical knowledge and hypotheses concerning the factors influencing fuel choices in rural households, with regards to their adaptation to growing fuelwood scarcity and their perceptions concerning the importance of fuelwood problems relative to other household needs. The quantitative results from Sections 5.1 to 5.3 are integrated in Section 5.4 to draw conclusions with regard to impacts of woodfuel consumption by different consumer groups on deforestation and forest depletion, and the role of woodland regeneration. In Section 5.5 two issues are discussed: the quantifiable and non-quantifiable economic impacts on deforestation in Malawi; and which groups bear the main cost of deforestation and depletion. The latter is explored with regard to the uses and relative importance of forest products for rural households in Malawi, because deforestation and forest depletion has implications for social equity aspects of energy policy, and potentially for farm household choices concerning tree planting on farms and woodfuel supply-oriented policies. In Section 5.6, findings and policy implications are discussed.

Chapter 6 analyzes the rural household energy policy implemented by the GOM since the early 1980s. The discussion draws on findings from previous chapters, compares the results of these policies with experience from elsewhere, and draws policy implications. The chapter is subdivided into four sections. In Section 6.1, an overview of the rural household energy policy is given and the reasons for the GOM's emphasis on supply-oriented woodfuel measures are discussed. Section 6.2 analyzes farm forestry, agroforestry and communal forestry policies, with an emphasis of the analysis on farm forestry policy. Concerning the latter, a fundamental issue of what empirical basis and information that was available at different stages of policy design and changes, were policies based? In Section 6.3 the rural electrification policy of Malawi is discussed in connection with controversial issues concerning the interdependence between rural electrification and rural development. Finally, Section 6.4 summarizes the chapter and outlines policy conclusions.

The main subject in Chapter 7 is the analysis of the factors determining and influencing fuel choices, interfuel substitution and energy consumption of urban households in

Malawi. The chapter has six sections. Section 7.1 discusses the findings in the literature about the relative importance of factors which have been found to influence energy consumption and interfuel substitution. This discussion focuses on the concept of the 'energy transition' and the notion of a 'preference fuel ladder', including some recent criticisms of those notions. In Section 7.2, the household energy database is discussed, together with questions relating to the poverty status of low-income households. This is followed, in Section 7.3, by an analysis of factors which may have influenced the energy consumption and interfuel substitution of urban households in Malawi. In Section 7.4, the main factors for the massive backward fuel substitution which took place in Malawi between 1983 and 1990, are discussed. An analysis of selected household energy policy issues, including the supply of fuelwood from fuelwood plantations to the urban poor, the introduction of pine charcoal in urban markets and pricing policy measures, are discussed in Section 7.5. In Section 7.6, conclusions for urban household energy policies and policy implications arising from rural-urban equity considerations are drawn.

Chapter 8 is sub-divided in two sections. The first summarizes the research findings and methodological and policy conclusions with respect to deforestation and the scope of woodfuel policies, conceptualizing and operationalizing farm household decision-making, rural household energy consumption and responses to fuelwood stresses, and rural and urban household energy policy. The second section discusses the relevance of this research with regard to the methodology of INEP and the relationship between the conceptual framework of INEP and IHEP, and the operationalization of the latter. In addition, implications concerning overall development policy orientation, data and institutional issues for operationalizing IHEP are drawn.

Chapter Two

SOCIO-ECONOMIC AND DEMOGRAPHIC DEVELOPMENT

Chapter 2 is subdivided into four sections. Section 2.1 begins with an introduction to the geographical characteristics and administrative structure of Malawi in order to familiarize the reader with the country. An understanding of the administrative structure in terms of the definitions of regions, districts and Agricultural Development Divisions (ADD) and their respective geographical boundaries is important with respect to the statistical and survey data which are used in this research. Essentially, all surveys and other research conducted in Malawi, as well as development plans, use these administrative categories.

In the second section (2.2), past demographic development trends including determinants of migration patterns, population projections and problems associated with macro- and micro-determinants of reproductive behavior in Malawi, are discussed. The section starts with a discussion of past and projected demographic development trends to provide a basis for the analysis of relationships between population growth and changes in the availability of arable land and forest resources discussed in Chapters 3 and 4 respectively. This is followed by a discussion of migration patterns which aims to clarify the question of whether there is evidence for strong urbanization pressures which pose a challenge to household energy policy. Population projections are then discussed to show the pressures Malawi faces concerning processes of land fragmentation and deforestation. As discussed in Chapters 5 and 6, changes of these variables have important implications for the design of sustainable farm, agroforestry and communal forestry policy options. Finally, the possible linkage between declining natural resources and population growth is discussed.

The third section begins with an overview of the development policies, structural growth constraints and past performance of the Malawian economy. As Malawi is predominantly an agricultural economy, agricultural policies and their impact on the income development of smallholders, is discussed. Agricultural policies also have an impact on other important macro-variables such as changes in land use and access to forest resources. The implications of changes in these variables, and their relevance for the design of rural household energy policy, are discussed in subsequent chapters. This section also includes a brief overview of the energy sector and the household energy sector in particular. Finally, general linkages between overall economic development and the household energy sector are discussed. Embedded in this discussion is a broad overview of the main objectives of the energy and household energy policy which has been pursued in Malawi.

In Section 2.4 the main findings of the discussion are summarized. Further implications of the macroeconomic development strategy and future population growth in Malawi for changes in land use, natural resource management and other aspects relevant for household energy policy are discussed in subsequent chapters.

2.1 GEOGRAPHY AND ADMINISTRATIVE STRUCTURE

Malawi, a land-locked country in Africa, has a total area of 119 140 square kilometers (km^2), subdivided into a land area[1] of 94 275km^2 and areas occupied by waterbodies (lakes and marshes) of 24 865km^2. The country shares borders with Mozambique, Zimbabwe, Zambia and Tanzania and is subdivided into three major administrative regions: Northern, Central and Southern. The Northern, Central and Southern regions are subdivided into five, nine and ten districts respectively which are shown in Figure 2-1 overleaf. For development planning, statistical and administrative purposes, the country is subdivided into eight ADDs, two in the Northern region, three in the Central region and three in the Southern region as shown in Figure 2-2. The subdivision of Malawi by regions, their disaggregation into districts and ADDs is important for the understanding of the coverage of data which are used in this research. Most of the administrative boundaries of districts coincide with the administrative boundaries of the ADDs to which they belong.

Major differences between ADD and district boundaries exist only in the Salima and Lilongwe ADDs where certain parts of the Dedza, Ntcheu, Mangochi and Salima districts belong to either of these ADDs.[2] The ADDs are further divided into so-called Rural Development Projects (RDPs). RDPs consist of Extension Planning Areas (EPA)[3] which are further divided into blocks. Their geographical definition and boundaries are not relevant for this research and are therefore not shown. It is, however, important to note that surveys undertaken by the Ministry of Agriculture use the block as the sampling unit, while the National Statistics Office (NSO) uses the village, sub-village or a cluster of villages as enumeration areas (see Malawi Agricultural Statistics 1993).

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[1] Various estimates of Malawi's total land area are available but their differences are marginal. The National Physical Development Plan's (1986) estimate was 94 275km^2, while a more recent estimate by a World Bank study (World Bank 1992b, Volume II, Annex 1: 15) amounted to 94 407km^2.

[2] An estimate of the areas of districts which belong to specific ADDs is contained in Eschweiler (1993). The Salima ADD covers Nkotakota, Salima, one-eighth of Mangochi, one-quarter of Ntcheu and one-eighth of Dedza district, while Lilongwe ADD covers Lilongwe, seven-eighths of Dedza and three-quarters of Ntcheu district. In the Southern region, Liwonde ADD covers Machinga, Zomba and seven-eighths of Mangochi District.

[3] EPAs are expected to have uniform rainfall, temperature, topography, soils and other natural resources and are therefore used for agricultural planning purposes.

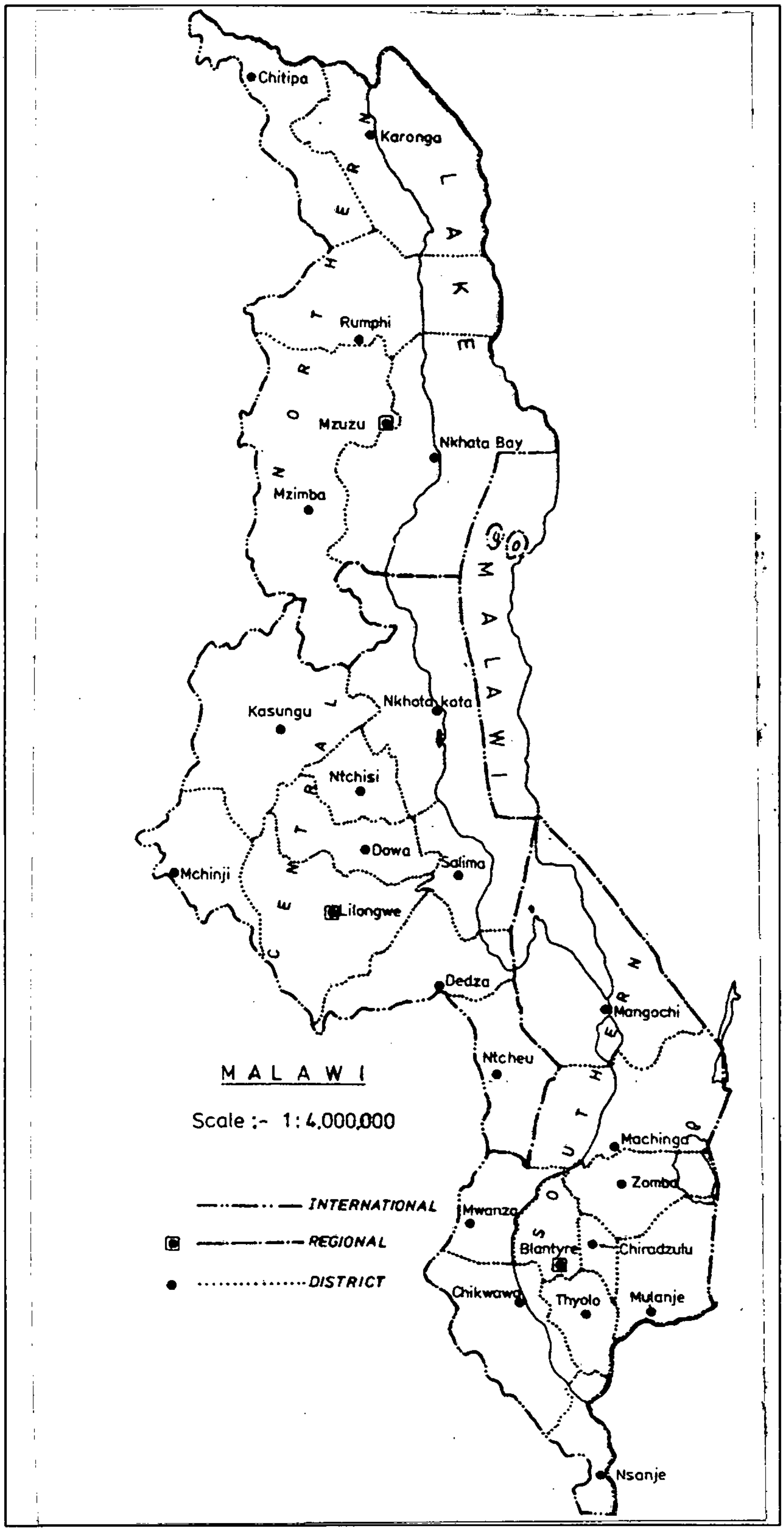

FIGURE 2-1 Administrative boundaries

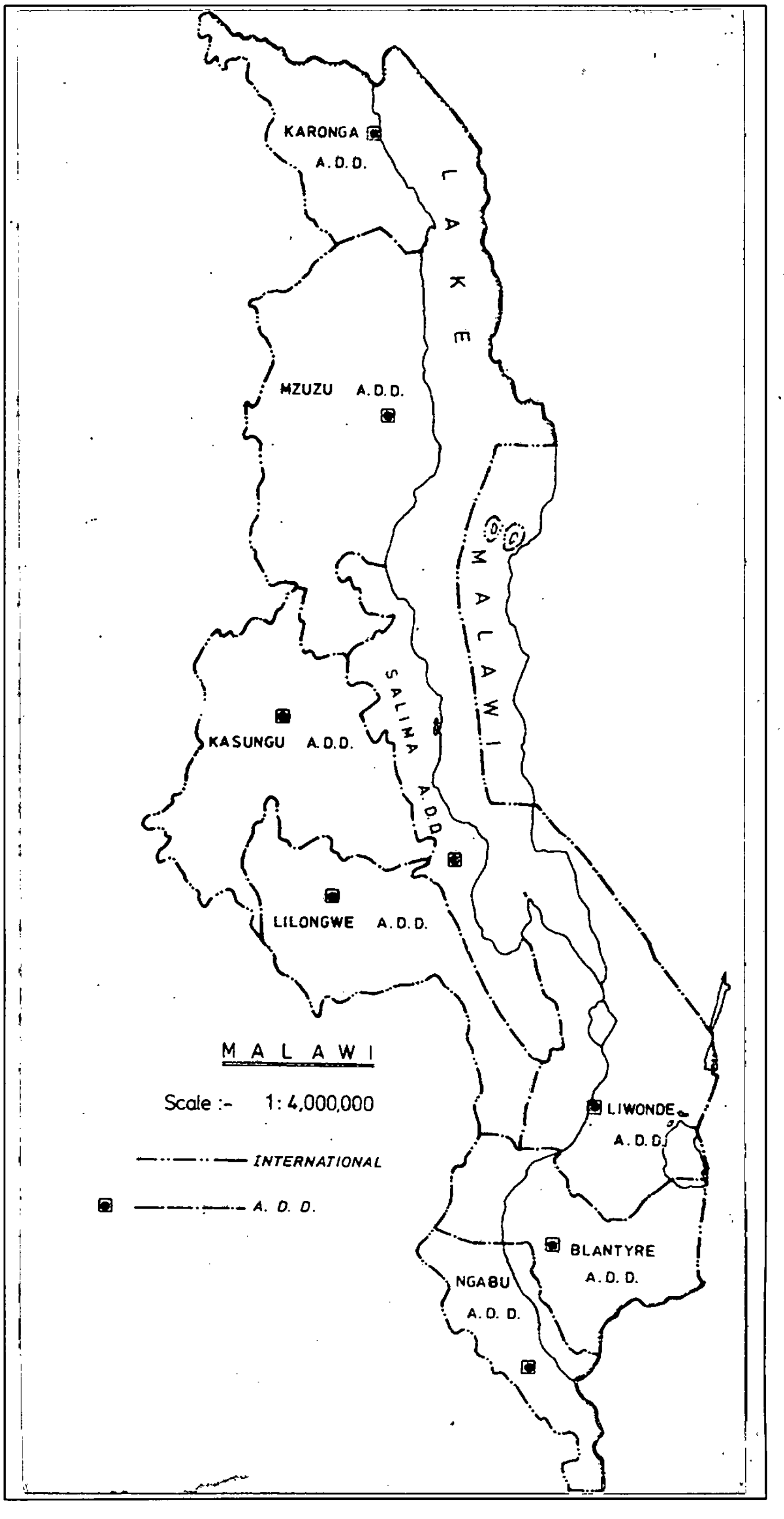

FIGURE 2-2 Agricultural Development Divisions

2.2 DEMOGRAPHIC DEVELOPMENT

The analysis of population growth is the common starting point for the analysis of household energy issues because of the broad linkages between population growth, land use changes, natural resource utilization and deforestation. This section highlights the main features of demographic development during the period 1966-87 and discusses the main assumptions and results of recent population projections for Malawi. Population data and projections are used in the following chapters for various calculation purposes.

2.2.1 Population dynamics and variables

The demographic database

The National Statistics Office has conducted population censuses in 1967, 1977 and 1987 and demographic surveys in 1970-72 (Population Change Survey), 1982 (National Demographic Survey) and in 1984 (Family Formation Survey) respectively. Crucial population parameters such as total fertility rates and life expectancy, which are needed to ascertain intercensus demographic developments as well as for population projection purposes, were not available until 1994.

Several selected characteristics of the demographic development in Malawi between 1966 and 1987 for the three major regions and districts are summarized in Annexes 2-1 and 2-2. Though most of the data shown in the Annexes are self-explanatory, a few comments and explanations are warranted.

Population growth and variables of population change

The population of Malawi was enumerated in the 1987 census at 7.98 million. The inter-census (1977-1987) population growth rate of 3.6% accelerated considerably relative to the growth rate of 2.9% experienced during the period from 1966 to 1977. The growth rate of 3.6% included about 300 000 refugees from Mozambique. Excluding the refugee population would still have resulted in an estimated population growth rate of 3.3%. Since 1966 the population has almost doubled. From a regional perspective, population growth accelerated more strongly in the less populated Northern region relative to the most populated Southern and the Central region. Between the census periods, strong variations in the population growth rates took place at the district level, ranging from negative changes in districts with both comparatively low and high past growth rates to overproportionally positive increases in districts with previously average growth rates. There is also no consistent correlation between growth rate changes and sex ratios.

The intercensus (1967-77) total fertility rate (TFR) of 7.6 was estimated by the 1982 Malawi Demographic Survey (NSO 1987: 29) to have remained constant. TFRs differ little between rural and urban areas, but significant regional differences exist, ranging from 7.1 to 8.3 in the Southern, 5.8 to 9.6 in the Central and 7.1 to 8.3 in the Northern region. As no TFR estimate is available from the 1987 population census, a consensus estimate for the TFR since 1982 of 7.6 was adopted in the recent Population Sector Study carried out by the World Bank (1992a) and the population projections developed by the Department of Economic Planning and Development (DEPD) which are discussed in DEPD (1992). Indicators supporting this assumption are the estimate of a low modern contraception prevalence rate of no more than 4% (House & Zimalirana 1991: 10),[4] the start of child spacing programmes only by 1984, the low school enrollment rate of girls which is usually interpreted as a proxy for increased economic well-being, and the general adverse income development.

Combining the income development experienced in Malawi with Dasgupta's (1992: 95) finding of a positive correlation between declining TFRs and increasing income per head (which was derived from time series and cross-section data for 98 developing countries), also lends support to the assumption that fertility rates are unlikely to have changed much, if at all, since 1982.

Mortality has shown a declining trend in Malawi. The NSO (1984) estimated that the life expectancy for the period 1977 to 1982 was 42.4 and 39.2 years for females and males respectively. A further increase during the period 1983 to 1987 was generally assumed partly in response to the introduction of child spacing services. Pending NSO estimates based on the 1987 census, made for the period 1985 to 1990 by the World Bank (1992a), were 49.5 years for females and 47.4 years for males. DEPDs (1992: 13) estimates were slightly lower at 46.7 and 50.0 years for males and females respectively due to the experienced upsurge of malaria.

Population distribution and migration

The increase of the national sex ratio from 90 males per 100 females in 1966 to 95 in 1987 reflects the reversal of the massive outflux of male workers in the 1960s which sought employment predominantly in the mining sectors of South Africa and the neighbouring countries Zimbabwe and Zambia. Restrictive employment policies adopted in South Africa and a less favourable economic climate in the neighbouring countries triggered a reversal of this flow in the late 1970s and the 1980s. Additionally, the change in the sex ratio reflects the

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4 House and Zimalirana also report about the prevalence of numerous other factors inducing high fertility, including early marriage (50% of all women are married at age 18 and almost all marry) and fast remarriage when divorced or widowed.

effects of the suspension of domestic labour recruitment for work in foreign countries in 1974 which effectively stopped international migration thereafter.

Major changes in sex ratios at the district level reflect the sex composition of interregional and inter-district migration patterns. Most migrants are young unmarried males or married males who seek employment and leave their families behind in the rural areas. Significant changes in the sex ratio at district level, that is values in excess of 100 by 1977 and thereafter, were experienced in three districts. Strong rises in the sex ratio in the main tobacco growing districts of Kasungu and Mchinji between 1966 and 1977 are explained mainly by the rapid expansion of the tobacco growing industry in the 1970s. Blantyre, which was the capital of Malawi until 1970, had historically a high sex ratio (110 in 1966) which declined only marginally to 107 in 1987.

Data from the 1977 and 1987 population censuses, which are shown in Annex 2-3 show three important migration patterns. First, with regard to interregional migration, the Southern region experienced net inflows of 3.3% and 3.5% (as percentage of the population in the census years) at the expense of the Northern and Southern regions which experienced net outflows of 4.8% and 3.9% and 1.3% and 1.7% respectively. Secondly, most migration movements took place between districts within regions rather than between regions. The implication of the second factor is that migrants prefer to remain within or close to their region of origin. Thirdly, the quantitatively predominant migration movement has been rural to rural rather than rural to urban.

Rural-urban migration at the national level accelerated between 1966-77 which contributed to an increase of the urban population share[5] from 4.7% to 8.3%. Between 1977 and 1987 census rural-urban migration slowed down. However the growth rates of the population in the major urban and small urban areas remained high relative to the overall population growth rate, resulting in a total urban population share of 10.6% in 1987. Relative to the population growth rate, urbanization increased by a factor of 2.4 between 1966 and 1987 albeit starting from a low base. Compared to the average urbanization rate in Sub-Saharan Africa of 27.2% in 1990 and especially in comparison to its neighbouring countries, Malawi's urbanization rate is still rather low.[6]

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5 Urban areas include all townships, town planning areas and district centres. An urban area need not be an administrative centre, but must have other facilities such as a police post or a post office in addition to trading stores and a market.

6 Urbanization rates for Malawi's neighbouring countries, that is Mozambique, Tanzania, Zambia and Zimbabwe, were 26.8%, 32.8%, 55.6% and 27.6% respectively in 1990, while Malawi's urbanization rate was estimated at 14.8% in the same year (UNDP/World Bank 1992: 317).

Among the major urban areas the largest city, Blantyre, is the commercial centre of Malawi, while Lilongwe is the political and administrative centre. The urban centres of Mzuzu and Zomba are treated as major urban areas more according to their size relative to the small urban centres rather than in terms of having true city characteristics.[7]

As shown in Annex 2-1, the national average population density has doubled between 1966 and 1987, reaching a value of 85 persons/km^2 in 1987. This makes Malawi one of the most densely populated countries in Africa. The regional average population densities (shares) in the Northern, Central and Southern regions were 34 (29%), 88 (39%) and 125 (50%) respectively in 1987. Population densities vary considerably in the Southern and Central regions. In the Southern region, the districts belonging to an area called 'Shire Highlands' have the highest population densities ranging from 171 to 293 persons/km^2. The second most heavily populated area comprises districts located in the Southern part of the Central region with densities ranging from 73 to 159 persons/km^2.

Government policy and economic determinants of internal migration

A crucial question for the analysis of household energy consumption patterns and the design of household energy policies is which factors have been driving the migration patterns in the past and, given the comparatively low present urbanization rate, whether a significant increase of rural-urban migration may take place in the future. The first question has to be evaluated in the framework of government policies related to urban-rural migration and the relationship between changes in the structure of the labour force and concurrent employment opportunities.

The main policy instrument of the Malawi government which aimed at stemming the influx of rural population into the urban areas was the National Wages and Salaries Policy which was introduced in 1971. The policy had the dual objective of keeping wages for unskilled and semi-skilled workers low so as to maintain the competitiveness of its industries, increase employment opportunities in the formal sector and contain the income gap between the urban and the rural sector (GOM 1969). Among the key policy instruments were the statutory minimum wage (SMW),[8] and wage level guidelines for non-skilled and semi-skilled workers in government, which were supposed to be observed by the private sector. The ratio of real minimum wages between these skill groups decreased continuously from 1.65 in 1970 to 1.26 in 1992 (World Bank 1993b: 24).

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[7] The characteristics of the major urban areas in Malawi are discussed in Chapter 7.

[8] The statutory minimum wage was in existence before independence and was differentiated by major urban areas and other urban and rural areas. Corresponding to these categories are consumer price indices which are constructed by the National Statistics Office on a monthly basis.

That most of the migration movements occurred within the rural areas suggests that the decline of this ratio is indeed representative of the wages which have been paid to non-skilled labourers. Supporting evidence for this suggestion was provided by a survey conducted by the Ministry of Labour (MOL) in 1990 (MOL 1990) and a recent study (World Bank 1993b) which addressed this issue in the context of an in-depth analysis of the labour market. The study of the MOL found that during the period 1988 to 1990 most employers complied with the minimum wage policy except for smaller estates especially in the tobacco sector for unskilled workers and that the rural SMW was also the maximum pay for 90% of the estate workers. The World Bank study found that the wage policy of large urban employers for entry level workers was to pay the SMW and that there was extensive non-compliance of small urban employers with the urban SMW.

Statistics about the growth of the labour force and the growth and sectoral structure of employment (World Bank 1993b: 7) show that the average annual growth rate of the urban labour force of 4.5% has slightly outpaced the weighted average annual growth rate of employment in the major urban-domiciled industry and service sectors. The estimated urban unemployment rate in 1987 of 4.5% indicates that some workers have been absorbed in the sectors agriculture, forestry and fishing. Constrained urban employment opportunities and the deteriorating ratio between urban and rural wages appear to have acted as a deterrent to rural-urban migration. An additional factor which may have acted as a disincentive for rural-urban migration is that the unemployment rate for the age and sex group which was found to migrate primarily, that is young males, was almost twice as high (9.4% for the age group 15-19 and 8.9% for the age group 20-24) as the average unemployment rate for males of 4.8% in 1987 (World Bank 1993b: 39).

The pattern of migration within and between regions is a response to a combination of income related pull and push factors, that is the search for employment opportunities and declining per capita land availability and farm income opportunities. In the Southern and Central regions, the net migration figures by district in the intercensal period 1977-1987 (see Annex 2-3) show a pattern of net outflows from districts with high population densities to districts with low population densities, whereby inflows into the latter districts are considerably higher for tobacco and particularly for burley tobacco growing areas.[9] Population densities and per capita land availability are correlated suggesting that land availability is a major factor inducing migration.

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[9] The interpretation of migration moves to and from districts in this paragraph and the calculations discussed in the next sections were based on the data shown in Annex 2-1.

However, there are remarkable differences among these regions. The ratio of population densities for districts with major outflows relative to those with major inflows in the Southern region was in the range between 2.0 to 3.5. The percentage of out-migrants in the total population of districts in the census year 1987 in the Central region (3.6%), where per capita land availability is higher than in the Southern region, was 50% lower than in the latter region. This reinforces the suggestion that scarcity of land is an important push factor and that the strength of this push is related to differential availability of arable land.

However, the migration pattern within the Southern region suggests that employment opportunities in the tobacco growing districts may have been an even stronger factor than differential land availability. About 94% of the migrants moved out of districts which have a ratio of population densities relative to the receiving districts of between 1.35 to 2.7. Even though no data are available from the 1987 census as to the final destination of the intra-regional migrants, employment data for burley tobacco estates in the Central region show that 79% and 13% of their labourers and tenants came from the Central and Southern regions respectively (Mkandawire et al 1990: 5).

In the Southern region, where the per capita availability of arable land is the lowest in Malawi, 40.6% of 246 000 migrants went to Blantyre district (28.8% into the rural areas and 11.8% into the city), 25.7% migrated into other regions and of the remaining 33.7%, 22.7% moved into tobacco growing districts with a below average population density of 86. The remainder moved, with comparable shares, to districts with low population densities ranging between 67 and 79 persons/km^2.

In summary, the main factors driving migration have been land scarcity combined with income opportunities in the fast growing estate sector. Whether a major shift in migration patterns towards increased rural-urban migration will occur in the future is dependent on the complex interaction between population growth, the implied growth rate of the labour force, economic growth and particularly the ability of agricultural policies to stem the trend of stagnant land and labour productivity in the smallholder sector. These factors are further discussed in Chapter 4.

2.2.2 Population projections[10]

Two main population projections were recently prepared for Malawi. These are projections made by the World Bank (1992a) in the context of the Malawi Population Sector Study and by the Population and Human Resources Development Unit of the Department of Economic

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[10] The remainder of this section is a summary of Annex 2-4, which contains a broader discussion of projection assumptions which are presented in the following and of macro- and micro-variables influencing economic fertility.

Planning and Development in 1992 (DEPD 1992). Given the recent vintage and the underlying in-depth analysis of existing demographic trends for these projections, they combined may be considered as a reasonable base for estimating a realistic range for population growth in Malawi.

Projection assumptions

Population projections in Malawi have to deal with a number of data shortcomings and future unknowns.[11] Among them, in addition to those related to the major forecasting variables of mortality and fertility, two major uncertainties relate to estimates for the human immune deficiency virus (HIV) prevalence rate and the demographic impact of an estimated number of Mozambican refugees of 0.94 and 0.33 million in 1987 and 1991 respectively (GTZ/UNHCR 1992: 3). These four variables are the main scenario parameters of the DEPD and World Bank projections. The underlying assumptions for these variables are reviewed in the following in order to identify whether any particular set of projections or scenario has specific merits.

Concerning the scenario parameter 'refugees', the World Bank assumed that all refugees would be repatriated within a few years, while DEPD considered scenarios with and without refugees. On account of limited data available about the prevalence and incidence of HIV in Malawi, the DEPD and the World Bank considered three and five different scenarios respectively. The World Bank scenario shown in Table 2-3 refers to the 'medium-threat' scenario. Regardless of the different assumptions used in both projections, it is important to note that the future impact of HIV prevalence in both population projections also differs because different projection methodologies are employed. The Bank used an epidemiological-demographic model, while DEPD used the Demographic Projection Model (DEMPROJ)[12] and relied on exogenous assumptions as to the spread of HIV. Because both projections focused on fertility rates, only one mortality scenario was used. The much larger uncertainties related to the future development of fertility rates were captured in three fertility scenarios (constant, moderate and strong decline). Differences between these scenarios rely mainly on different assumptions about the governments commitment and investment in population control measures and programmes, contraceptive use and socio-economic trends. For the last projection period the total fertility rate (TFR) assumptions in

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[11] These problems are discussed in detail in DEPD (1992: Chapters 1-3).

[12] The DEMPROJ population projection model was developed by the Futures Group, Washington, DC, USA. The model uses the standard cohort component method. A description of the model is given in Futures Group (1990).

fertility scenarios 'moderate' are both about 6.8 and vary only slightly in the rapid decline scenario (DEPD-TFR: 5.8; World Bank-TFR: appr. 5.2).[13]

Population growth scenarios and results

Lower base assumptions as to the existing HIV prevalence in the 'medium threat' scenario which was coupled with the fertility scenarios leads to higher population growth rates in the World Bank study compared to the DEPD projections, while the DEPD assumptions concerning the repatriation of refugees result in a higher estimation of future population growth. However, even if current HIV infection levels were known with more accuracy, long term impacts of the acquired immune deficiency syndrome (AIDS) on mortality and population growth could vary tremendously on account of uncertainties related to variables which determine the future course of the epidemic (World Bank 1992a: 6). These uncertainties as well as uncertainties related to the future TFRs make it extremely difficult to assign superior predictive quality to any specific scenario. Yet it has to be taken into account that the constant fertility and the rapid fertility decline scenarios were deliberately constructed to ascertain lower and upper bounds for future population growth.

Population growth projections are not an end in themselves but are made to analyze the broad socio-economic implications of alternative scenarios for planning and policy in all sectors. Based on the above discussion, results from selected population scenarios which best capture the likely range of the population development are shown in Table 2-1. The DEPD figures refer to the year 2002, while the World Bank figures refer to 2005.

TABLE 2-1 Projected population of Malawi in 2002 and 2005 (millions)

Source:	*Department of Economic Planning & Development*					*World Bank*
Scenario:	*No refugees*	*No refugees*	*No refugees*	*Refugees with AIDS*		
Scenario parameters						
AIDS	*None*	*Worst case*	*Best case*	*Worst case*	*Best case*	*Yes*
Constant fertility	12.87	12.14	12.38	13.49	13.76	14.12
Moderate fertility decline	12.49	11.78	12.01	13.10	13.35	13.69
Fast fertility decline	12.02	11.32	11.54	12.59	12.84	12.59

Source: DEPD data from DEPD 1992, Tables 3, 4 & 6. World Bank data from DEPD 1992, Table 9

The most interesting result of comparing the main scenarios is the large variation in the final outcomes until 2002. Even under the assumptions of the lowest and less realistic scenario, the average annual population growth rate would still remain significant at 2.2%. Within the more likely context of a moderate decline in fertility levels combined with the

[13] The World Bank data for 2002 were interpolated. See DEPD (1992: 12, 37) for a description of the total fertility rate scenarios for both projections.

reality of the HIV/AIDS epidemic in the country, population growth rates of around 3% or more are likely to prevail until 2002. This represents in absolute figures an increase from 7.98 million in 1987 to at least 12 million people in Malawi even if most of the refugees were repatriated.

Linkages between rural fertility and natural resource degradation

With regard to the fertility behaviour of rural families, an important issue is whether there exist linkages between natural resource degradation, including declining fuelwood availability and access to other forest resources, and fertility changes. Dasgupta (1992: 99) has suggested that such a relationship may exist, where, given household labour constraints, the labour contribution of children to cope with household chores such as fuelwood and water collection and other activities, may become crucial for survival. As shown in Chapters 3 to 6, the conditions which need to exist to potentially create such a linkage, can be considered to exist in many areas of Malawi. However, the available data are too aggregated and insufficient to test this hypothesis.

2.3 ECONOMIC DEVELOPMENT AND THE HOUSEHOLD ENERGY SECTOR

In Chapter 1, the different levels of planning and their integration within INEP were discussed. Within this framework, national development strategies and sectoral policies, including energy and household energy policies are interdependent and need to be coordinated. Section 2.3.1 provides an overview of Malawi's economy, main development strategies and recent economic performance. Section 2.3.2 starts with a brief introduction of the energy and household energy sector of Malawi. This is followed by a discussion of the relationships between macroeconomic development policy and household energy policy, combined with an introduction to household energy policies of Malawi.

2.3.1 Macroeconomic development policy and household energy issues

The relationship between development policies and household energy issues and policy is largely determined by the impacts which development policies have on the variables that determine household income and on associated changes in access to land, land-use and the quality of natural resources. These changes are particularly important for the smallholder households which are most affected by such changes because of their stronger reliance on these resources. In the following the interaction between the economic development strategy which was pursued in Malawi since the country gained independence in 1965 and the growth and income performance of the economy is analyzed. In a country like Malawi, where 90.3% of the total population and 92% of the labour force resided in the rural areas in 1987 (NSO 1991: 20), agricultural development policies and agricultural growth are closely related to the country's overall economic performance. Therefore the linkages between the development of the agricultural sector and the household energy sector are emphasized.

Overview of the economic development in Malawi

A detailed analysis of the economic development process and major policies which are relevant for household energy policy is discussed below. For introductory purposes, the main features of the economy and relevant policies, are summarized.

Real per capita growth in Malawi has been almost stagnant since the early 1980s. The agricultural sector was the main source of growth of the Gross Domestic Product (GDP) contributing more than 80% to the foreign exchange earnings of the economy. The agricultural sector consists of the estate sector which produces most of the export goods (tea, tobacco and sugar) and the smallholder sector, which had between 1.7 to 1.8 million households in the early 1990s.

Except for the agro-processing industry and limited textile industry production, no major manufacturing industries have been developed in the country. This is due to the relatively low level of education of the workforce and Malawi's geographical location where long transport distances to ports in Tanzania and Mozambique constitute an important cost disadvantage for developing an export-oriented manufacturing sector. Thus the development of the manufacturing sector concentrated mainly on the substitution of imports.

Since the 1960s growth policy has focused mainly on the estate sector. Smallholders were excluded from the production of the lucrative burley tobacco until 1989. Attempts to develop the productivity of the smallholder sector included large-scale rural development projects, which had a rather mixed success. Since the late 1980s, economic policy started to focus more on the development of the smallholder sector, because the economic growth rates in the estate sector started to show signs of weakening and the productivity of major crops in the smallholder sector, where the majority of households are poor (see Chapter 4) was stagnant or even declining. A number of factors have contributed to declining agricultural productivity, including the continuous fragmentation of land, production on less suitable agricultural land (see Chapter 3) and difficult access to productive inputs (see Chapter 4).

Economic development strategy

Since the country gained independence in 1965, Malawi's growth strategy was based on a combination of an export-led agricultural strategy and an industrialization policy based on import-substitution (Kadyampakeni 1988).

The agricultural development strategy was formulated on the background of an extremely narrow export base. The data in Table 2-2, which are also depicted in Figure 2-3, show that between 1965 and 1970 four agricultural export commodities, that is tobacco, tea, groundnuts and cotton, earned about 80% of total export income. This situation implied a high degree of vulnerability of export earnings to changes in the terms of trade. In principal, growth and diversification of export crops in the agricultural sector could have involved both the smallholder and the estate sub-sectors. However, based on the premise that smallholder production of export cash crops was generally less efficient compared to the estate sector, the latter sector was considered as the main engine of agricultural growth and export expansion. This premise resulted practically in the implementation of agricultural policies which continued to maintain the dualistic structure of the agricultural sector which was inherited from colonial times. Duality was economically characterized by an estate sector producing most of the cash and export crops and a smallholder sector producing mainly food crops (Sahn & Arulpragasam 1991). Other important aspects of the dualistic structure were that both agricultural sub-sectors were subject to different legal, policy and institutional circumstances with regard to land tenure, crop production and marketing opportunities and producer prices. This framework clearly had a restraining impact on the production possibilities and income generating potential of the smallholder sub-sector (UNDP 1993).

TABLE 2-2 Composition of domestic exports: 1965-1992 (in per cent)

Crop	*1965-69*	*1970-74*	*1975-79*	*1980-84*	*1985-89*	*1990-91*	*1992*
Tobacco	32.3	43.9	52.1	50.8	59.2	73.1	74.2
Tea	28.3	21.7	20.1	19.4	13.7	9.6	7.6
Sugar	0.1	4.4	10.8	12.2	9.9	6.5	7.0
Groundnuts	14.5	9.3	5.4	2.5	2.0	0.1	0.0
Cotton	5.5	4.1	1.1	0.7	1.1	1.8	1.2
Other	19.4	16.6	10.5	14.4	14.2	8.8	9.9

Source: Financial and Economic Reviews; Economic Report 1993

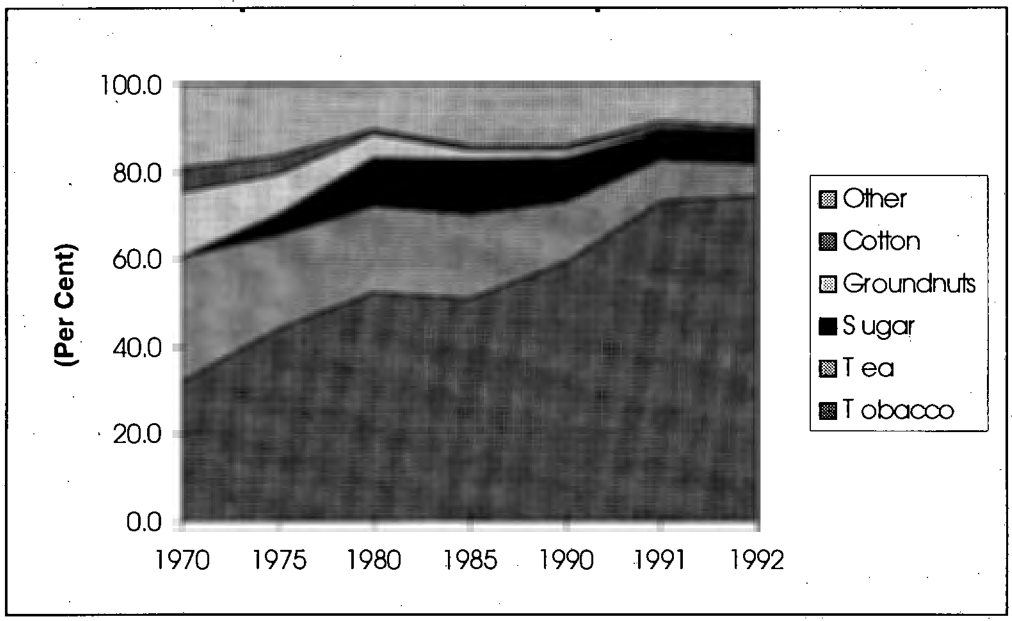

FIGURE 2-3 Composition of domestic exports 1970-92

Agricultural policies reinforced the existing dual structure specifically by discriminating against smallholders with regard to their choice of crops, access to agricultural inputs and opportunities to market surpluses. Smallholders were prohibited through a licensing system to participate in the production of the higher value-added crops such as flue-cured and burley tobacco. They were also paid producer prices for cash crops by the Agricultural Development and Marketing Corporation (ADMARC) which were substantially below export parity prices,[14] while estates could sell their output directly at border prices (Kydd & Christiansen 1982; Shaw 1988; Lele 1987). The producer pricing policies therefore limited the real income growth of those farmers who produced a surplus and also implied a development bias towards the urban sector who benefited from this policy through low consumer prices for maize. Christiansen and Kydd (1987: 20) calculated that between 1972 and 1981, 76% of ADMARCs profits from the implicit taxation of smallholders were channeled through direct investments and loans to the estate sector.

Economic growth performance between 1965 and 1979

The overall economic growth performance of Malawi between 1965 and 1979 was favourable with an average real growth rate of 5.7%. The real average growth rate of the agricultural sector was 4.0%, which was composed of a 9.5% growth rate in the estate sub-sector and 3.4% in the smallholder sector, while industry, private services and government services grew at 7.5%, 8.2% and 4.4% respectively (CODA 1993: 2-6). Thus, the estate sector was the leading source of growth as envisaged in the agricultural development strategy, but

[14] Throughout the 1970s, the producer prices paid by ADMARC for smallholder tobacco averaged 20 to 30%of export prices (export unit values) at which ADMARC sold into the international market. The implicit taxation resulted in large profits for ADMARC (Gulhati 1989: 21).

the growth in the smallholder sector was only slightly above the population growth rate of 3.0%. The estate sub-sector accounted almost entirely during the period 1968-79, for the growth in agricultural exports (Christiansen & Kydd 1987).

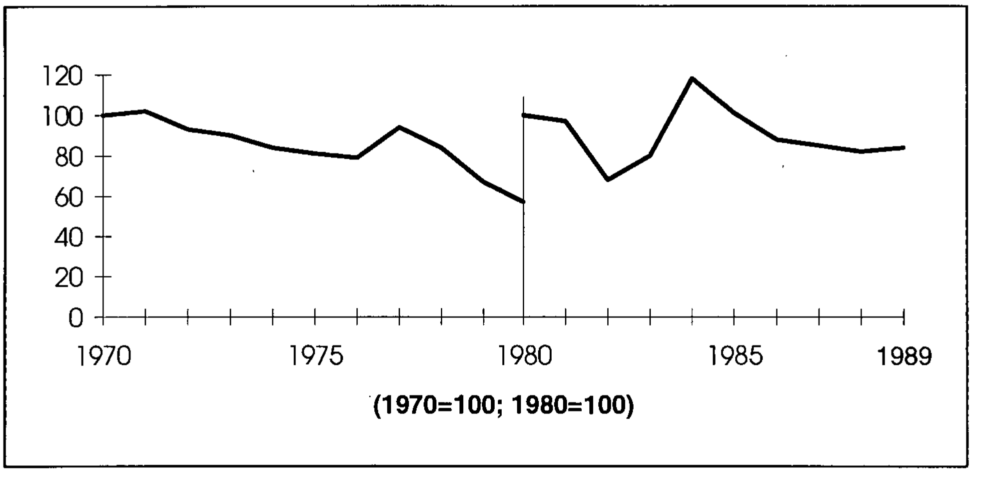

FIGURE 2-4 Development of terms of trade 1970-1989

Despite the favourable growth development until 1979, the economy remained vulnerable to the impact of external factors such as the changes in the terms of trade, which showed a deteriorating trend in the 1970s as shown in Figure 2-4. Compared to the period 1965 to 1970 when the average share of agricultural exports was about 82%, this share increased to 89% in 1979 with a strongly increasing share of tobacco exports (see Figure 2-3). Droughts in 1980 and 1981, combined with other adverse external developments which occurred between 1978 and 1981, brought the favourable overall growth performance to a halt in 1980 when GDP growth slowed down to 0.5% and then declined by about 5% in 1981.

The balance of payments crisis which Malawi experienced in 1979 to 1981 was partly induced by the growing deficit of the current account balance which was due to the deterioration in the terms of trade of the major export commodities and the decline of net foreign capital inflows (excluding overseas development assistance). Other external factors contributing to balance of payments problems and a decline in economic growth was the surge in international interest rates which started to increase from a level of 6.5% in 1977 to a peak of about 16.5% in 1981 and only broke again through the two-digit level in 1985. Higher interest rates resulted in considerably higher service cost of the external debt which had been accumulated during the 1970s and which assumed a constantly rising share of GDP.

Total gross domestic investment and savings peaked in 1978 and declined sharply between 1979 and 1981 and thereafter. The ratio between the resource gap, that is total investment less domestic savings, and total investment has been increasing since 1977. The major share of the resource gap was financed externally by the government which led to a sharp increase of government debt service and thus contributed to a deterioration of the government budget deficit. The budget deficit as a percentage of GDP (in constant 1978 prices) jumped from a manageable level of between 5 to 10% between 1971 and 1979 to around 16% in 1980 and 12.5% in 1981 (Economic Report, various issues).

Structural adjustment and economic performance since 1980

The structural constraints to growth, that is the narrow export base, the limited participation of the smallholder sub-sector in export crop production and stagnant growth in the sub-sector, as well as rising external debt and balance of payments difficulties called for a rethinking about the adequacy of the past development strategy, particularly with respect to the smallholder sector. Additionally, the country's dependence on oil imports and the reliance on woodfuels and concerns about deforestation emerged as a long-term development problem (Kydd & Hewitt 1986).

With respect to the agricultural development policy since independence until 1980, Kydd and Christiansen (1982) came to the conclusion that the standard of living of the smallholders had deteriorated during this period and that a change of the policy bias against smallholders, including the introduction of adequate pricing policies, should be put onto the policy agenda. Similarly, the integrated rural development projects for smallholders, which started in the early 1970s, were abandoned in 1978 and then replaced by the National Rural Development Programme, were judged by Mwakasungura (1984) as a failure because they were expensive and did not improve the welfare of the rural population.

Three structural adjustment loans (SAL) were extended to Malawi in 1981, 1983 and 1985 plus one supplementary loan in 1987. These loans were primarily intended to finance imports while the associated structural adjustment programmes (SAP) were addressing the above-mentioned structural growth constraints and internal fiscal and balance of payment problems but emphasized different aspects of these problems over time. The central objective of the first structural adjustment loan which was adopted in 1981 (SAL I), was to restore economic growth by diversifying the foreign exchange earnings base of the agricultural sector through the introduction of new crops whereby the smallholder sector was intended to assume the leading role. This objective was tantamount to a rapid commercialization of the smallholder sector which was intended to be facilitated by gradually removing the existing constraints to the improvement of agricultural productivity and income. Consequently, the cornerstone of the agricultural policies initiated under SAL I to effect this change consisted primarily in the gradual removal of price distortions. This involved the simultaneous increase of producer prices to provide production incentives and the removal of fertilizer subsidies which were putting a financial strain on ADMARC.[15]

To promote agricultural exports, devaluation of the highly overvalued currency was imposed under the SALs as well as restrictions on foreign exchange to curb imports and thereby to improve the current account balance.

The adequacy of the policy measures, which were taken in the context of the structural adjustment programmes to address the structural growth problems of the economy and their impacts on income distribution and poverty in the 1980s, have been analyzed in-depth by several authors. For the purpose of analysis in this chapter, the implications for the resulting overall income development and the insights gained with regard to the role of pricing and non-price policies, are of prime interest because of their bearing on household energy consumption and woodfuel policies.

The SAPs had a rather mixed success, at least until 1987 when more steady growth was resumed in Malawi. Figure 2-3 demonstrates that policies to diversify the export base have not been very successful. The share of agricultural exports in total exports remained virtually unchanged compared to the 1970s, but the increased reliance on tobacco exports also increased the vulnerability of the economy to changes in the international tobacco market. Due to the stagnant growth in the agricultural sector, export earnings have not been sufficiently increased to avoid growing trade deficits. The balance of payments situation has shown some improvement since 1987, except for 1992, which was a severe drought year. As a result, the external debt position only started improving since 1987, although the decline in the external debt since 1987 was primarily facilitated by the restructuring of Malawi's debt in 1988.

The growth performance of the principal sectors of the economy between 1973 and 1992 is shown in Table 2-3 and depicted in Figure 2-5. They show that the composition of GDP remained largely unchanged. Except for the extreme drought year 1992, agriculture accounted on average for 37% of GDP. Manufacturing growth contributed an average of 12.6% to GDP and remained virtually unchanged during this period. Small shifts among other sectors were mainly due to the strong growth rates in government services between 1980 and 1987. However, as in the 1970s, the most significant structural change took place again within the agricultural sector. The GDP share of the smallholder sub-sector declined

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[15] A review of the policy objectives and policies introduced under SAL I and SAL II, and their respective performance, is discussed in the study by Kydd and Hewitt (1986). The major difference between SAL I and SAL II was that the latter emphasized policies related to the improvement of public finance and balance of payment difficulties.

from 29.1% in 1981 to 25.5% in 1991. Conversely, the estate sector which remained the main source of growth, increased its share in GDP from 6.9% to 9.3% during the same period and reached an unprecedented share of 11.0% in 1992.

The total real average economic growth rate of the economy between 1981 and 1991 was 3.85%. It was only marginally outpacing the accelerating population growth during the 1980s which ranged between 3.3 and 3.6%.[16]

The economic growth rates underlying the slight shifts in the structure of GDP show that growth rates of the smallholder sector remained relatively stagnant and could not keep pace with the population growth rate. For reasons further explained below, pricing policies which intended to shift the cropping pattern of the smallholder sub-sector from local maize varieties to cash crops, were unsuccessful. The total cropping area planted to low-yielding maize varieties increased from 67.2% to 76.5% from 1983/84 to 1990/91, while the total cropping area planted to higher yielding maize varieties increased from 7.2% to 12.7% during the same period (MAS 1993: Tables 2.4-2.6). Other crops, mainly groundnuts and cassava, were displaced for maize crops because the total area cultivated in the years compared remained virtually constant. Despite the increasing share of higher-yielding maize varieties in the total maize area planted and an estimated increase of fertilizer use by 58%[17] during this period, the land productivity for maize production, as measured by the average combined yield for all maize varieties, has not increased and possibly declined (MAS 1993: Table 2.3). Stagnation of land productivity for almost all other smallholder food and cash crops can be observed in the Malawi Agricultural Statistics (MAS 1993: Table 2.3) for the same period.

The blame for a relatively poor general performance of the economy and particularly of the smallholder sector in the 1980s cannot be entirely attributed to the design of the SAPs, on account of three factors. First, the economy was hit by a dramatic rise in transport costs due to the closure of Malawi's main rail link to the sea port of Beira in Mozambique, leading to an abrupt increase in import costs. This external shock had lasting negative impacts on agricultural production, export revenues and overall economic performance (Van Frausum & Sahn 1991). Secondly, droughts in 1986 and 1987 hampered growth of the agricultural sector and thus overall economic growth. Thirdly, and most important, the failure to

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[16] See the discussion in Section 3.3.

[17] The actual increase of fertilizer sales was 88%, that is, from 74 759 tonnes to 140 300 tonnes between 1983 and 1989. Sales and use of fertilizer by smallholders differ because of leakages (resales) to the estate sector. The extent of leakage has been subject to considerable controversies. The figure for the increase of fertilizer use has been based on the assumption that leakages amount to about one-third of total sales.

increase the productivity and income of smallholders was partly due to weaknesses in the design of the policy packages and partly due to their inconsistent implementation.

TABLE 2-3 Gross domestic product: 1973-1992 (MK million at 1978 prices)

	1973	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*
Agriculture:										
- Estates	29.6	32.2	38.9	39.4	47.5	48.6	51.3	53.0	50.4	61.7
- Smallholders	194.0	196.0	191.4	218.2	239.0	246.3	252.8	231.2	210.6	215.9
Total	223.6	228.2	230.3	257.6	286.5	294.9	304.1	284.2	261.0	277.6
Industry	99.2	106.9	125.8	121.7	127.9	143.5	144.4	146.5	142.2	142.4
Government services	51.1	56.9	58.2	61.2	64.0	67.2	72.3	78.4	83.3	87.9
Private services	171.6	194.1	204.2	216.5	207.1	236.9	246.4	255.2	237.9	237.2
GDP at factor cost	545.5	586.1	618.5	657.0	685.5	742.5	767.2	764.3	724.4	745.1

	1983	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
Agriculture:										
- Estates	66.1	65.5	66.0	65.4	70.1	75.2	82.6	90.2	98.5	106.7
- Smallholders	223.8	240.9	242.0	244.5	242.4	243.6	244.0	235.6	269.0	168.3
Total	289.9	306.4	308.0	309.9	312.5	318.8	326.6	325.8	367.5	275.0
Industry	147	146.3	157.4	154.6	158.7	167.8	181.2	198.1	205.9	211.5
Government services	92.2	101.7	108.2	118.0	134.5	142.6	143.3	145.3	149.8	154.8
Private services	242.1	251	267.8	268.1	264	269.1	283.7	310.2	332.5	330.8
GDP at factor cost	771.2	805.4	841.4	850.6	869.7	898.3	934.8	979.4	1055.7	972.1

Source: Statistical Yearbooks; Financial & Economic Reviews; Economic Report, 1993

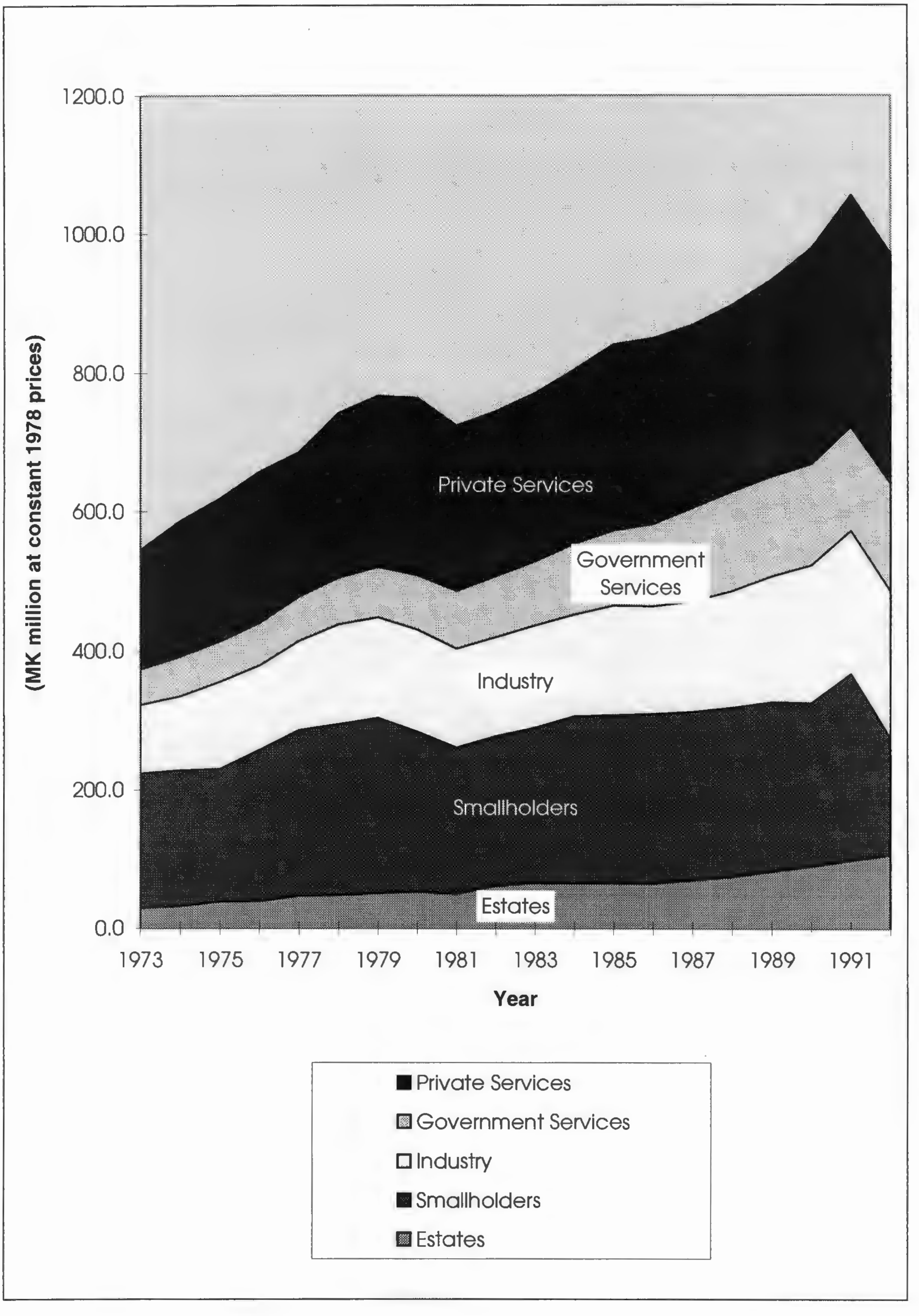

FIGURE 2-5 Composition of gross domestic product 1973-1992

Concerning the latter issue, the main criticism raised by several agricultural policy analysts was that producer price and input price (seeds and fertilizer) increases were poorly defined objective (Sahn & Arulpragasam 1991). Producer prices for cash crops were raised several times in the 1980s but the trend to increase producer prices for maize, the main staple food crop for all smallholders in Malawi, more than for cash crops, had negative impacts on the adoption of export crops by smallholders. Because the majority of smallholders are net purchasers of maize (see Chapter 4), the shift in relative prices benefited net maize producers but had negative income effects on net maize consumers and accelerated the abandonment of export crops in favour of maize (Kydd & Hewitt 1986).

One main reason for the poor implementation of changes in input and output prices was that there was an inherent conflict between the emphasis of the World Bank on the promotion of cash crops and the concern of the GOM about the impact of higher prices for maize and other food crops on the food security of rural households (Harrigan 1988). As suggested by Harrigan (1988), this problem could have been overcome by a better sequencing of policies and more emphasis on other policies to improve smallholder productivity prior to the implementation of producer price incentives. This latter issue, that is the lack of addressing sufficiently the microeconomic non-price constraints (extension, access to credit, improved storage and transport, land constraints) or, vice versa, the overemphasis of the SAPs on pricing policy measures, has been identified by many researchers (Lele 1987; Mosley & Smith 1989; Sahn & Arulpragasam 1991; Harrigan 1988) as the prime reason for the failure of the smallholder sector to increase agricultural productivity and to produce more cash crops.

Further analysis of these constraints and their role for the analysis of peasant decision-making behaviour is conducted in Chapter 4. It is also important to point out that the design of woodfuel policies which were implemented since the early 1980s in Malawi and which partly aimed at increasing the production of wood as a smallholder cash crop, shared the same assumptions about the responsiveness of farmers to price incentives. The implications of this perspective are discussed in Chapter 6.

The overall implication of the growth performance of the economy since 1981 on real income as measured by GNP per capita is shown in Figure 2-6. Modest declines and increases alternated during this period. The 1980 income level was only attained again in 1991 before the severe drought in 1992 led to an unprecedented level of income decline. The overall income development masks however the strong divergence of income trends between the major socio-economic groups, that is smallholders in the rural areas and formal sector wage earners both in the agricultural sub-sectors and urban areas. The income development of these groups is associated with several data and conceptual problems.

These are discussed in Chapters 4 and 7 respectively in the context of household income analysis.

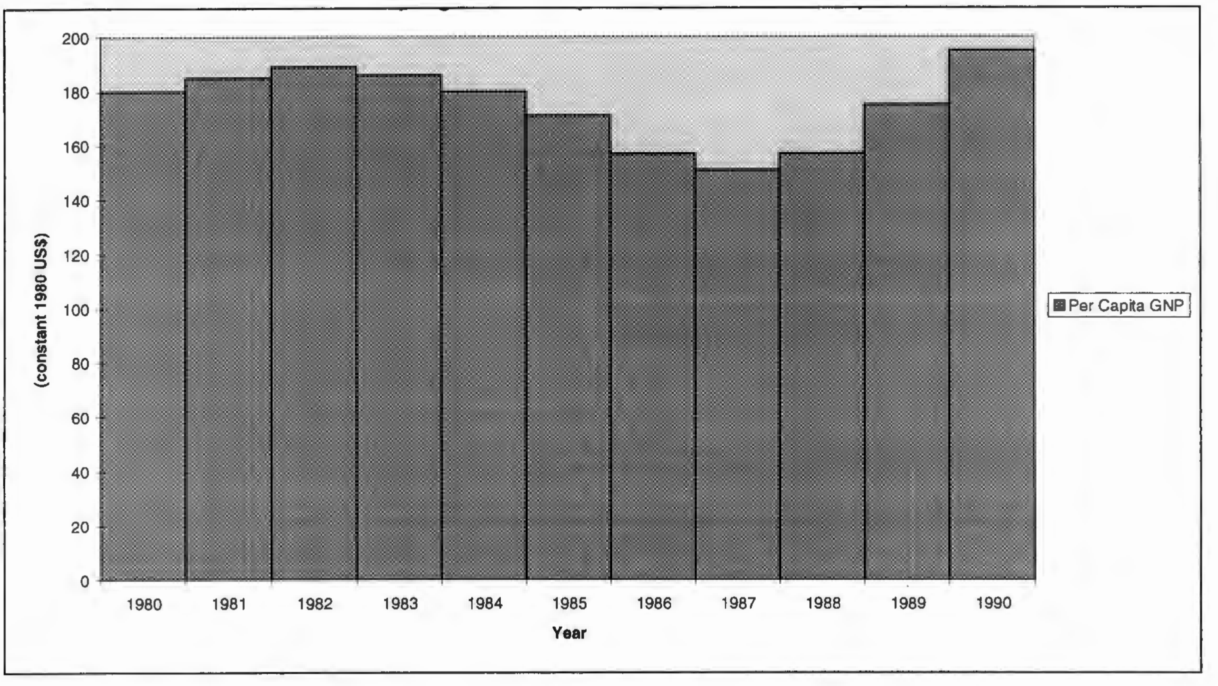

FIGURE 2-6 Per capita gross national product (in constant 1980US$)

Even though structural adjustment programmes genuinely have a long-term perspective, they did not directly address the problem of the high population growth rate in Malawi which put considerable financial strain on the fiscal resources of the country. To the contrary, the fiscal policies adopted to restore healthier government finances had negative impacts on parameters which co-determine fertility behaviour such as education and health. Government consumption as a percentage of GDP increased from about 13% in 1981 to about 25% in 1987 and then slightly decreased to about 22.5% in 1991.[18] Expenditures during this period did not keep pace with revenues which required increased debt financing. This in turn increased the share of public debt financing from 27.4% to a peak of 40.1% in 1988 with a subsequent decline to 29.1% in 1992. As a result of the pressure on the budget deficit, the share of social services (education, health and community and social services) in recurrent expenditure (in nominal terms) which was 21.3% in 1981 has averaged 18.6% between 1981 and 1992, and reached an historical low in the drought year of 1992 with 16.2%. In real per capita terms (in 1992 constant prices) total social expenditure, that is recurrent and development expenditure, declined from 1983/84 to 1991/92 from MK47.5 to MK36.5, a drop of nearly 24%.

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[18] These and the following data in this section are based on data contained in the annual issues of the *Economic Report* which is published by the Department of Economic Planning & Development.

2.3.2 Overview of the energy and the household energy sector in Malawi[19]

Malawi's energy reserves comprise minor quantities of coal in the existing mining areas (approximately 2.0 million tonnes) and an additional hydroelectric potential of about 7.0 Terawatt-hours (TWh), and fuelwood.

Energy production, other than fuelwood and charcoal, is based on the mining of small quantities of coal from two mines in the Northern part of the country and electricity is hydro-based, except for some small diesel stations. Coal is mainly consumed by the textile and agro-processing industries which also import smaller quantities from Moatize in Mozambique. All liquid fuels (mainly diesel, petrol and kerosene) are imported using a diversified import system, including imports from South Africa, Mozambique, Tanzania and Zimbabwe due to supply security concerns. Energy imports make up about 65% of commercial energy consumption.

Of a total consumption of commercial energy of 9.6 Petajoules (PJ) in 1990, 42.4% was consumed in the transport sector, 20% in the industrial and mining sector, and 8.4% in the household sector. The agricultural sector consumed 11.9% of the total commercial energy, virtually all of which accrued to the estate sector, because the smallholder sector is not mechanized. Commercial energy supply is dwarfed by the supply of traditional fuels, that is fuelwood and charcoal, which contribute about 91.0%[20] of total energy consumed in the country.

A detailed analysis of woodfuel supply and demand for 1990 is carried out in Chapter 5. Woodfuels are mainly consumed by households and by the tobacco industry. As discussed in Chapters 6 and 7, rural households mainly consume fuelwood and small quantities of kerosene and agricultural residues, while urban households consume mainly fuelwood and virtually all the charcoal produced in the country, in addition to limited quantities of paraffin and electricity. Thus household energy use is dominated by woodfuels. Coal is practically not consumed in urban households, because the coal quality is only suitable for industrial heat applications and coal prices are not competitive with other fuels.

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[19] The data quoted in this sub-section are from the energy statistics presented in *SADC energy cooperation policy and strategy* (SADC 1996: 36).

[20] The supply and consumption of the main agricultural residue, that is maize stalks and cobs, is estimated in Chapter 5.

2.3.3 Linkages between the household energy sector and national development goals

Concerning the relationship between household energy and macroeconomic and social development objectives, there are four main linkages and issues which are of prime relevance to the formulation of household energy policy. These are:

- financial impacts
- impacts on economic growth
- rural-urban equity considerations
- intra-urban equity considerations

Financial impacts

Financial linkages between the household energy sector and the macro-economy exist mainly with regard to the requirements for long-term investments in energy supply infrastructure and the impact of energy imports which are attributable to household energy demand on the balance of payments. Balance of payments impacts reflect changes in household energy consumption patterns, that is the substitution of woodfuels either by commercial fuels or conversely greater reliance on woodfuels and inferior energy forms such as agricultural residues. Changes of household energy consumption patterns toward commercial fuels or deepened reliance on inferior traditional fuels are referred to as upward substitution and backward substitution, respectively. This fuel substitution process is to a large extent driven by the economic growth process and the associated development of real incomes. The rate of this fuel substitution process at comparable real income levels is generally faster in urban than in rural households. The difference in income elasticities of demand for commercial fuels of these two consumer groups can be mainly attributed to their differential access to liquid commercial fuels and electricity (see Chapters 5 and 7).

Incorporating the household energy sector into the macroeconomic framework by estimating, for example, the financial impact of woodfuel displacement by liquid fuels on the current account and balance of payments, may be a useful exercise to demonstrate the financial importance of the woodfuel sector in terms of foreign exchange saved and hence the consequences of undervaluing woodfuels in the national accounts (Peskin et al 1991: 4). However, as pointed out in the *Review of policies in the traditional energy sector* - overview of *past activities and main issues* (World Bank 1993a: 9), such calculations refer to rather hypothetical future situations. The point is that the 'what if' question posed in this approach yields a rather abstract or indicative figure about the order of magnitude of possible fuel import requirements in a future year which cannot be quantified with much precision because of the complexities involved in the transition process.

Therefore, for practical household energy policy and planning purposes the analysis of scenarios which address the linkages between economic growth, real income development and other determinants and constraints which determine the interfuel substitution process and which track this process over time, are more relevant because the management of the transition process is the prime interest of policy and decision makers.

The *Statement of Development Policies 1987-1996* (DEVPOL 1987) which was issued by the Government of Malawi (GOM) in 1987 outlines the country's national development strategies and policies and their implementation through sector strategies and policies. In the energy policy section of DEVPOL high energy costs are mentioned as a constraint to economic development. In 1987 commercial fuels (petroleum products and coal) were estimated to supply only 8% of total primary energy consumption (DEVPOL 1987: 73) but their import costs were equivalent to 17% of total export earnings (NEP 1990: 45). Therefore the 'minimization of oil import costs by utilizing the least-cost supply sources ... available to Malawi' (DEVPOL 1987: 72) was adopted as the main energy policy strategy. This strategy formulation emphasized the substitution of petroleum products by mobilizing competitive domestic energy supplies rather than a policy which put a premium on foreign exchange reserves and which aimed at curtailing oil product imports at the cost of economic efficiency.

The impact of commercial energy consumption by households on foreign exchange income or the balance of payments was not identified as a major policy issue in DEVPOL or the National Energy Plan (NEP) which covered the planning period 1988 to 1997. This was due to the fact that consumption of imported petroleum products by households in Malawi is confined to rather low levels of kerosene consumption (see Chapters 4 and 7). Kerosene[21] is consumed mainly by urban households. The share of total kerosene imports in total export earnings declined from 1.0% in 1983 to 0.3% in 1992.[22] About 20% is consumed by households.

Potential impacts on sustainable economic growth potential

Long-term impacts of the household energy sector on economic growth and the objective of sustainable economic development may be perceived in terms of the potential impacts of both urban and rural woodfuel consumption on deforestation and its implications for environmental and economic resource degradation. As discussed by Serafy and Lutz (1989),

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21 In official government publications and statistics in Malawi the terms 'paraffin' and 'kerosene' are often used interchangeably. This practice has been adopted in this work.

22 Percentages were calculated using import and export data from the Monthly Statistical Bulletin (MSB), February 1993 issue which is published by the NSO.

the traditional system of national accounts (SNA)[23] which is used for income accounting is considered as useful for measuring short- to medium-term changes of national economic activity and hence for demand management and stabilization policies. However, the measures of national income such as gross domestic product (GDP), net domestic product (NDP), gross national product (GNP) or net national product (NNP) are not able to capture adequately long-term sustainable national resource use. This is due to the erroneous accounting of defensive expenditures to protect or restore the environment as final expenditure in the traditional SNA and the fact that the degradation or depletion of natural resources is not accounted for as a charge against current income to reflect the depreciation of natural assets (see Bartelmus 1989).

In this context, deforestation and forest destruction involves both real and potential long-term direct and indirect costs such as the deterioration of watersheds through soil erosion, and the reduction of the sustainable supply of forest resources and ecosystem services (biodiversity). In countries where the existing database has not been sufficiently well established to value natural asset depreciation and external or defensive costs, the long-term economic costs of deforestation may only be guessed in very broad terms. The absence of reliable cost estimates has implications for integrated economic development and energy and household energy planning because natural resource accounting can be considered as a tool which contributes to decision-making about investment priority areas and the allocation of environmental and environmentally-related investments.

Household energy related strategies and policies, which are separately discussed in DEVPOL in the forestry and energy policy sections, were not based on any quantitative assessment of the long-term economic costs of deforestation in terms of the valuation concepts and accounting conventions which have been proposed to deal with this matter. This was due to the lack of adequate data and the fact that conceptual work to integrate environmental and resource accounting into the traditional SNA only started in the early to mid-80s and is still under development. Rather, woodfuel and forestry policies were based broadly on concerns related to the effects of land degradation such as soil erosion in water catchment areas and concerns about the impact of deforestation on future woodfuel supplies.

The woodfuel policy which was outlined in DEVPOL was developed on the background of the assumption that the annual average deforestation rate was about 3.5%, with even higher rates assumed to exist in certain areas. The estimated high deforestation rate and associated

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[23] The notion of 'traditional' national accounts refers here to the accounting principles and concepts of the conventional United Nations System of National Accounts which forms the basis for national accounting in most countries including Malawi (see NSO 1985: 1).

environmental concerns resulted in woodfuel and forestry policy being declared as a priority policy area. The objective of the NEP was to establish an energy policy agenda and to support the implementation of strategies and policies in other sectors. However, due to data limitations, the NEP was not able to address in depth the implications of household energy use, particularly of woodfuel consumption, on economic growth. Due to the same reason and methodological shortcomings, the NEP produced gloomy deforestation scenarios which were essentially based on linear assumptions between population growth and woodfuel consumption. Thus the forecasting methodology relied fundamentally on those assumptions which have come under severe attack in the criticism of the woodfuel gap theory. As a corollary to this, the woodfuel policy continued to perceive household energy consumption as the main contributor to deforestation in the country.

The issue of which woodfuel consuming sectors contribute how much to deforestation and who bears the costs of resultant environmental degradation is a separate sub-sectoral issue which is clearly crucial for effective policy design. In this context, Peskin (1989: 73) has noted that environmental damage caused by households is inflicted upon the household sector itself (because of its large reliance on environmental services from the afflicted resources) compared to environmental damage caused by the industrial and public sectors, which tend to produce external effects, the costs of which are borne mainly by other resource users. With regard to the question of the relative impact of household energy woodfuel use on economic growth as compared to the impact of other sectors, Peskin's statement bears no *a priori* implication for woodfuel policy because this question can only be resolved empirically. However, the simple fact that rural households are more reliant on forest resources and products than their urban counterparts introduces the important link between household energy policy and equity considerations (see next section).

Impacts of household woodfuel consumption on economic growth, income and employment can be viewed both in negative and in positive terms. As shown in Peskin et al (1991: 3-5), woodfuel markets may represent a major economic activity in terms of employment, market value and income generation. In most developing countries a major part of the commercial woodfuel trade is not captured in the national accounts because woodfuel trading is an informal sector activity. For example, the market value of woodfuels consumed in the major urban areas of Malawi in 1990 was MK16.3 million which is roughly equivalent to the sales value of electricity to urban consumers or 22.5% of total electricity sales in the same year.[24] The non-monetized part of the sector, that is collection of fuelwood

[24] The market value of urban woodfuel sales was obtained by using consumption figures for woodfuels from Ng' ong' ola (1991: Tables 48 and 49) and the unpublished average annual prices for woodfuels of the NSO for 1990 which were made available by the Ministry of Energy and

for household use in rural areas, may also represent a considerable part of national income when the time used for fuelwood collection is shadow-priced.

Important sectoral forward linkages may also exist between the utilization of wood and other forest products in small-scale forest-based industries. Such industries may contribute only a small share to total value added but may represent a considerable source of employment and income generation for rural households. These issues are further discussed in Chapters 4 and 5.

Urban woodfuel consumption and rural-urban equity considerations

The share of urban households in total woodfuel consumption is usually considerably smaller than the share of rural households. However, the typically observed larger share of charcoal in the energy consumption pattern of urban households, compared to their rural counterparts at comparable income levels, involves a disproportionally stronger claim on the utilization of the existing woodfuel resource base. This is due to the inefficient charcoal production technologies which are commonly employed by rural charcoal producers and the fact that charcoal production represents a fairly intensive harvesting regime because whole trees are cut. In comparison, the fuel gathering practices of rural households are generally much less environmentally disruptive because cutting live wood for household energy consumption is usually an exception rather than the rule.

The mining of trees from customary lands for urban woodfuel supplies forms part of a broader economic development issue, that is the terms of trade between the rural and urban sector. Where woodfuel supplies for urban households are supplied from indigenous woodlands at prices which do not reflect the full economic resource costs, the effect is not only underpriced woodfuel. Because rural households are known to derive a range of beneficial uses from forests, in the long term urban households also either impose additional costs or may even largely deprive rural households from obtaining these benefits. The implications of urban woodfuel use represents an equity issue which has to be considered in the design of household energy policy. Of course, this issue is not confined to the dimension of rural-urban equity considerations when other woodfuel users contribute to deforestation and depletion of forest resources.

Inefficient fuelwood markets tend to exacerbate the disproportionate distribution of costs and benefits associated with urban woodfuel use. Where urban fuelwood traders or transporters hold substantial market power, rural woodfuel suppliers are price-takers and

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Mining in Lilongwe. Electricity sales data of the Electricity Supply Commission of Malawi (ESCOM) are those published in the January 1991 issue of the MSB.

economic rents are appropriated downstream. This tends to impede price incentives for tree growing initiatives by smallholder farmers.

The main national objectives mentioned in DEVPOL include the reduction of poverty, achievement of rapid and sustained growth and improvement of the income distribution (DEVPOL 1987: 13). Deliberately no priority was assigned to any of these objectives. Rather the weights which will practically be given to these objectives were explicitly left to policy decision-making in the individual policy areas. With regard to equity considerations, DEVPOL states that the poorest sections of the society were to receive particular attention by introducing programmes which would address specific poverty problems. To address poverty issues, the introduction of fuelwood programmes, the scope and contents of which were not further specified, was envisaged.

A mainstay of the woodfuel policy was the provision of incentives to foster private tree planting by institutions, the private sector and notably smallholders. This part of the woodfuel policy had only indirect equity implications. It was related to the expectation that the incentives and the introduction of measures to police the supply of traded woodfuels from customary lands would raise the supply of woodfuels from commercial producers which would thereby mitigate the pressure on woodfuels from customary lands (DEVPOL 1987: 77). However, probably in view of the difficulties involved in effectively policing woodfuel supplies from customary land and thus their uncertain impact on the development of market prices which would encourage farmers to grow woodfuels as a cash crop, the expectations as to possible quantitative results of this strategy in terms of reducing the current deforestation trend were formulated cautiously. For the planning decade the expectation was expressed that realistically only a slowdown of the rate of deforestation could be anticipated (DEVPOL 1987: 77). The GOM also stated the policy objective to continue pursuing investments in urban woodfuel plantations to meet urban woodfuel demand (DEVPOL 1987: 77). This was a direct approach to address urban-rural equity issues related to the exploitation of woodfuel stocks from customary land.

Deforestation, woodfuel prices and equity considerations related to the urban poor

Equity issues are also a traditional social policy concern across the income groups of urban households. Where woodfuels represent a major portion of urban household energy consumption and a significant share of household expenditures, policy makers are concerned about woodfuel price developments which, relative to the development of real incomes, may result in an increasing share of energy expenditures in total expenditure. Accordingly, only the relative budget share for household energy consumption matters. This implies that concerns about the affordability of woodfuels will arise both in situations where real woodfuel prices outpace real increases in disposable income and where real constant or even real declining woodfuel prices outpace real declining income. In situations where woodfuel stocks have been depleted to such an extent that depletion translates into sustained real price increases for woodfuels which reach the useful energy costs of backstop fuels, the better-off urban households, which are less constrained in affording the costs involved in fuel switching, may conveniently switch to commercial fuels. Since the lower income urban households face the tightest constraints in switching to modern fuels, often even in situations where they are heavily subsidized, equity and poverty considerations always generate pressures to secure their supply with affordable woodfuels.

All these situations typically generate conflicts and therefore potential for inconsistencies between woodfuel policies focusing on price- or market-led woodfuel supply from rural suppliers, and poverty alleviation and equity objectives for lower-income urban households. The former policy aims to ensure attractive woodfuel prices at the farmgate of private suppliers. The latter objectives try either to keep the level of woodfuel prices low or to introduce a supply mechanism which ensures that the urban poor can be effectively targeted and supplied with woodfuel at lower market prices without excessive leakages to other buyers in urban woodfuel markets. Excessive leakages will exert downward pressure on woodfuel prices and thus countervail price-led supply responses. However, in a country like Malawi, where a considerable share of the urban population can be classified as poor, there exist intrinsic problems in effectively segmenting the urban woodfuel market (see Chapter 7).

The woodfuel policy laid down in DEVPOL had a long-term perspective because energy pricing measures which could have had a short to medium, though uncertain and limited, impact on the energy budget of the urban poor were not given a prominent role. This is evidenced by the policy objective of minimizing cross-subsidization between commercial fuels (kerosene and electricity). All other measures to address this problem were of a long-term nature. Specifically, the government intended to introduce charcoal supplies from government pine plantations to facilitate a switch from charcoal produced from indigenous hardwoods. They also envisaged an improved woodstove programme and the augmentation of woodfuel supplies from government-owned woodfuel plantations by new investments. Because the feasibility of introducing low-cost charcoal supplies into the urban market was unproven and the chances of success of an improved stove programme were also uncertain in 1987, expectations that energy-related equity and poverty issues could be addressed had to rest heavily on future supplies from government and private fuelwood plantations.

Even the success of the latter supply option was subject to uncertainties. Because of the extensive reliance of the development expenditures of the government on external financing,[25] the implementation of its fuelwood plantation programme was largely dependent on the consent of the World Bank, which had been the main supplier of funds to the forestry sector since the early 1980s, and of other donors. Government-run fuelwood plantations started to fall out of favour from about the mid-80s because supplies from private sources, notably from farm households, were increasingly regarded as cheaper supply options and thus more consistent with the objective of least-cost energy supplies. Policy analysis carried out by the World Bank (1986: 5) came to the same conclusion for Malawi. As a consequence of this assessment, the World Bank, which had financed the establishment of government-run fuelwood plantations from the late 1970s, refused to support further investments after 1986. However, the GOM, which at times had rather controversial discussions about this issue with the World Bank, continued to pursue this supply option. This is evidenced, for example, by the ambitious Blantyre City Fuelwood Project (BCFP) which started in late 1986 with support from the Government of Norway (BCFP 1993: Annex 1). Some important lessons can be learned from this project with regard to the economic viability and implementation of woodfuel plantation projects and the supply of low-income urban households with fuelwood. These issues are further discussed in Chapter 7.

Thus, it may be concluded that DEVPOL assumed that there was a general lack of policy options with potential to effectively address the woodfuel related poverty and equity problem of the urban poor in the short-term. Yet, within the government woodfuel pricing policy, there was an element which, even though it was not explicitly designed to tackle equity issues, was implicitly, and perhaps intentionally, doing this. The declared principle for the pricing of woodfuel supplies from government plantations was to undercut the prices of woodfuels from private and customary land in order to 'discourage the use of indigenous fuelwood by urban consumers' (DEVPOL 1987: 41). As the share of fuelwood in low-income urban households is usually considerably higher compared to higher income strata, the pricing policy objective was effectively shielding these households, at least to some extent, from market price developments of fuelwood. Since there were no accompanying policy measures attempting to segment the woodfuel market, it was practically impossible to jointly discourage urban household use of indigenous wood and to address poverty issues.

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[25] The share of funds from external donors for the development expenditure of the GOM in the financial year 1987/88 was 83.7% and remained in excess of 80% until 1990/91 (UNDP 1993: Table 7).

However, the main problem of the woodfuel policy of the government was that the declared pricing policy objective contradicted the policy of the government to leave woodfuel prices from customary or private land uncontrolled and moreover to undertake woodfuel market policing measures to increase the price of woodfuels in urban markets. The implications of implementing these conflicting policy objectives are further discussed in Chapters 6 and 7.

2.4 SUMMARY AND CONCLUSIONS

Household energy policy

- The general objective of the energy strategy of the GOM in the 1980s was to pursue a least-cost energy strategy in all energy sub-sectors. The implementation of this policy objective involved the cost-efficient import substitution of petroleum products. With regard to oil products, the household energy sector played quantitatively a subordinated role insofar as the share of kerosene had a low and declining share of total export income. In the 1980s the household energy policy was based on the assumption of a high deforestation rate in the country. Policy analysis carried out by the National Energy Plan was entrenched in the methodology of the fuelwood gap theory. Therefore scenarios were produced which forecast a continuation of high deforestation in the country. This reinforced the existing perception of a looming woodfuel crisis. They also implied that household woodfuel consumption was the main contributor to deforestation.

- Social equity and poverty alleviation were additional key objectives for the design and implementation of household energy policy. The urban household energy policy for commercial fuels relied on a limited cross-subsidization of kerosene and electricity. The main energy demand management measures consisted in the introduction of more efficient woodfuel stoves in urban areas. The main pillars of supply-oriented woodfuel policies for urban households was to increase supplies of fuelwood from government-owned plantations and measures to foster private supplies. To encourage private supplies, mainly from smallholders, contradicting fuelwood pricing objectives were formulated. On the one hand, government intended to raise the real price of woodfuels, while on the other hand it intended to keep woodfuel prices low by exercising price controls through the supply of woodfuels from government plantations at gazetted stumpage fees. In order to dry out woodfuel supplies from customary land, the GOM instituted the policing of woodfuel flows to the major cities. The rural household energy policy consisted entirely in supply-oriented woodfuel measures.

Economic development and income growth

- The economic development since the 1980s was characterized by a difficult environment where deteriorating terms of trade and high international interest rates exerted strong pressure on the foreign exchange balance. This in turn exerted considerable pressure on the GOM to pursue fiscal discipline and to implement a structural adjustment programme. Agricultural policy intended to increase and diversify export earnings and to develop a policy framework within which the smallholder sub-sector would be induced to produce a higher share of cash crops. By the end of the 1980s and early 1990s the results of these policies were mixed to disappointing. The reliance on tobacco exports had considerably increased and made the country even more dependent on the price performance of one single crop. Overall the smallholder sub-sector remained economically fairly stagnant. Per capita GDP of the population remained virtually unchanged between 1980 and 1985 and then declined before it reached approximately its 1980 level in the early 1990s.

Population growth and policy

- The high population growth which was experienced in the 1970s continued in the 1980s. Population policy measures were introduced only in the mid-1980s, but were restricted to the implementation of selective measures. In view of the stagnant development of the smallholder sector, the late start of the population policy may be regarded itself as a partial policy failure.

- Even though uncertainties concerning future demographic patterns remain, no drastic decline of the population growth rate within the next decade can be realistically expected. The development of fertility rates is the most uncertain factor in population projections. In sub-Saharan countries lineage considerations appear to exert a strong impact on population growth rates which are higher compared to other countries with regard to the income-population growth relationship. The hypothesis that declining natural resource availability exerts a pressure to maintain high fertility rates could not be analyzed due to a lack of adequate data. However, available evidence suggests that high children labour participation rates prevail.

Migration patterns

The urbanization process in Malawi between 1977 and 1987 has accelerated in comparison to the previous ten years. However, the migration pattern was dominated by movements within rural areas rather than by rural-urban migration. The growth of employment opportunities in the estate sector, combined with increasing land scarcity in Malawi as well as limited income earning opportunities in the major urban areas of Malawi, explain this pattern.

Chapter Three

POPULATION GROWTH, LAND TENURE SYSTEMS AND RESOURCE MANAGEMENT

The analysis of past failures of woodfuel strategies, policies and projects has given rise to a criticism and reconsideration of household energy policy. It has also led to research aimed at developing a new conceptual framework for the analysis and design of household energy policy. The main features of this change especially in conceptualizing woodfuel problems, which is now addressed by many researchers in the field as a paradigm change or the development of a new paradigm, form the basis for this dissertation.

The main result of the ongoing discussion is that the conceptualization of woodfuel problems has previously been entrenched in an extremely narrow and therefore counter-productive perception of woodfuel as being purely an energy issue. An integrated analysis of the issues involved now requires future research to considerably enlarge the scope and level of detail of analysis. This has occurred in two major and interrelated directions.

The first research direction incorporates macro-variables such as population growth, the functioning of land tenure systems and the dynamics of land-use changes into the cause-effect analysis of woodland denudation. The second research direction calls for an improved understanding of the relationship between the factors determining household decision-making, in general, and in relation to the role of woodfuels, and the integration of this micro-economic perspective with the markets farm households interact with.

The objective of this chapter is to analyze key issues discussed in the literature pertaining to the dynamic relationships between population growth, land tenure systems, land extensification and intensification and deforestation in Malawi as well as to prepare the basis for an extended discussion of some of these issues in the following chapters. The in-depth discussion of these issues in several chapters is due to their general complexity and linkages to detailed sectoral issues. Therefore this chapter focuses first on structural and dynamic characteristics of these processes. The discussion of the relationship between population growth and deforestation is expanded in Chapter 5 where woodfuel supply and demand is analyzed.

The first section (3.1) discusses relationships between population growth, land-use changes, deforestation and household fuelwood shortage. The analysis shows the complexity of these relationships and the need for country-specific empirical analysis because there exists no clear or systematic patterns in these relationships.

Formal and informal (or traditional) land and tree tenure regulations, and changes thereof, influence the management of off-farm and on-farm natural resources. The existing framework in Malawi, in relation to elements of the relevant theory and empirical findings from other countries, is analyzed in section 3.2.

An understanding of the linkages between population growth and the changes of land use extensification is a central issue for household energy policy analysis. Changes in the physical availability and access to off-farm resources, notably forest resources, have an impact on rural households in terms of the benefits which they derive from forests and other types of land. A decline in availability and access forces households to choose between a number of adaptations which are central to the design of rural household energy policy and implementation. Resource losses and degradation, combined with land fragmentation, changes the conditions under which smallholder households operate and thus has an influence on resource allocation decisions on farms. The process of natural resource utilization on customary land also has a bearing on their future management by rural people. These issues are discussed in detail in subsequent chapters. Section 3.3 prepares the background for the discussion of these issues. In section 3.4 main conclusions from this chapter are drawn.

3.1 POPULATION GROWTH, LAND-USE CHANGES, DEFORESTATION AND HOUSEHOLD FUELWOOD SHORTAGES

Linkages between population growth, deforestation and fuelwood shortages

Barnes (1990: 1) in an analysis of fuelwood shortages in sub-Saharan countries has identified three primary causes of deforestation, that is 'an increase in woodfuel consumption; expansion of agriculture into forests or woodlands, which reduces available tree stocks; and overgrazing caused by an increase in cattle production'. Though population growth increases woodfuel consumption, he further states that population growth alone is not a sufficient condition for the occurrence of deforestation or household energy shortages. In his own words (1990: 1): `The distribution of population, land use intensity, agroclimate, carrying capacity of the soils, and the level of economic development are all important in determining whether there are or will be household shortages.'

The implication of these arguments is that population growth, and related indicators such as arable land availability, are poor predictors for deforestation or household fuelwood shortages. This is supported by evidence which can be derived from statistical data compiled by Bilsborrow and Ogendo (1992: 38-40) for all sub-Saharan countries. From their data for the period 1985-90, it can be concluded that high population growth rates which were observed in virtually all countries (most growth rates were in excess of 2.7% per annum) are associated with both very high and very low estimated deforestation rates. For example, Tanzania had a population growth rate of 3.6% during this period which was accompanied by an estimated deforestation rate of only 0.3%.

A similar result was derived for the relationship between the available land per economically active person in agriculture in 1965 and 1987 and estimated average population growth rates during the 1980s.[1] However, fuelwood deficits and population were found to be correlated in a number of African countries (FAO: 1983). These examples of linkages between population variables, land-use availability and deforestation show that general conclusions about these relationships cannot be derived without a more detailed country-specific analysis of the interaction of these variables over time.

A framework for interpreting the linkage between population growth and land-use changes

In addressing the question of 'how much of the land-use changes can we attribute to population growth?' Bilsborrow and Ogendo (1992: 38) have suggested a broad framework for analyzing this relationship which is more explicit than, for example, Barnes' concerning dynamics and phasing. Their approach builds on the concept first introduced by Davis (1963) of a 'multi-phasic response' of land-use changes to population growth. The proposed framework builds on the empirical evidence that the pressure of population growth on land has been accommodated by demographic responses such as reduction of fertility levels, out-migration or the postponement of marriage and non-demographic responses. The essence of their approach is described by the authors as follows:

> There are four phases involved in the responses of land-use practices to population growth, each involving several adjustments, many of which are consecutive, others concurrent, and even some cumulative. The four phases may be classified as tenurial (Phase I), land appropriation or extensification (Phase II), technological (Phase III) and demographic (Phase IV).

Some of these phases are further subdivided into the following stages:

Phase I: Tenurial Phase; Stages: Accommodation - Fragmentation - Reclassification

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[1] No statistical (regression) analysis was performed to interpret the data provided by Billsborrow and Ogendo because simple inspection of the data showed that no statistically significant relationship can be derived.

Phase II: Land Appropriation and Extensification

Phase III: Technological Phase; Stages: Intensification - Nucleation

Phase IV: Demographic Phase

The single phases and stages, their relationships and combinations over time and the extent and forms in which they occur are directly influenced by a wide range of contextual factors related to natural resource endowments, institutional and attitudinal factors and government policies. The multitude of possible factors that shape the responses demonstrate the complexity involved. Consequently, the explanatory and predictive power of the approach has objective limitations. In this respect, Bilsborrow and Ogendo (1992: 38) argue that the general relationship between types of responses is characterized in such a way that the intensity of a particular type of response reduces the stimuli for others, and that the relative likelihood of occurrence for a specific response can be gauged from, and is linked to, the constellation of contextual factors. For the purposes of the issues discussed in the following, their conceptual framework is essentially used as a background for interpretation of the respective developments in Malawi at the end of this chapter.

3.2 LAND TENURE SYSTEMS AND RESOURCE MANAGEMENT

Land tenure systems are of interest in this research in five main respects. First, their development reflects if and how population pressure on land resources is being mitigated by changes in tenure arrangements. Bilsborrow and Ogendo (1992: 38) argue that changes in tenure arrangements are the most likely response to population growth induced land pressure because migration is an undesirable option. Therefore, if effecting tenure changes is constrained for whatever reason, other adaptations will occur. Secondly, secure land tenure is commonly perceived as playing a role in capital formation based on the assumption that tenure security reduces investment risks. Risk reduction has the desirable effect of promoting long-term farm infrastructure investments which are considered as prerequisites for sustainable land management. Thirdly, as trees on farms can be considered permanent structures, tree and land tenure security must be also considered to influence decisions concerning tree planting and management. A related common perception is that security of land tenure is associated with access to credit. Fourthly, within the category of customary land tenure, there is the important distinction between open access and common property resources with widely different implications for sustainable land use and natural resource management. Fifthly, specific commercial land tenure regimes and covenants codetermine the management practices on commercial land, including sustainable management and planting of fuelwood.

These issues are discussed for smallholders and commercial farms which were the main targets for the woodfuel supply policy of the GOM.

3.2.1 Types of land tenure systems

In Malawi three land tenure systems are distinguished: public, private and customary land. The definition of these tenure categories was provided in the Malawi Land Bill (1965). *Customary land* is held, occupied or used under customary law. *Public land* is land which is occupied, used or acquired by the government and any other land not being customary or private land. It consists mainly of land used for forest reserves and game parks. *Private land* is owned, held or occupied under private ownership and is classified into the classes leaseholds, freehold and customary land converted to private land. The former two land classes revert automatically to public land when surrendered. The latter category was created under the Customary Land Act (1967) and is confined in its application to Lilongwe ADD. An important provision of the Malawi Land Bill (1965) with important consequences for land use changes was that customary land could be converted to leasehold land with the consent of the traditional chiefs.

3.2.1.1 Customary land and tree tenure[2]

Allocation, utilization and inheritance of customary land

Malawi's societies are matrilineal (Chewa) in the Southern and Central regions and patrilineal (Tumbuka and Ngoni) in the Northern region. Customary land tenure arrangements show some minor variations among ethnic groups but the customs governing land tenure are rather uniform.

The allocation of customary land and arbitration of land disputes is vested in the local chiefs, sub-chiefs and village headman (local authorities) who are indirectly political appointees. Village headmen can grant rights of administration to heads of lineages which are entitled to further subdivide their estates among members. Individuals qualify for the allocation of land subject to their capability of using it and social acceptance by the community and the headman, regardless of whether they are community members or outsiders. Land is not necessarily allocated as a contiguous plot. In fact, many family members may hold several parcels of land in the village area or even in separate villages. Allocation of customary land does not establish a legal right of ownership but usership and control rights. Although the village headmen retains in principle the right to revoke usership rights and hence to reallocate land, under customary practice land is irrevocably

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2 This section draws largely on the work of Mkandawire and Phiri (1987) and Ng'ong'ola (1986) and several government laws which were passed between 1965 and 1967. The latter are mentioned in the text.

distributed unless a severe criminal offence such as murder, theft or witchcraft is committed or land is left fallow for a fairly long period. In practice, there have been only very few cases of enforced land repossessions. The concept of land having a market value is unknown. Consequently, the idea of sale of land does not exist. This fact implies the predominance of the concept of intergenerational usership-inheritance rights.

Inheritance of land generally involves both the transfer of use rights and of leadership roles. In the patrilineal Northern region inheritance is clearly regulated by primogeniture whereby the eldest son always inherits the land. Under conditions of limited land availability, other sons are expected to acquire their own land, while under land scarcity conditions the elder son is expected to share land with brothers. Among the matrilineal societies land reverts to the matrikin or 'mbumba' who have the right of land allocation within individual households of the matrilineage. A mbumba represents an extended family of a minimal lineage of consanguine sisters, usually led by an uncle or a brother, who collectively decide who will take up cultivation of land. Under the matrilineal system, inheritance is usually made from uncles to maternal nephews and nieces. Under land scarcity conditions, land may get subdivided among mothers, brothers, maternal nephews or grand children. Hence, inheritance rules in general have no in-built mechanism to prevent land fragmentation, though the matrilineal inheritance is perceived to involve a greater fragmentation of land.

An important implication of customary law in Malawi is that all aspects of land utilization are at the sole discretion of the smallholder. Therefore chiefs and headmen cannot mandate or enforce, for example, land husbandry measures which are recommended by the extension service of the Ministry of Agriculture. Land disputes are settled by local authorities (Nankumba & Machika 1988).

Land capital formation, uxorilocality and matrilineal inheritance

As noted by Ng'ong'ola (1986: 2) uxorilocality (residing in the spouse's village) and matrilineal inheritance have been viewed as disincentives for males to invest in land because a husband will not pass the land to his sons and husbands are expected to leave the village when divorced or, in some areas, to leave when the spouse dies (Minae et al 1993: 9). The reason advanced for the latter relationship is simply that a husband is deterred from major investments because he will not pass on the land to his own sons. In this respect Dickerman and Bloch (1989: 17) claim that this contention is not supported by evidence. However, in view of the results of a micro-village study in Malawi, where men and women were expressing contradictory views as to the disincentive properties of the matrilineal inheritance system, Shanmugaratnam et al (1992) assume a slightly more cautious stance by arguing that 'there is no solid evidence to support this argument'. There is similar evidence from Minae et al (1993: 9) who observed reluctance of a few farmers to participate in conducting on-farm trials with fruit trees, but it was generally concluded from field observations that 'there is no convincing evidence of male farmers being reluctant to invest in agroforestry'.

A trend of inheritance along patrilineal lines among matrilineal ethnic groups associated with permanent land improvements has been observed by Mkandawire and Phiri (1987: 12). It is however unclear whether they interpret this shift as mere coincidence or as implicit evidence against the disincentive proposition. It has also to be taken into account that there is also no *a priori* reason for the existence of such a causal relationship because land improvements can independently be induced by numerous other factors, such as perceived productivity gains, access to the marketing of cash crops and hence investment opportunities and changes in perceived increases of market prices for existing cash crops. Indeed, as reported in Dickerman and Bloch (1989: 17), land scarcity and enhanced commercialization of smallholder production have been held responsible by some researchers, including Mkandawire, for this shift.

Land tenure security, capital formation and access to credit

As noted above, security of tenure is usually perceived as a strong precondition for agricultural capital formation including land improvements and farm forestry (Bruce & Noronha 1987). However, as noted in Atwood (1990), there is no conclusive evidence for this conception. In view of the discussion above, the conclusion can be drawn that the customary land tenure in Malawi represents in general a high degree of tenure security. This view is also shared, for example, by Riddell (1985). Therefore, land tenure insecurity does not seem to represent a constraint to investment in the common types of farm capital investment such as land improvements, trees and perennial crops, livestock, tools and equipment, and structures (Levi 1979: 1053).

According to Lutz and Young (1992: 249) there is empirical support for a linkage between a higher degree of security of tenure and access to credit. As will be discussed further below, access to credit is a major constraint to investment and productivity enhancement of smallholders in Malawi. It cannot be disputed that security of tenure is a general condition for access to credit. However, it has to be considered that for analytical and practical purposes, it is not helpful to infer access to credit from a postulated general relationship between tenure security and access to credit. Instead, specific socio-economic and financial micro-variables are involved in this relationship, determining under which circumstances what type of credit is available to which type of borrower, and from which type of financial intermediary. These aspects are discussed below.

In agreement with modern credit principles, access to capital market loans from established formal financial intermediaries can only be expected if either one, but with increasing loan size and loan maturity both, of two conditions is fulfilled. The first condition is that land collateral has to represent a marketable financial asset presupposing the existence of a functioning land market. The second condition relates to the proof of a cash flow of a borrower which is sufficient to serve as a cushion against financial distress. The first condition is not fulfilled for smallholders in Malawi because a land market for customary land does not exist. In addition, experience in Africa and other developing countries shows that collateral-based lending, even for large estates, may be a rather risky undertaking.

However, as will be shown in Chapter 4 and what is also intuitively clear from the context of Malawi's smallholder sector which is dominated by subsistence production, incomes are too low to establish creditworthiness for most lenders. From this it can only be expected, that even if a legally sanctioned land market for privatized customary land would develop in Malawi, access to credit from formal financial institutions is unlikely to come forward on any major scale because of the low income of the large majority of the smallholders. Hence, it may be concluded that access to credit for most smallholders in Malawi is primarily an issue of financial deepening by introducing specific non-collateral based lending mechanisms rather than an issue of establishing a land market.

An interesting aspect concerning the relationship between land and credit is a lending practice which is accepted under customary law and increasingly practiced in areas under land pressure (Mkandawire & Phiri 1987: 52-3). Pledging of land (pinyolo) for loans in cash or kind often involves other households and particularly rural moneylenders. This kind of loan is usually extended to cope with emergencies rather than as a means of access to credit for regular consumption purposes or for the purchase of agricultural inputs.

Reform of customary land tenure and its results

Several reforms of customary land were introduced by three land statutes adopted by the GOM in 1967. These were in addition to the Customary Land Act (CLA) mentioned above, the Local Boards Act (LBA) and the Registered Land Act (RLA). In this context, the provisions of the CLA and the LBA (in that order) are of main interest because the LBA deals with technical issues of general land registration.

The objectives of the CLA, as reflected in its preamble, and official government positions (GOM 1965: 23), were derived in the context of the then prevailing conception that viable economic systems require tenure security in terms of individual land ownership and economically sized landholdings. Consequently, the main focus of the CLA was to consolidate fragmented land and to replace group land rights with individual land rights, including land demarcation. The latter obviously intended an intervention into matrilineal inheritance customs. An important provision of the CLA (Sections 3(1) and 3(2)) was that it was to be applied to designated agricultural development areas. In fact, it was only applied within the Lilongwe Land Development Programme (LLDP) which forms part of the LADD. The implementation of the programme within the confines of the LLDP faced a multitude of practical complications because of complex and unforeseen problems on the ground including strong community objections to individual land ownership (Ng'ong'ola 1986).

In this context only selected provisions of the law and its results are of interest. The demarcation of land appears to have been rather effective to reduce widespread disputes over land borders, and legal titles to land have eliminated the remaining influence of the chiefs on land control. The granting of individual land rights was originally intended by the law but was overruled by a policy decision to record only family rights. This change has proved to be counterproductive or at least ineffective relative to the underlying objectives of customary land reform in two main respects. First, the matrilineal succession rules were hardly influenced. Secondly, a land market has not developed yet. Concerning the latter, the question arises whether it could altogether be reasonably expected that the customary land reform laws would have a major impact on the creation of a land market at least within a tangible time frame.

According to the RLA (Section 121 (2)) the family representative shall have 'the sole and exclusive right of the land' and may therefore dispose of it even if no unanimous decision for the sale of family land could be established. Technically, this provides a strong disincentive for the creation of a functioning land market because taking effective possession of the land by a lender, is subject to the condition that a potential buyer is assured that an intra-family decision about the sale of land has been effectively reached. Otherwise protracted acquisition proceedings involving possible additional financial claims and community hostilities may be expected to materialize, increasing risks and transaction costs. The likelihood of encountering such problems is even higher for a loan collateralized by land because such a consensus cannot legally be introduced as a covenant in a loan agreement in Malawi. Moreover, any assurance of the existence of such consensus by the borrower is of no material importance to the lender in case of a loan default because, under conditions of financial stress, the family's land is the only guarantee for food and shelter. In theory, it would be reasonable to expect the emergence of a land market under conditions of increasing land scarcity and in the proximity of urban areas where land prices and rents have soared in the 1980s.

However, it is interesting to note that there was virtually no response to customary law reform from the supply side. Only a negligible number of lease or sale applications were submitted to the Lilongwe Local Land Board by 1986, all of which involved tiny acreages for commercial purposes rather than the sale of a complete family landholding (Ng'ong'ola 1986). The lack of a supply response suggests a continuing prevalence of traditional views of land as an intergenerational asset and of risk-related rational economic behaviour rather than the working of a demand constraint that is exercised by the registration of family rights on the sale of land. Some supporting evidence for this view is indirectly provided by experience from Kenya where customary land reform establishing individually registered ownership rights was already conducted in the 1950s. Bradley (1991: 209-10) reports in this respect:

> There has been a resurgence of litigation over who holds what interests in land, particularly in areas of Kenya that are experiencing severe population pressure. This development has been encouraged by judicial attitudes that now tend to regard the land tenure reform programme as an exercise in the efficient administration of land registration rather than the privatization of land rights.

Customary land tenure and common property resources

The degradation of natural resources including fisheries, woodlands, grazing areas[3] and land in general[4] has been widely recognized as being caused by the common property nature of these resources. Hardin (1968) who has pioneered this discussion, puts the inefficient management of natural resources down to them being managed without clearly defined property rights to the resource. The common property model assumes individual profit maximization and non-cooperation among resource users (Livingstone 1991: 80). Since nobody owns the resource, that is there exists insecurity of tenure and lack of a management control mechanism, it is rational for the profit-maximizing individual to maximize its use and hence to overuse it.

Overuse is the outcome of a misallocation of resources which, in economic terms, refers to a situation where the marginal private costs are below the marginal social costs, the

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[3] See, for example, Livingstone (1991) for a discussion of the common property resource concept in the context of land degradation by pastoralists.

[4] See, for example, Bojo (1991) for a discussion of land degradation policy issues and their link to the common property resource concept.

difference being what is called marginal user cost.[5] In the case of a private woodcutter, the marginal user costs are only represented by the opportunity costs of the time required to collect the wood. Hence, he does not account for the marginal user costs. This implies that the market price of fuelwood or charcoal will be below the economic value of the resource. Thus a larger amount of wood is consumed than is socially desirable. Overuse of the wood resource also implies that marginal extraction costs increase faster than under a situation where marginal private costs are equal to marginal social costs. As a consequence, private utility maximization means that users mutually impose costs on each other which makes them worse off than they could have been if they were to cooperate in woodfuel resource management.

The assumption that common property regimes are inherently destructive and inefficient frameworks for the management of natural resources has been challenged on the basis of examples where common property resources, in combination with specific user rights for specific user groups, have been managed efficiently over long periods. This implies that *a priori* reasoning is insufficient to determine whether common property resource regimes inherently involve natural resource degradation or not. In view of this finding, a distinction has been made between 'common property' and 'open access' resources.[6] By definition, only the latter type of regime lacks a control mechanism for efficient resource management. Therefore the economic effects described above apply only to resource management situations which fulfill the conditions defining 'open access' resources. However, as Teplitz-Sembitzky and Schramm (1989: 129) have pointed out, the stability of existing common property resource agreements cannot be taken for granted: when a natural resource increases in value, it becomes more difficult and therefore less likely to keep out other resource users and to maintain informal access controls among existing users.

Customary land and tree tenure

Under customary law in Malawi, fuelwood for non-commercial purposes can be collected throughout the country by anyone free of charge, though the law prohibits the cutting of naturally growing trees. Access to woodfuel resources is in general not institutionally or formally organized, for example, by allocation of temporal or permanent user rights to specific groups. Furthermore, no informal community-defined group rules are known to be practiced. These empirical circumstances define the woodland resource management on customary land in Malawi as a typical case of an open access resource.

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[5] See, for example, the definitions of these terms in Openshaw and Feinstein (1988: 4-7) who also discuss the definitions from a legal and historical perspective.

[6] See, for example, the definitions of Pearce (1988) and Openshaw and Feinstein (1988). The latter also discuss these definitions from a legal and historical perspective.

Forests on customary land and village forests were traditionally under the administrative control of the local authorities until the control and management was transferred to the Department of Forestry (DOF) in the Ministry of Forestry and Natural Resources (MFNR) in 1985. However, traditional authorities continue to allocate customary land regardless of whether this involves bushland or land occupied with major tracts of natural forest. The change in policy has created uncertainties with regard to tree ownership because indigenous trees tend to be thought of by the rural people as belonging to the government which may act as a disincentive to plant indigenous tree species on farms. This disincentive is accompanied by the rule that cutting of trees from customary land is prohibited unless authorization has been obtained from the DOF. Thus when indigenous trees are cut and sold, the burden of proof to forest employees (who police rural areas and markets) that the tree was privately grown, rests with its owner. This situation acts as an additional disincentive to planting indigenous trees on farms. In addition to the uncertainty whether the government owns indigenous trees on customary land, there exists the potential problem that other resource users, which were found in field surveys in some communities to prune trees on other smallholdings without prior permission, may also cut privately planted indigenous trees (Minae et al 1993: 9). This problem also acts as a disincentive for planting indigenous trees.

As noted in Leach and Mearns (1988a: 84), two features are common to African land and tree tenure systems: 'trees can create tenure' and 'tree and land tenure frequently do not coincide'. In this context, Dickermann and Bloch (1989: 31-32) have observed in Malawi what they call a 'paradox' situation. Due to the open access characteristics of woodlands, community members consider their right to the use of trees as unrestricted. This induces farmers who were allocated a plot of land with substantial tree resources to cut down trees as fast as possible. However, as quoted in Minae (1993: 5), Riddell (1985) found that demarcation and clearing of trees are traditional measures to indicate ownership of land. At the same time, clearing of trees to prepare the land for agricultural use or to indicate ownership practically always coincide. Therefore it is always difficult to prove that because indigenous trees are regarded as communal property, accelerated cutting will occur. Yet, the inherent overutilization of open access resources, which seems to apply to trees on allocated customary land, implies that the new owner of the land has an incentive to cut his wood resources as fast as possible. From this point of view, the observed behaviour is rational rather than paradoxical. This supports the view that tree and land tenure also do not seem to coincide in Malawi concerning indigenous trees.

The notion that 'trees can create tenure' is usually applied to situations where trees are grown to create tenure or where ancestral rights to land are inferred from the planting of trees. Paradoxically, the perception that indigenous trees belong to the government may also involve the fear that the government might derive tenure rights from the existence of indigenous trees on farm land. The fact that some farmers do not plant tree species declared as protected may serve as an indication for the existence of such fears. The insecure tree tenure which is related to indigenous trees on croplands in Malawi may act as a disincentive to grow such trees. This suggests that smallholders may display a preference for non-indigenous species. However, other beneficial uses from indigenous trees may counterbalance these disincentives. These issues are further discussed in Chapters 5 and 6.

3.2.1.2 Tree tenure on leasehold and freehold estates

Leasehold estates are granted to private individuals by the GOM and are subject to several land utilization covenants. One covenant requires estate owners to keep 10% of their land under forest. This covenant was introduced with the objective that estates which have high wood requirements for tobacco curing and drying (see Chapter 5) attain self-sufficiency of supply. Penalties for forestry offences which are defined in the Forest Act (1964) include a maximum fine of MK100 or 12 months imprisonment. These fines are much too low to act as a disincentive to commit such offences and there is also no track record for the enforcement of these penalties.

3.3 POPULATION GROWTH, LAND EXTENSIFICATION AND FRAGMENTATION

Changes in land-use and land fragmentation are long-term inevitable processes which accompany population growth in developing countries. The causes and impacts of these processes are of key importance for household energy strategies and policies, particularly for the rural households which are directly involved and affected. In relation to the major flaws of the woodfuel gap theory, in-depth knowledge about the characteristics of these processes have been identified to play a crucial role in the overall strategy and design of household energy policies in rural areas with regard to the following issues.

First, Leach and Mearns (1988a: 10) have pointed out that the identification of who causes land-use changes and contributes to deforestation, is a prerequisite for the strategic outlook and the issues which have to be addressed to ensure the sustainability of woodfuel supplies. They argue that if land clearing is the major cause for deforestation, the key questions are how long this process can continue until the land clearing frontier, that is the exhaustion of arable land, is reached and what are the implications for woodfuel supplies?

Secondly, as discussed in the previous section, overuse or depletion of the forest reserves in economic terms represents a misallocation of the resource. One remedy proposed by economists to correct this misallocation is to introduce stumpage fees or royalties in order to equate economic and financial costs. If land clearing is mainly caused by smallholders as assumed, for example, by Leach and Mearns (1988a: 10), then the collection of royalties becomes an arduous, if not impossible task, depending on their poverty characteristics.

Thirdly, if land clearing is the major cause of deforestation, an important strategy to maintain the sustainability of woodfuel supplies is to slow down the land conversion process through land intensification measures. In developing countries where subsistence farmers represent the majority of the rural households, this implies a move from traditional to improved farm management methods. Virtually all attributes of the smallholder production system[7] are within the realm of agricultural policy. For that reason several researchers (Leach & Mearns 1988a; Bradley et al 1991) have pointed out the important implication that a major part of the responsibility for sustainable woodfuel supplies rests on agriculture and forestry and, of course, on their respective policies. This, in turn, is one reason why woodfuel problems cannot be addressed from a policy perspective by regarding them solely in terms of being an energy problem. Consequently, researchers such as Giri (1991) have noted that only limited useful research has been carried out concerning the relationships between traditional energy and agriculture.

Fourthly, the process of land extensification itself has implications with regard to the relative attractiveness of forestry policy options, depending on who are the gainers and the losers in this process.

Fifthly, a question which is intertwined with the previous issue is how population growth in rural areas is absorbed in terms of land extensification or fragmentation. The assumption that land extensification is mainly caused by smallholders may not be generalizable in the sense that land extensification and fragmentation (nucleation) are not necessarily adjustments which are caused by the same socio-economic group.

Sixthly, land fragmentation by definition reduces the available per capita farm land. This gives rise to the question what the implications for farm forestry responses and initiatives are: are trees squeezed out from farm land or not?

Land use extensification combined with changes in land tenure is one of the processes accompanying the commercialization of agriculture in Malawi. The dynamics of this have long-term impacts on the rural population in terms of reduced access to natural resources on customary land and possible alienation or attitudinal effects, with consequences for open

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7 The main attributes referred to are the technology employed, power sources, labour and capital intensity, market orientation and access, land tenure, landholding size and required recurrent agricultural inputs.

access resource management. The process of land extensification in Malawi has been associated with a rapid fragmentation of smallholdings creating additional pressures on resource management on farms. In the following the quantitative changes of land-use and the impacts of population growth on land fragmentation[8] are discussed.

3.3.1 The process of land extensification

Availability of agricultural land

Malawi is facing an increasing scarcity of arable land. The Land Resources Evaluation Project (LREP 1992) evaluated the total land area of the country and classified soils into four simplified quality categories for major rainfed crops under improved traditional management. The soil categories are classified as (1) Good (for 8 or more crops), (2) Moderate (suitable for 1-7 crops), (3) Marginal (suitable for 1 or 2 crops) and (4) Unsuitable (for all crops). The distribution of these land categories within the ADDs is shown in Table 3-1.

TABLE 3-1 Soil suitability by class and agricultural development district

ADD	KRADD	MZADD	KADD	SLADD	LADD	LWADD	BLADD	NADD	Malawi
Soil class					*('000 ha)*				
1: Good	181.2	605.5	697.2	334.8	671.2	548.0	270.3	96.0	3 404.1
2: Moderately good	190.3	538.2	649.4	162.3	136.2	257.0	262.3	143.0	2 338.6
3: Marginal	173.7	333.9	31.7	187.0	179.3	208.0	296.1	241.0	1 650.7
4: Unsuitable	213.5	470.0	206.3	232.4	185.1	329.0	194.5	204.0	2 034.7
Total	758.7	1 947.5	1 584.6	916.4	1 171.8	1 342.0	1 023.1	684.0	9 428.1
					(Percentage of total)				
1: Good	24%	31%	44%	37%	57%	41%	26%	14%	36%
2: Moderately good	25%	28%	41%	18%	12%	19%	26%	21%	25%
3: Marginal	23%	17%	2%	20%	15%	15%	29%	35%	18%
4: Unsuitable	28%	24%	13%	25%	16%	25%	19%	30%	22%

Source: LREP 1992, cited in MASM (1992: 1-3)

The data in Table 3-1 show that only two ADDs, that is KADD with 81% and LADD with 69%, have a higher share of good and moderately good land than the national average, while the NADD has by far the lowest share (35%). A comparison of the available good and

[8] It is emphasized here that at this stage of the analysis, resource availability or relative scarcity focuses on physical resource availability. Land scarcity or woody biomass scarcity in connection with population growth, demonstrate the broad implications of physical scarcity if enhanced agricultural productivity and enhanced woody biomass supply- or demand-side measures or other policies, are not forthcoming fast enough to mitigate or absorb the impacts of resource scarcity. In the context of Billsborrow and Ogendo's framework of multi-phasic response which was introduced in this chapter, the question of scarcity is important with regard to whether it may reach a severity in the foreseeable future that can be accommodated by a technological phase including improved resource management or is more likely to trigger a demographic response, that is an accelerated rural-urban or rural-rural migration process.

moderately good land by ADD which is shown in Table 3-2 demonstrates that only about 50% of the moderately good land is still unused (assuming that the good land has been used first).

TABLE 3-2 Estimated utilization of arable land by soil class and ADD in 1989

	KRADD	*MZADD*	*KADD*	*SLADD*	*LADD*	*LWADD*	*BLADD*	*NADD*	*Malawi*
Soil class					*('000 ha)*				
1: Good	181.2	605.5	697.2	334.8	671.2	548.0	270.3	96.0	3 404.1
2: Moderately good	190.3	538.2	649.4	162.3	136.2	257.0	262.3	143.0	2 338.6
3: Marginal	220.3	682.7	968.1	409.5	796.3	716.2	566.4	220.9	4 580.3
% of class 1&2 used	59.3	59.7	71.9	82.4	98.6	89.0	100.0	92.4	79.8
% of class 2 used	20.5	14.3	41.7	46.0	91.9	65.4	100.0	87.3	50.3
% of class 3 used	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	2.1

Source: based on data shown in Table 3-1

Blantyre ADD which also has the highest population density has not only exhausted its suitable agricultural land but even encroached on marginal land, while the Lilongwe ADD, which has the second highest population density, has virtually exhausted its suitable agricultural land. Overall the data show that Malawi is approaching the agricultural frontier in terms of physical availability of suitable agricultural land.

Land distribution changes among tenure categories

The process of land extensification in Malawi was accompanied by a major shift in land use between tenure categories. The main shifts which are shown in Table 3-3 involved a decline of the customary land area by 16.4% or 1.33 million ha between 1964 and 1992. Thereof, two-thirds were converted to leasehold land and the remainder to public land.

TABLE 3-3 Changes in land tenure (1964-92)

Year	*Public land*	*Customary land*	*Freehold land*	*Leasehold land*	*Total land*
			('000 ha)		
1964	1 107	8 183	168	72	9 530
1967	1 207	8 101	153	69	9 530
1970	1 526	7 778	148	79	9 530
1973	1 592	7 701	108	130	9 530
1976	1 681	7 526	85	237	9 530
1979	1 674	7 548	52	256	9 530
1982	1 660	7 358	52	379	9 449
1985	1 642	7 271	52	484	9 449
1988	1 642	7 066	52	689	9 449
1989	1 642	7 007	52	795	9 496
1992	1 642	6 851	52	951	9 496

Source: Mkandawire et al (1990: Tables 1.1 & 1.3) for 1964-89

Data for 1992: Author's estimate

Note: Customary land area was calculated as residual

Public land increased as a result of converting customary land into game parks and large forest reserves and, to a limited extent, from freehold land that was surrendered to the state. The expansion of agricultural estates which is reflected in the increase of leasehold land occurred in two distinct phases. During the first phase which took place between 1970 to 1979, in the wake of the agricultural policy favouring estate expansion, customary land was converted to leasehold land. This phase was characterized by the expansion of large estates. The mean estate area leased during this period was 202ha, while the subsequent phase showed a rapid decline of the mean size of estates from 80ha in 1980 to 26ha in 1989 (Mkandawire et al 1990: 13). The associated quantitative reduction decline of the customary land area which is shown in Table 3-3 masks the overproportional decline in the availability of remaining arable customary land. This is simply due to the fact that most of the latter type of land is not arable, while customary land which was converted to estates tends, of course, to be arable (Mkandawire & Phiri 1987: 31). The second phase reflected a strong response to several developments which are discussed further below.

The expansion of estates using customary land is likely to have been perceived by smallholders and non-resident villagers as a threat to long-term land availability in their village area. Among common irregularities observed in a field survey conducted by Mkandawire et al (1990: 46) was `the apparent emergence of covert land sales, with some traditional authorities issuing land to individuals from outside the local community without due consideration of the future land needs of their constituents'.

Almost half (42%) of the leaseholders covered in the survey were found to have previously cultivated part of their registered landholdings. A striking feature of the survey data is that only 16% of the largest (>100ha) registered estates were acquired by farmers having formerly cultivated part of the land. Recalculation of the survey figures (by the author) using mean estate sizes shows that it is likely that the incidence of estate acquisition by outsiders, that is persons not residing in the village, in terms of total hectareage acquired, was at least 75%. Of the remaining 25%, a considerable number of local farmers have extended existing landholdings by integrating customary land. This apparent process of land alienation may be expected to trigger fears concerning the future availability and access to land and defensive reactions of the local people. To what extent local smallholders who were able to acquire additional customary land through estate formation were motivated primarily by their concern to secure control of land rather than by immediate production objectives, cannot be quantitatively ascertained because land use data for new leasehold estates, which could help to clarify this issue, were not available. However, Ng'ong'ola (1993) and Noronha (1992), who are among the leading experts on land tenure issues in Malawi, have suggested that an element of defensive reaction was clearly involved.

The main reason for the growth in applications to register estates appears to have been to gain legal access to the production of burley tobacco. This process was triggered by the introduction of a quota and licensing system for burley tobacco in 1982/83 and the removal of restrictions for tobacco growing in specific areas in 1989. Quotas are only issued to farmers producing a leasehold title with a minimum holding size of 10.2ha (Olney 1992: 3). In response to the favourable income earning opportunities from tobacco (see Chapter 4) and to the meeting of this licensing restriction, some smallholders have pooled their customary landholdings to register an estate. Additionally, larger smallholders have followed the practice to register several leaseholds for the sole purpose of obtaining additional quotas which were used to increase burley tobacco production on their existing holdings.

Particularly between 1986 and 1989 a flurry of new leasehold estate registrations took place, resulting in an increase in the number of estates from 5 657 (pre-1986) to 14 595 in 1989. The majority (68.3%) of the newly registered estates were found to have less than 30ha (Mkandawire et al 1990: 13). During this period, the leasehold estate area increased from 517 000ha to 795 400ha or by 53.6%.

Recent data on the development of the number of registered estate tobacco growers between 1985 and 1992 (Olney 1992: 2) show that the number of growers increased by 4 284 which represents a share of 48.2% of the total estates registered during this period. Between 1989 and 1992, the number of growers has further increased dramatically from 7 593 to 18 036. Based on the assumptions that the mean size of the 10 443 estates of tobacco growers which were registered after 1989 was 15ha (representing a conservative reduction in view of the mean size of 26ha for new estates in 1989) and that 50% thereof consisted of converted customary land previously owned by smallholders, an estimated total of 156000ha, including 78 000ha of land allocated by traditional authorities, was converted to leasehold estates. A considerable portion of the new estate registrations must have occurred in the main tobacco growing areas in Kasungu and Lilongwe ADD, implying that part of the expansion in LADD is likely to have involved the conversion of land on marginally suited soils.

No statistical data are available to ascertain the number and combined hectareage of smallholders by holding size who have pooled their land into smallholder estates. However, it can be quite safely assumed that smallholders with less than about 1.5ha are unlikely to have pooled their holdings to anything but a negligible extent. This conclusion can be inferred from two sources of information. First, as shown in Mkandawire et al (1990: 39), most of the small-scale estates were financed from accumulated savings. Secondly, as will be shown in Chapter 4, households with landholding sizes of 1.5ha and below belong to the category of poor and cash-constrained households. These households have hardly any savings and also very limited access to credit, let alone to the size of credit required to develop an estate or to finance the production inputs for burley tobacco which seems to have primarily induced the formation of estates.

The above land-use changes have substantially reduced the availability of land and access of the rural population to customary land. As a result, the poorer segments of the rural community who were apparently not able to participate in this process, have increasingly responded by encroaching on estates in the form of fuelwood and pole collection, grazing of animals and even cultivation of land (Mkandawire et al 1990: 64). This reaction resembles a general defense mechanism by rural people in response to land alienation which is portrayed, for example, by Redclift (1992: 256):

> if these (environmental) resources are exploited by economic interests from outside the area local people may be unwilling, or unable, to lend their support to this commercial exploitation of `their' local resource system. Excluded from management of their local environment local people cease to be stewards, and become poachers.

It is difficult to make inferences at this stage of the analysis about the impact of external resource exploitation on the attitudes and behaviour of local people with regard to the management of those common property resources which are still accessible, but not legally or informally, under their control. The fact that estate encroachment is a widespread phenomenon provides indirect evidence that rural households are facing resource constraints. This is further evidenced by the results of the analysis which is carried out in Chapter 5.

It may be hypothesized that fears or expectations of further appropriation of land resources, inclusive of forest resources, may induce local people to create their own defensive reaction in the sense that they try to gain enhanced control over the remaining resources by trying to establish formalized user and management rights. This issue is important for the discussion of communal woodland management options which are discussed in Chapter 6. On the other hand, the land alienation process which has been sanctioned by government land laws and which was induced by agricultural policy, may also have contributed to the overconsumption of woodfuel resources in an open access system. However, their is no information available in Malawi which could be used to analyze the latter issue.

However, it has to be taken into account that institutional reforms are required to support the development of community-based resource management systems. Relevant principles of required institutional reforms have been formulated, for example, by Soussan et al (1992: 143):

> The role of the state as a facilitator means that effective decentralization, in which control over local resources is given to local communities, is required.

and by Redclift (1992: 256):

> Amongst the most appropriate measures for effecting ... change is the assignment of management responsibilities to local institutions, strengthening community-based resource management systems, and introducing a variety of property rights and land tenure arrangements.

However, it has to be considered that the implementation of these recommendations have to reckon with the fact that effective decentralization and a stronger role of local institutions may be impeded by the realities of the local political economy, because the very institutions who come into play at the local level may, as was partly the case in Malawi,[9] represent a severe obstacle in this process.

3.3.2 Fragmentation of smallholder landholdings

The process of land extensification has been accompanied by a rapid fragmentation of land in Malawi. The average size of smallholder landholdings decreased from 1.54ha in 1968/69 to 1.16ha in 1980/81 (Pryor 1988) when the last National Sample Survey of Agriculture (NSSA) was conducted. This average figure masks the tremendous compression of landholdings by size category that took place between the survey years. While in 1968/69 only 28.7% of all households had less than 2.0ha of land, this percentage has increased, as shown in Table 3-4, to 81% in 1980/81 and to 87.3% in 1987/88.

[9] See the above citation from Mkandawire which highlights the conflicts of interest between the traditional institutions and smallholders in the process of customary land acquisition. As will be discussed in Chapter 5, local leaders have sometimes also been instrumental in allowing estate owners, particularly tobacco estates, to clearfell large tracts of trees on customary land.

TABLE 3-4 Average holding sizes by Agricultural Development Division and the percentage of households within a holding size category

Holding size (ha)	*KRADD* %	*MZADD* %	*KADD* %	*LADD* %	*SLADD* %	*LWADD* %	*BLADD* %	*NADD* %	*Malawi* %
0.0 - < 0.5	45.0	20.1	6.0	20.2	31.3	29.4	40.2	15.0	26.0
0.5 - < 1.0	30.2	23.3	16.2	33.8	28.0	39.7	35.4	29.9	29.9
1.0 - < 1.5	13.9	18.7	25.0	25.3	19.5	19.0	15.0	22.2	20.4
1.5 - < 2.0	7.0	14.2	20.5	11.2	10.3	7.2	5.3	13.2	11.0
2.0 - < 2.5	2.1	9.1	12.9	4.2	4.9	2.7	1.3	6.3	5.1
2.5 - < 3.0	0.7	5.0	6.9	2.2	2.1	1.2	1.1	3.3	2.7
> 3.0	1.2	9.6	12.4	3.1	3.9	0.7	1.7	9.9	4.8
Average (ha)	**0.74**	**1.76**	**1.08**	**1.08**	**1.03**	**0.85**	**0.77**	**1.14**	**1.11**

Source: MOA, Annual Survey of Agriculture 1987/88.

NSSA data for 1980/81 also show the existence of large differences in land pressure by ADD. It is apparent that the land pressure is most pronounced in the Southern region because the cumulative percentage of households for all landholding size categories is much higher. The implications of these tightening land constraints on smallholder land allocation and management practices since the early 80s, which determined the physical availability of land for woodfuel supply-oriented options in the smallholder sector, are further discussed in Chapters 5 and 6.

Table 3-5 puts the impact of population growth on the fragmentation of landholdings in perspective until 2002. The underlying simplified assumptions for the calculations shown in the table are a population of 12 million people, a population share of rural households of 85%, a constant average household size of 4.7 persons, and that the growth in households is absorbed entirely by existing land. The last column in Table 3-5 shows that the average holding size would decline to 0.68ha. Two important indications can be derived from this table in connection with other variables. First, the rural poverty line in Malawi, which is discussed in Chapter 4, corresponds to a landholding size of 1.0 to 1.5ha. This implies that more households would fall into this category. Secondly, a considerable number of smallholders would be pushed towards extremely small landholding sizes or even landlessness. This in turn is likely to lead, as discussed in Chapter 2, to continued and perhaps accelerated migration from small-scale farms. Because the agricultural frontier is being approached in many areas of Malawi, the adoption of land-saving agricultural options, primarily in the form of productivity increases, assume key importance.

TABLE 3-5 Projected changes in the distribution of smallholder landholding sizes

Landholding size category	*Per cent of total holdings (1987/88)*	*Assumed mean holding size*	*Estimated number of households*	*Total land held*	*Number of households in 2002*	*Additional land needed in 2002*	*Average holding size in 2002*
(ha)	*(%)*	*(ha)*	*('000)*	*('000 ha)*	*('000)*	*('000 ha)*	*(ha)*
0.0 - <0.5	26.0	0.30	343.4	103.0	562.8	65.8	0.18
0.5 - <1.0	29.9	0.73	394.9	288.3	647.2	184.2	0.45
1.0 - <1.5	20.4	1.22	269.4	328.7	441.6	210.0	0.74
1.5 - <2.0	11.0	1.72	145.3	249.9	238.1	159.7	1.05
2.0 - <2.5	5.1	2.22	67.4	149.5	110.4	95.5	1.35
2.5 - <3.0	2.7	2.72	35.7	97.0	58.4	62.0	1.66
>3.0	4.9	3.95	64.7	255.6	106.1	163.3	2.41
Total	**100.0**		**1 320.8**	**1 472.1**	**2 164.6**	**940.5**	**0.68**

Source: See text for method of calculations

3.4 SUMMARY AND CONCLUSIONS

The findings and conclusions of the main themes discussed in this chapter may be summarized as follows:

- There is no noticeable deficiency of customary land tenure security which may adversely affect the motivation of smallholders to invest in permanent improvements of their landholdings and in crops with a longer gestation period (but see the remarks on matrilineal inheritance in Section 3.2.1.1). In addition, land husbandry decisions on smallholder landholdings are firmly under their control. The policy implication is that supply-oriented woodfuel policy measures are not inhibited by land tenure insecurity.

- With regard to tree tenure on smallholder farms, there is evidence that, as in some other African countries, land tenure and tree tenure do not coincide. Indigenous trees appear to be perceived by rural people as belonging to the resources to which they have overall usership rights, regardless of the customary or legal land rights. This perception may inhibit the planting of indigenous tree species. Since user rights to indigenous trees on allocated customary land appear to be fairly unrestricted and, given resource pressures, farmers have a rational incentive to cut indigenous trees on farm land in excess of what may be required by their normal consumption requirements. However, other beneficial uses of tree products to which smallholders have prime access to on their land, constitute an overriding consideration in the decision to retain or to clear trees on customary land which is being prepared for agricultural use.

- Contrary to the usual meaning of the notion that trees can create tenure, in Malawi there is an element of fear among some farmers that indigenous trees on smallholder plots may create a precedent for the government to claim land ownership, meaning that the reverse relationship can also exist. The latter aspect provides an additional disincentive for both preserving existing and planting indigenous trees. This perception may have been nurtured by the experience that persons not belonging to their community were able to acquire, legally and partly with support of their local leaders, a considerable amount of customary land.

- Though security of tenure is a general precondition for access to credit, the specific economic conditions of smallholders determine what type of credit and institutions they are in principle able to access. Existing formal land tenure rights and traditional perceptions of land as an intergenerational asset, impose high risks and transaction costs for effectively taking possession of land. This makes family-owned land a poor collateral.
- Inheritance rules under customary law, in both matrilineal and patrilineal societies in Malawi, do not appear to impose inherent restrictions on the fragmentation of land.
- Leasehold estates are required by law to maintain 10% of the estate land with trees. However, the existing penalties for non-compliance and their enforcement are ineffective.
- The massive registration of new estates in Malawi throughout the 1980s and early 1990s has considerably reduced the availability of customary land and forests and legal access of the rural population to their utilization. The customary land conversion, which may be rightfully regarded as land alienation, has materialized against the background of two partly interdependent developments, that is dwindling resources of good and moderately good agricultural land in Malawi and continuous fragmentation of average landholding sizes in the smallholder sub-sector. The majority of poor farmers have not participated in the land distribution process on account of their financial resource constraints and limited political influence on agricultural policy. Most of the legally converted customary land appears to have been acquired by outsiders with support from local leaders. The combination of these factors is likely to have instilled among the majority of the smallholders the perception that local resources were being alienated.
- The widespread phenomenon of rural people encroaching estate land suggests that the existing off-farm land and forest resources are overall insufficient to meet the productive and consumptive needs of smallholders. The resource squeeze induced by land alienation had two contradicting implications for woodfuel policies in Malawi. On the one hand, in the perspective of a defensive reaction to these developments, it provides the basis for the losers in this process to consider the potential benefits of institutionalized mechanisms and the push for policies towards more effective control of land resources and community-controlled resource management systems. On the other

hand, these processes may compound the existing inherent overutilization of open access customary land. Which of these processes may dominate is not entirely clear. Judged by the absence of informal or formal resource management practices, it appears that resource pressures have not yet led to the establishment of such systems. (Additional evidence is provided in Chapter 6).

- Decentralizing responsibilities for local resource management in rural areas of Malawi has to take into account that mechanisms to ensure accountability of local leaders becomes part of implementing such policies.
- The land fragmentation process in Malawi, which is driven by population growth and traditional inheritance rules, is very likely to continue unabated unless substantial land-saving agricultural productivity increases counteract or even reverse this trend. Altogether progress in this respect has been rather limited in the past 10-15 years in Malawi.
- The fragmentation of farm land in Malawi which is related to approaching agricultural land frontiers, indicates the importance of land constraints for smallholders and thus for the design of supply-oriented fuelwood policies and options.
- In relation to the framework for interpreting the relationship between land-use changes and population growth suggested by Billsborrow and Ogendo, it appears that Malawi has hitherto absorbed population growth in the rural areas through land extensification and fragmentation because demographic responses, such as a decline in total fertility rates, has not occurred during the past 20-25 years and rural-rural as well as rural-urban migration has been limited.

Chapter Four

RURAL HOUSEHOLD ENERGY POLICY AND FARM HOUSEHOLD DECISION BEHAVIOUR

The analysis of widespread failures of past energy policy interventions, especially in rural areas, has led researchers to focus both on the underlying structural and market factors that cause fuelwood stresses and on the decision behaviour of households under specific constraints and objectives. The objective of the first section is to provide an overview of the main elements of this discussion and to conceptualize farm household decision-making behaviour from a theoretical point of view. Section 4.1.1 briefly reviews some of the approaches and their specific focus on single and particular sets of variables and constraints that are considered crucial to the understanding of farm household behaviour in relation to fuelwood shortages and policy interventions. This discussion is followed in Section 4.1.2 by an illustration of the interactions between changes in macro variables and farm household decisions, with the objective of emphasizing the need for a flexible energy policy approach and for a systematic conceptualization of peasant[1] behaviour. The latter issue is discussed in Section 4.1.3. Diverse economic concepts, combinations thereof, and specific conceptual frameworks are applied in woodfuel policy research. Most aspects of these approaches are either related to, or form part of, microeconomic farm household models which address the rationale of resource allocation decisions of households. In Section 4.1.4 general characteristics of these models are discussed with the aim of ascertaining their relation to, and potential role for, integrated woodfuel policy analysis. Section 4.1.5 discusses selected farm household models and concepts.

In Section 4.2, the characteristics of several rural household groups are discussed, in order to clarify whether a separate treatment for household energy policy analysis purposes may be required.

The third section (4.3), applies and tests for Malawi, some of the relevant concepts and hypotheses derived from the discussion in Section 4.1.4. This is done with the objective of exploring the nature of constraints under which different farm households make their resource allocations, and of determining how peasants could be stratified for policy purposes. Closely intertwined with this topic is the analysis of income-generating and other

1 The terms 'farmer' and 'peasant' are used interchangeably in the following. However, as discussed in paragraph 4.1.3 in the literature on farm household models, the term 'peasant' is defined by specific socio-economic characteristics of farm households.

survival strategies of farm households, with a bearing on woodfuel policy issues. In Section 4.4 the development and composition of income of smallholder households is analyzed. Finally, in Section 4.5, the discussion in Chapter 4 is summarized and policy conclusions are drawn.

The results of the analysis in Chapter 4 provides a basis for the analysis of policy issues in Chapters 5 and 6.

4.1 ANALYTICAL FRAMEWORKS FOR RURAL HOUSEHOLD ENERGY POLICY ANALYSIS

4.1.1 Energy policy failures, household objectives and constraints

Any strategy and policy measures addressing aspects of the welfare of households rests upon explicit or implicit assumptions about household objectives, preferences and household decision-making under resource constraints. This appears to be a simple truth but the conceptualization of peasant household behaviour has posed major problems in the past, as is evidenced by the widespread failure or mixed successes of supply- and demand-oriented woodfuel strategies and projects. The failures which have been experienced in the past are ultimately a testimony to the fact that policy analysts, policy makers and implementers had to a varied extent a partly deficient perception, and hence made wrong assumptions concerning both the nature and extent of the problem they wanted to address, and the factors influencing peasant household decision behaviour.

Past failures point to the need of avoiding, or at least being extremely cautious, in working with assumptions as to peasant household objectives and behaviour which are not backed by an analysis of household decision behaviour in a specific economic and social context. This insight is essentially addressed by Eberhard (1992) who has highlighted the necessity of understanding the 'livelihood systems of rural communities' in their entirety, in the context of fuelwood research and strategy design.

Common insights gleaned from critically reflecting upon the mistakes that have been made in designing policy interventions for rural households associate the high incidence of their failure with shortcomings in understanding households' objectives, their hierarchy of needs and priorities, the relative importance of external market constraints (access to credit, labour markets and income- earning opportunities), changes in the availability of natural resources in woodlands (physical scarcity) and household resource constraints.

The root cause of past failures in woodfuel policy design and implementation has also been associated with the narrow energy-focused perspective embedded in the fuelwood-gap paradigm, and its strong notion of physical scarcity of woodfuels. Common indicators which were used to gauge fuelwood scarcity, are the time involved and distance travelled, to collect firewood. There is nothing wrong *per se* with such indicators. The problem starts with their interpretation. From a simple supply-demand perspective, one expects that increased fuelwood scarcity will increase the cost of fuelwood supply if the demand curve does not shift. To offset the increased supply costs, the traditional policy approach was to promote woodfuel interventions such as improved cooking stoves or woodfuel supply-side measures. The crucial assumption upon which these interventions were based was that securing household energy fuel supply was a priority concern of rural households and hence the impact of physical scarcity of woodfuels in terms of increasing labour demands, for example, would induce households to participate in the policies and programmes designed by the energy, and mainly forestry, planners. However, the limited response to policies whose design was entrenched in scarcity considerations, indicated that the scarcity concept had intrinsic limitations when used in isolation from the resource endowments and constraints under which rural households operate. Foley (1988: 16) has formulated this insight, but also points to some of the fundamental social and resource constraints that provide the material basis for the perception of whether, or to what extent, fuelwood scarcity constitutes a problem: `Interventions are less likely to succeed if they do not recognize that physical scarcity means nothing unless it is related to the human dimension.'

As Peter Dewees has cogently pointed out, one has to ask whether these costs (costs imposed by physical scarcity or distance) are the outcome of physical scarcity itself or of much more fundamental issues such as labour shortages, land endowments, social constraints to wood resources, or cultural practices. These 'human issues' are both complex and dynamic and frequently undergo rapid and adaptive change which the outsider may easily miss.

Implicit in Foley's statement is that physical woodfuel scarcity is not a meaningful concept as such. Rather scarcity is a relative concept which is determined by the availability of resources to rural households. In other words, given a specific woodfuel resource availability in a particular area, regardless of whether the woodfuel stocks are considered as well-stocked or seriously depleted, the perception of scarcity from the point of view of individual households is determined by the relative availability of labour of households or the tightness of their labour constraint. Therefore, even under conditions of depleted woodstocks, woodfuel scarcity may not matter if sufficient labour resources are available to collect fuelwood. Conversely, where woodfuel is still relatively abundant, but household labour is severely constrained, for example in female-headed households (FHH), woodfuels may be perceived as scarce. From here it follows that possible responses of households with different resource endowments and access to external resources may involve numerous adjustments which may be implemented sequentially or in varying combinations. Examples of such adjustments are increased buying of fuelwood, switching to or increasing the reliance on inferior fuels (less preferred woodfuels and agricultural residues), implementation of consumption strategies (skipping of meals or sharing of meals with neighbours of family members) and implicit fuel saving strategies (pretreatment of foods, change of the type of foods cooked, etc).

Implicit in Foley's statement about the relationship between labour constraints and perceived scarcity is that there are opportunity costs involved, and hence trade-offs, in using labour for alternative uses. This points to the need to chose a broader and more systematic framework to conceptualize household decisions which systematically integrates these relationships. Such a requirement is also implicit in Foley's characterization of 'human issues' in that he associates land endowments and social constraints to wood resources and social practices, with the problem. In economic terms, such constraints may be interpreted as intra-household constraints for the allocation of resources to produce goods and services, while social practices constraining household members' participation in particular activities may involve inefficient intra-household labour resource allocation.

A similar implicit reference to trade-offs involved in the allocation of the time women spend between existing activities, and time changes associated with the adoption of fuelwood saving options such as an improved woodstove, is made by Cecelski (1987: 130):

> Any additional activity required or requested as a result of development programming must be carefully weighed against her current time allocation to ensure that a change will not leave her and her family worse off than before. A woman will not use a lorena-type cookstove if she has no time to gather the wood it requires and no implement to cut the wood to size.

Again, the relevant issue for policy purposes which is expressed in this view is not related to fuelwood scarcity but to labour constraints, and the integration of a particular cook-stove and its implicit woodfuel requirements into the existing labour allocation of a household. Even though the prediction that a particular type of woodstove will not be accepted when its use requires additional labour which cannot be accommodated by a labour-constrained household appears intuitively logical, such conclusions implicitly assume that the household is at the same time not willing or able to purchase wood. Hence, such conclusions appear to be valid only for labour- and cash-constrained households, but not for rural households in general. For example, a household may be labour-constrained due to a mix of labour requirements for home work, field work and off-farm labour work or informal income-generating activities. If these activities generate sufficient income to purchase additional quantities of wood, the labour constraint may exist but may not represent the major impediment to buy a stove.

A further dimension of alternative situations which applies to many rural households in areas of rain-fed agriculture, is that labour constraints are seasonal. Under these circumstances, a cash-constrained household may face a tight seasonal labour constraint during the field preparation, growing and harvesting season. This impedes the adoption of a lorena stove for the reason cited by Cecelski and particularly because of the high opportunity costs of time involved, but there may be sufficient time available to collect woodfuel during the agricultural off-season. If no remunerative alternative employment is available during this season, the importance of the labour constraint for the adoption or non-adoption of a lorena-type cookstove vanishes completely and the likely response of a household or woman becomes indeterminate. To clarify such issues, in-depth analysis of the seasonal labour demand profile is required.

To be of operational value for policy purposes the identification of household resource constraints, and particularly the most binding constraints, is doubtlessly important. However, as illustrated in the previous examples, the allocation of household resources and resource constraints have to be analyzed jointly and in connection with an adequate conceptualization of household objectives, to understand household decision-making considerations in rural households.

A third example of how the relationship between general variables and the potential for woodfuel development initiatives can be established, is provided by Bradley et al (1993: 25). The authors have identified six variables from the sampling of approximately 550 farms in the district of Murang'a, Kenya, different combinations of which are interpreted as broad indicators for gauging potential responses to woodfuel development interventions. In their own words:

> attention is drawn to those same general factors which have a bearing on woody biomass and woodfuel provision on the farm. In this instance, six variables have been used to demonstrate the distinctive differences between the 14 farm types of the district: cash crop emphasis, firewood shortage, the purchase of firewood, the importance of external monetary support to the farm, and farm and farm household sizes. With these results it becomes possible to describe and assess individual farms with respect to their potential reaction to woodfuel development intervention. In saying this, we are not suggesting that each farm must necessarily accept or reject development initiatives, merely that a range of significant influencing factors have

been identified, and their expression across a wide range of farms (altogether approximately 530) observed.

This empirical approach may in practice be a useful and efficient tool for such purposes. However, the limitation of this approach is that the objectives and the decision-making behaviour of peasant farmers which are related to these variables, are not explicitly explained or conceptualized. The discussion of the underlying conceptual framework of this approach will be discussed further below.

4.1.2 Relationships between markets and household decision variables

Integrated household energy policy analysis has to take into account how non-energy related policies may affect and change the variables which energy-related policies are also addressing. The type of variables and markets that are involved, and the relative importance of those markets to generate income, vary significantly for the broad categories of farm and urban households. Labour markets and informal goods and service markets represent the principal markets for urban households to generate income. Income for the majority of rural households holding land, on the other hand, is primarily determined by goods markets for agricultural produce and to a lesser, though not insignificant extent, by rural labour markets. For urban households, wage levels in urban labour markets tend to change more predictably because they are largely dependent on economic and demographic factors affecting supply-demand conditions and specific labour market policies, such as restrictions on migration and statutory minimum wages.

Rural household income instead may change must faster and more erratically because of domestic policy changes (market liberalization, price policies, changes in subsidies, enhanced access to credits), and changes in the international terms of trade. Other markets of interest are credit markets, access to which affects households' opportunities to finance productive inputs and investments in durable consumption goods. In addition macroeconomic policies such as currency devaluation may have different impacts on real incomes in urban and rural households, because they have different patterns of consumption. A currency devaluation acts like a tax and will force different adjustments in the consumption behaviour of urban households depending on the composition of their basket of consumption goods. Farm households may be in a better position with respect to the impact of devaluation on income, depending on pricing policies for agricultural inputs and producer prices, and their degree of dependence on cash crops.

The implications of such policy changes are important in two major respects. First, sustained changes in the real level of income influence the energy choices of households and hence their movement along the fuel ladder. Secondly, and most relevant for rural households, it changes directly or indirectly the opportunity costs of land and labour. In principle, all energy options - other than energy prices - that may be considered for rural households, involve different requirements as to the amount of household resources in terms of labour, land and cash resources which need to be utilized. Changes in access to and of prices in labour markets and goods markets for smallholders, will affect the opportunity costs of land and labour. For example, enhanced access to productivity-enhancing inputs or access to the market of a profitable cash crop, will increase the opportunity costs of land and labour. If such change is widespread and opportunity cost increases are relatively high, for example, the value of wood produced on farm land suitable for the alternative crop will decrease because opportunity costs of land figures as a cost factor in wood production under these circumstances. Lower returns from wood production may lead to rather different responses of smallholders concerning the decision to grow trees on their farms depending on specific household characteristics. A few examples will illustrate this point.

Assuming that farmers with larger holding sizes and higher incomes are less risk-averse, higher crop prices may lead, for example, to the uprooting of existing woodlots. If, however, comparatively less risk-averse households with larger holding sizes have sufficient land available to pursue at the same time a risk diversification strategy, they may leave their existing woodlots untouched. On the contrary, smallholders with relatively small holding sizes may be more inclined to chop down existing or planted trees on their farms, because the relative impact of income increases from a profitable cash crop may be high and their land constraint may not allow them to pursue a crop-related risk diversification strategy. It is also conceivable that household labour constraints do not allow them to get involved in the production of a profitable cash crop (assuming higher total or seasonal labour requirements), or only to a limited extent. Cultivation of a cash crop may be considered unfeasible or risky when it demands additional labour inputs, the use of which coincides with increased competing time demands or when availability of incremental labour is subject to uncertainties due to the exigencies of life. A household operating under such conditions may be objectively or subjectively constrained to respond to new opportunities and will consequently not alter the subjective opportunity costs of land. Of course, the same arguments could be applied to the option of a smallholder to establish a woodlot, given real or anticipated opportunities to change his cropping pattern.

The above examples demonstrate possible impacts of, and responses to, market price changes under different resource conditions with regard to decisions concerning the integration of trees by smallholders. Other policies and programmes targeted at the rural population, address directly and indirectly existing constraints and problems that adversely affect their scope of economic choices and income-earning opportunities. For example, enhancement of rural water supplies will reduce labour spent on water collection and hence improve either the female or the total household labour budget. The relaxation of labour constraints may enable women to spend more time on fuelwood collection or, if income opportunities exist, to reallocate time to such activities and to buy fuelwood instead. Other outcomes are possible depending on whether women or men control the households' financial resources. If men control most of the cash income earned by women, their preferences may be overruled and they may end up collecting firewood.

The crucial point of the above examples for the analysis of households is to exemplify that energy policy interventions have to be integrated into the framework of changes in the markets and policies that have a bearing on household production and consumption decisions. This relationship, especially as far as rural smallholders are concerned, does not primarily focus on resultant changes in income but on the dynamic interaction of economic and social variables that provide the basis and dynamic framework for woodfuel related interventions. A broader policy perspective is also necessary both to clarify how woodfuel and certain energy policy measures are related to other policy measures and which contributions can realistically be expected from them to achieve general social and economic policy objectives. This takes account explicitly of the possibility that changes in non-energy related policy variables may potentially render even well conceived energy policy interventions obsolete or less effective, if they are not designed flexibly enough to accommodate such changes through fine tuning or the introduction of complementary measures. Hence, resilience of energy policy measures and consistency between energy policy and sectoral and macroeconomic policies, is a *conditio qua non* for successful policy design.

The more recent policy research which focuses on woodfuel policy including farm forestry, agroforestry and communal forestry (see hereto in detail Chapter 6), is framed to a large extent in terms of how farmers respond to changes in resource availability and what the role of tree subsystems are in this context. This analysis is usually based on the population driven fragmentation of landholding sizes, and analyzes how farmers respond given their differential access to capital, land and labour under certain market and price situations in the woodfuel markets, and how trees may fit into different farming systems under these circumstances.[2] The conclusions of comprehensive research in the area of woodfuel policy, such as the research by Bradley (1991), Bradley et al (1993) and Leach and Mearns (1988a) which has been crucial to establishing a new conceptual framework of thinking and

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2 A brief synopsis of this approach is described in a publication of the Food and Agriculture Organization (FAO) of the United Nations (see FAO 1989: 107-108.)

research for woodfuel policy in the overall development context as well as of many other researchers in this area, has been the recognition of analyzing the smallholder household economy in the context of markets and social relationships which condition household behaviour and responses.

The scope of analysis which is deemed necessary to understand and design policies, for example, for farm forestry, is reflected by Arnold (1987): 'Land, labour, capital and markets appear to be the essential variables that control economic viability of smallholder tree growing'. The key variables mentioned by Arnold do not address explicitly the role of social relationships and refer to smallholders, that is farmers which are known to have very distinct economic characteristics as a group with internal social and economic stratification.

These variables are explicitly considered, for example, by Bradley (1991: 87) who has developed a more complex 'conceptual framework for the analysis of African production systems'. This conceptual framework was developed and applied by the authors in the context of the Kenyan Woodfuel Programme.

4.1.3 Conceptualization of peasant households

The core concepts of the framework proposed and used by Bradley et al for the analysis of woodfuel policy issues are outlined and discussed in the following as a basis for the subsequent discussion of relevant methodological approaches for this study.

The conceptual framework builds on the interrelated concepts of a 'peasant mode of production', 'physical reproduction' and 'social reproduction'. Starting from the debate about the role of the peasantry within the transition from pre-capitalist to fully developed capitalist relations of production, the issue of importance to the analysis of woodfuel issues is the 'need to build a context in which the varying ways that different smallholders have adjusted to modernization can be identified and related to this process of transformation' (Bradley 1991: 74). This transformation process which is associated with changes in labour allocation, resource access and distribution of cash income and goods in kind, and 'social adjustments' within the 'family enterprise' are conceptualized as 'having a bearing on a households' receptivity to the technical changes implicit in a development programme'. For this reason 'there is a necessary interest in the notion of the peasantry simply because its defining characteristics will have a very strong bearing on the process of development' (Bradley 1991: 75).

Four defining characteristics of peasants are identified by the author. First, ownership of the land and control over decision-making rests generally with the family, which implies that the means of production and the producer are not separated. Secondly, the basic unit of production is the household and its family farm and the reproduction process of the household relies primarily on family labour. Thirdly, production is both for subsistence and for the market. In this context, it is worthwhile to note for further discussions below that goods for reproduction which are not marketed are referred to as 'use-values' and marketed goods are 'surplus-values'.[3] The third peculiarity can also be expressed as the existence of a dual economic nature: the peasant household is a mixture between a family and an enterprise which simultaneously engages in production and consumption. Fourthly, a characteristic which may not be generalizable for peasant households elsewhere but which is specific to the situation in Kenya, is that 'the division of responsibilities (and to a certain extent labour) within the family reflects the division between subsistence and commodity production'. In other words, there exists a gender-specific division of labour whereby women concentrate their activities on food production while men are primarily engaged in cash-crop production and external wage work.

In this context Bradley also mentions the process of increasing 'individualization of social relationships' which refers to the 'gradual replacement of a clan-based, collective focus and its replacement by one built on individual community'. As pointed out in Ellis (1988: 11), even though several writers have interpreted the economic aspects addressed therein, that is the non-market exchange and sharing of goods, as a distinct feature of peasant societies, this feature is not necessarily unique.

Bradley (1991) introduces the concept of reproduction which involves both the simultaneous process of physical reproduction of labour, that is the satisfaction of basic needs and social reproduction which refers to the sustained social well-being and maintenance of the family, and the socialization of its members. Their conceptual framework is related to the 'recognition of reproduction as the primary rationale of the small farmer'. With regard to the question addressed above, that is how objectives of smallholders (peasants) can be conceptualized, the specific objectives associated with the concepts of physical and social reproduction were not further developed or applied. In this respect, it has to be noted that the concept of reproduction as used by the authors is not unique to small farmers but is generally applicable to households. However, some indirect guidance as to how the reproduction rationale of small farmers can be interpreted in relation to the operationalization of objectives in other economic concepts dealing with the rationality of farmer households (see the next section) is provided. They interpret the invoking of the concept of risk avoidance to describe the prime rationale guiding peasant

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3 The terms 'use-value' and 'surplus value' refer in this context to central concepts of Marxian socio-economic theory.

production decision as 'an implicit, though vaguely expressed recognition of the importance of reproduction strategies' (Bradley 1991: 88). This may be interpreted in the sense that social and physical reproduction strategies primarily reflect an orientation towards risk avoidance. However, discussions of other aspects related to the transition of the peasant economy suggest that the process of physical and social reproduction encapsulates in broader terms the main problems, concepts and models relevant to understanding the peasant household. This analysis captures the rationale or objective(s) to which resource allocation decisions of farm households are subject to in the transition process from production for subsistence (simple reproduction), to production for the market, which is guided by profit maximization (extended reproduction).

In order to interpret the conceptual framework suggested by Bradley, one has to understand the theoretical concepts relating to peasant households. At the heart of the debate about conceptualizing household peasant behaviour is the question of how peasants can be conceptualized in a way that has theoretical relevance for economic analysis. As shown in Ellis (1988), the conceptualization of peasant households in terms of distinctive characteristics has been approached from the point of view of social anthropology with regard to the social characteristics of peasant societies who focus on the distinctive features of peasant production in relation to their dominant economic activities, that is access to land, labour, capital and consumption. Social anthropology emphasizes three ideas: transition from self-sufficiency to integration into a market, subordination within society implying exploitation from outsiders and unequal access to power, and social stratification and subordination within peasant communities. Unique economic characteristics include *inter alia* those cited above from Bradley et al.

An additional important feature which relates to the concept of physical reproduction is the interdependence between production and consumption decisions, and the dual character of investment which may have both consumption and production aspects. Linked to the dual nature of the household is the problem that concepts of profit and returns to family labour are difficult to distinguish.

As shown above, Bradley uses the terms smallholder households, family enterprise, small farmer and peasantry in the same context. Therefore, it is not clear whether they aim at a distinctive economic and social concept of *peasant* households as such. An even more important aspect for this discussion is the point made by Ellis (1988: 9) who emphasizes that the definition of peasants in terms of a concept which has theoretical importance for economic analysis and empirical content, requires an integrating concept which is common to all, or most, of the distinct individual features. The integrating concept has two elements which were formulated by Friedmann (1980: 164). The first element, that is 'partial integration into markets' is self-explicatory and includes the option for the peasant (at least to some degree), to withdraw from the market. The second element is the 'limitation in the operation of market principles'. This element stresses the feature that peasants operate in distorted or imperfect product and factor markets.

In putting all the concepts together, Ellis (1988: 12) suggests the following economic definition of peasants:

> Peasants are farm households, with access to their means of livelihood in land, utilizing mainly family labour in farm production, always located in a larger economic system, but fundamentally characterized by partial engagement in markets which tend to function with a high degree of imperfection.

The above discussion and definition of peasants help to clarify one major component of the conceptual framework used in Bradley et al. Even though there are some ambiguities introduced through the use of different terms for peasant households, and the role of market imperfection is not explicitly addressed in their framework, it may be suggested that their approach is firmly rooted in the economic definition of peasants which also embraces social characteristics of peasant societies.

It needs also to be emphasized that through the integration of imperfect markets into the definition of peasants, policy failures to create or to improve the efficiency of such markets enter into the analysis.

The second component of their approach, which is relevant with regard to the economic rationale of peasant households and their role in the political economy, is firmly rooted in Marxian political economy.[4] The two concepts combined do not represent a fully fledged peasant theory in a theoretical or formal sense. Rather it is exactly what is labelled by the authors, a conceptual framework. Their framework has some more deep-seated methodological implications, the discussion of which has a long history, involves complex issues and has been at times rather controversial. This discussion is beyond the realm of this

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4 The concepts used in Bradley (1991) in the context of reproduction originate directly from Marxian socio-economic theory. A summary of the relationships between the concepts of production (productive assets and labour), social relations of production (describing the link between control over production means and distribution of production and income), mode of production (which links social relations of production to the technological characteristics and the legal, institutional and cultural structure of society), social reproduction in the form of simple reproduction (subsistence production without savings other than for next season production purposes) or expanded reproduction (production with savings and investment to increase production), is contained, for example, in Ellis (1988: 46-49).

research.[5]

4.1.4 Farm household models and household energy policy

Household decision behaviour in terms of the allocation of a households' time or family labour to home work (production of non-purchased goods and services related to household reproduction), home production of goods (for their own consumption or sale), market work (sale of labour), the allocation of non-labour production factors (land and capital), and the allocation of consumption between private production and market purchases are analyzed in household, or more specifically, farm household models. These models thus represent a conceptual framework for the analysis of household decision behaviour. Their main objective is to analyze or simulate the impact and likely reactions to policies which affect the circumstances under which the household operates and makes its decisions. The logical structure of these models, most of which are deeply rooted in the microeconomic concepts of neoclassical theory, is to make logical inferences about household behaviour based on assumptions as to single or multiple household objectives and the nature of the goods and factor (labour and capital) markets with which the household interacts.

In other words, farm household models integrate the economic parameters which have been identified as playing a crucial role for farm households when making decisions about the integration of tree systems into farms. In relation to this conceptual framework, researchers in the field of woodfuel and energy policy conceptualize the issue of how labour allocation decisions are made in peasant households by using certain concepts pertaining to farm household models, but hardly ever use a specific farm household model or explicitly refer to household models as a conceptual framework for farm household decision-making. For instance, the analysis of how households respond autonomously or are induced through policy measures, with regard to tree planting and tree management, emphasizes the role of specific internal resource and market constraints. In the context of farm household models, this approach implicitly conceptualizes household decision-making in terms of a *constrained profit maximization* problem or model. Other researchers relate household

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[5] The discussion refers here to the controversies between proponents of the dialectic methodological approach and logical positivism. It should be noted that Marxian political economy considers economic, social and political aspects of society as an analytically inseparable entity which has to be analyzed in the same conceptual framework or theory and which embodies conceptually a strong notion of social conflict. Instead, the economic concepts of the neoclassical economic theory which are also central to farm household theories, are characterized by a concentration on techno-economic factors which leave the discussion of social and economic dimensions to other disciplines of science, or treats them separately as expressions of pure rational economic behaviour. However, it has to be taken into account that these different methodological approaches are compatible over large areas of pure economic analysis.

behaviour and likely responses concerning woodfuel supply-enhancing or demand-management measures to a single constraint, such as the availability of labour. This view implies that a single constraint is regarded as most binding. Thus policy measures are chosen and are designed with a view to either relieve this constraint or to design measures in such a way that the additional resource requirements associated with a policy measure are likely to be accommodated by the type of household in question. This approach is based on the 'principle of the most limiting resource' which forms part of a set of principles underlying the neoclassical farm household theory (see below). Other researchers emphasize the role of risk and uncertainty to identify farmers' attitudes and exposure to risk, in order to design woodfuel policy packages with risk mitigating features which fit into the perceived risk profile of farmers.

In summary, single concepts or a mixture of concepts are used by researchers and notably but not exclusively by foresters, in the design of woodfuel policies to characterize peasants with regard to their resource allocation behaviour in relation to specific conditions. As these concepts are part of farm household theories or represent single theoretical concepts of farm household theories which may be integrated into broader theories, the question arises whether or, to what extent, they are relevant to rural household energy policy analysis.

In this context it has to be noted that farm household models do not treat woodfuel policy issues explicitly. This raises the question of how woodfuel and energy-related policies fit into these theories? There are several ways to answer this question, prior to the discussion of specific models, which will indicate how woodfuel issues may be directly assimilated into these models or related to key concepts.

A direct relationship exists with regard to decisions about the allocation of land to various crops, which is related to the question under which circumstances and in relation to which objectives and operationalized decision criteria, households plant trees as cash crops or for home consumption. This is also linked to the characteristics of tree systems as assets or consumption items and their relation to subsistence production and production for the market. From the overall perspective or question of how to integrate trees into farms, it is paramount to understand the existing situation on the ground and its dynamics before specific policies are designed which are deemed to suit the underlying objectives, needs and constraints.

Understanding real life situations with regard to household decision behaviour can be approached (and that is the approach which is usually taken, though it is methodologically not the exclusive method) by capturing household decision behaviour in situations with and without trees on the farm. The latter situation refers analytically to a situation which in the first instance ignores trees and focuses on the analysis of decision patterns of farm households in response to specific agricultural policies and their explicit and implicit assumptions about farm household decision behaviour.

From the analysis of farmers' responses to specific agricultural policies, inferences can be made with regard to those aspects which appear relevant for the choice and design of woodfuel and energy policy options. For example, agricultural policies and measures are premised on specific assumptions about key aspects of the decision behaviour of targeted groups of farmers and their likely responses. Thus they implicitly make use of a farm household model. For example, if farmers are found to be responsive to shifts in the relative prices for cash crops and perennials, it may be inferred that they primarily evaluate the options to grow trees (farm forestry, agroforestry or community forestry) from a commercial perspective. It has however additionally to be taken into account that the benefits from cash crops and trees are not strictly comparable in many respects because of the multipurpose character of the latter and hence contribution to production and consumption objectives. This adds an additional dimension to the analysis of woodfuel policy options, that is, the valuation of benefits of trees for other uses. Integrating this aspect into the design of woodfuel policies requires that valuation need to be addressed[6]. These issues are further discussed in Chapter 5.

Scope and adequacy of farm household models

The question posed in the previous section, whether specific peasant theories or specific aspects and concepts of peasant theories can contribute to the formulation of woodfuel policy analysis, requires a definition of the scope and type of theories which can be dealt with in this research. There exists an extensive literature in this field, the review of which is clearly beyond the scope of this research. The main characteristics of different theories and their theoretical shortcomings and problems in application have been discussed comprehensively in several publications, for example by Singh et al (1986a and 1986b), Ellis (1988) and the World Bank (1990a). This section draws primarily on these sources, particularly, the latter two. A second delimitation originates from the additional objective to identify which theories and concepts may be useful for an analysis of farm household decision-making in Malawi. The latter consideration has a bearing on the choice of household models which are adequate for country-specific circumstances. In this respect, the crucial question has been raised: which 'choice-theoretic' framework is adequate for African countries (World Bank 1990a: 40)? As will be seen below, the characteristics and

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6 It has to be emphasized that the notion of valuation of benefits does not imply that such benefits can be valued exclusively by applying standard methods of cost-benefit analysis.

definition of farm peasant households which were discussed above represent a basic conceptual framework which includes the relevant characteristics for peasant household models in most African countries, inclusive of Malawi.

An important issue for empirical research, is that the policy implications following from the implicit logic of these models have to be related to the findings of empirical research (Ellis 1988: 137). This issue is relevant in two respects. First, the basic assumptions of a farm household model have to correspond to the empirical situation and type of farm households encountered. Secondly, hypotheses have to be derived which can be tested against empirical research results. Apart from the question of representative assumptions, a crucial problem consists in the quantitative analysis of predicted cause and effect relationships. This problem refers, for example, to the quantification of price and income elasticities or other information from which the nature of responses can be convincingly gauged in the qualitative manner. It is worthwhile to note that the quantification problem is, of course, not unique to farm household models. The data problems associated with the quantification of elasticities of supply and demand for woodfuels were raised by Leach and Mearns (1988a: 9) as a reason why woodfuel gaps tended to be linearly extrapolated.

An important aspect from the viewpoint of empirical analysis, is that the main theories and concepts of farm household models cannot be considered as strict alternatives, in the sense that empirical analysis has to lead to the adoption of a particular model to fit a particular household situation. Rather, elements of alternative models can be combined to explain main aspects of household decision behaviour in particular circumstances. A caveat which is not unique to farm household models is that because of the simplified assumptions used in household models, they represent conceptual frameworks which should support analysis of issues rather than being regarded as methodological straightjackets (World Bank 1990a: 41).

From the above discussion it is evident that farm household models have to capture essential features of household and market realities. This is *per se* a complex endeavour, taking into account that the peasant household as defined above is situated in a spectrum of hypothesized situations which can be described from the point of view of farm household theories as follows. At one extreme end of this spectrum stands the neoclassical theory of commercial farm households in which the peasant household has lost its unique identity. Hence, farm households are analyzed in terms of rational decision-making units with the sole objective of profit maximization. On the opposite side of the spectrum stands the subsistence household with no integration into markets. In between lie peasant household theories which emphasize different aspects of peasant household behaviour in terms of the set of objectives and their relative importance, and the influence of markets they interact with.

Ellis (1988) has compared four categories of farm household theories which are of relevance for this research. The following discussion draws on the results of his research. All theories are based on the assumption that the farm household maximizes one or several objectives and share several key analytical principles[7] which are used in economic analysis.

4.1.5 Farm household models and concepts

Farm households as a profit maximizing entity

The key assumption of the 'theory of the optimizing peasant' is that the household principally aims at efficiency in terms of its three attributes, that is technical, allocative and economic efficiency. Several methods can be used to test these efficiency attributes. The first commonly used method to analyze allocative efficiency is the 'production function approach'. This approach involves the estimation of a production function from a sample of farms and the test of whether, or to what extent, the condition for allocative efficiency is met. As pointed out by Yotopoulos (1968)[8] this approach, which is always based on a sample of farms and a production function which reflects average conditions, cannot prove that farmers are efficient. If farmers are found to be efficient as a group an inference can be made that individual farmers attempt to be efficient. The concept of technical efficiency is used to compare the observed technical efficiency of individual farms or types of farms, with the maximum technically achievable yield, under specific farm conditions. Since 'yield gaps' may be due to profit-maximization considerations and technical and allocative efficiency, observed yield gaps can be broken down into these components. The theory of the profit-maximizing peasant in its pure form and the production function approach as a procedure for testing attempts to achieve allocative efficiency, are seen to have limited applicability for the analysis of peasant households. This is due to the problem that the assumptions of the theory, that is homogeneity of production functions and fully functioning or competitive markets in which households operate, are too restrictive to capture the reality of conditions which characterize most farm households. As a consequence, the variation in conditions of farm households and their causes, are obscured. This is in stark contrast to the requirement that policy should take into account significant

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7 These principles are common to microeconomic analysis of neoclassical models. In this context the economic principles refer to the terms 'variable and fixed resources', 'diminishing marginal returns', 'substitution principle', the 'principle of the most limiting resource', 'opportunity costs' and 'comparative advantage'. See, for example, Ellis (1988: 41-42), other authors cited by Ellis such as Doll and Orazem (1984) or microeconomic neoclassical textbooks.

8 Cited in Ellis (1988: 71).

variations of conditions and should target specific groups efficiently.

Despite these limitations of the theory of the profit maximizing peasant, empirical evidence of peasant farmers' responsiveness to changes in farm input and producer or market prices, indicates that economic considerations or economic rationality are a strong element of peasant decision-making. Therefore the objective of profit maximization and the striving of peasant households for economic efficiency cannot be entirely discarded. A more realistic theoretical approach therefore is to maintain the profit maximization objective and to integrate explicitly the constraints under which peasant households operate. This approach is equivalent to the concept of 'constrained profit maximization'.[9]

Constraints which may be considered are the existence of risk and uncertainty, trade-offs between profit maximization and other household objectives and market imperfections. As will be discussed below, some of these constraints help to explain peasant behaviour. It should be noted that the description of objectives as constraints in this context originates from linear programming theory. Objectives, other than the one chosen for maximization in the objective function, are addressed and technically treated as constraints. Linear programming models (LPM) are widely used for the analysis of the allocation of labour resources to the production of crops and off-farm income activities within peasant households.[10] An attractive feature of LPMs are the shadow prices which are contained in what is technically referred to as the 'dual solution'. Shadow prices measure the value of the resource which most limits supply at the margin. For instance, if labour is the binding constraint, the shadow price of labour measures the implicit price of labour if another unit of labour were available. In the context of woodfuel policy analysis, a shadow price for

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[9] It should be noted that in the literature some other concepts have been developed to explain empirical decision-making behaviour which cannot be explained in terms of pure neo-classical economic rationality. For example, the concept of 'bounded rationality' has been developed by Simon (1956), while the concept of 'selective rationality' has been developed by Leibenstein (1976). The concept of 'selective rationality' simply embodies the idea that the degree to which neo-classical rationality is applied is dependent upon the existing amount of financial, environmental or other resource-related pressures. When applied to energy consumption decisions, the concept of 'selective rationality' would predict that, for example, households in wood-deficient areas would be more concerned with constraints and would display more calculative behaviour concerning wood consumption levels and options, than households in areas with more ample wood supplies. The applicability of these general concepts to household energy consumption decisions has been analyzed, for example, by Hosier (1985) who found that the concept of 'selective rationality' is useful for examining energy consumption decisions of rural households in Kenya (see Hosier 1985: 125). For the analysis of energy consumption decisions in Malawi, these concepts are not discussed further mainly because the comparative data base to test these concepts is not available.

[10] This type of analysis has been applied to agricultural policy analysis by various researchers in Malawi, notably by Chipande (1986), Simler (1993b) and Becker (1990). It should be noted that this framework can principally be used to model farm forestry policy options. For example, one of the agroforestry options which are discussed in Chapter 6, has been integrated by Simler (1993b) in a linear programming model in order to analyze its economic viability.

labour may be interpreted as the value of labour which is withdrawn from production activities, for example, for woodfuel collection.

It should be noted that specifying LPMs for agricultural policy analysis, including woodfuel policy options, requires an adequate data base because the models' solution in terms of efficient resource allocations and shadow prices are extremely sensitive to the input data. Thus weak input data for the modelling of crop options and woodfuel supply options may lead to model solutions which may be far from reality. Despite this drawback and the general limitations of LPMs with regard to their linearity assumption, which has to be taken into account when analyzing model results, they represent useful tools to explore household decision-making. For example, the solution of a model simulating past policies over a specific time period can be compared with real world outcomes. The process of calibrating an LPM model to simulate actual outcomes itself requires a careful analysis of objectives, individual constraints and the assumptions made respectively. Often this analytical process generates more insights into the nature of the problem and the real life logic of decision-making than the quantitative results of an LPM.

Risk aversion

Risk aversion of peasants is a major issue in designing agricultural and woodfuel policies, because different sources of risks to which peasant households are exposed to and different attitudes to risk, have different implications for the scope and type of suitable policy measures.

When speaking of risk it has to be considered that risk and uncertainty are well-defined economic concepts, the relationship of which has to be clarified. Both concepts refer to the lack of perfect knowledge concerning decision-making parameters. Decisions under risk are defined as those for which probabilities of occurrence of events influencing future outcomes can be estimated. Decisions under uncertainty are defined as those for which no probabilities of occurrence of events can be estimated. Because risk is statistically defined, it is associated with the notion of objectivity. This suggests that a clear separation of the concepts is necessary. However, this view has been challenged in two ways. First, it is argued that likely future outcomes and probabilities of their occurrence can be subjectively estimated (Schlaifer 1969). Secondly, as pointed out by Ellis (1988: 83), in most decision situations only the subjective degree of probability is relevant, even if the probability of occurrence of certain events such as drought could be ascertained. Hence for application purposes, where the technical distinction between risk and uncertainty has no analytical or practical advantage, the terms may be used interchangeably. For the analysis of risk and uncertainty in relation to peasant household behaviour, however, Ellis (1988: 83) has suggested a useful redefinition of subjective probabilities of farm decision makers with the way these probabilities enter their economic decisions. The definition of uncertainty is not anymore linked to subjective or objective probability of events but is used as a descriptive term for the 'character of the economic environment confronting peasant farm households'.

Sources of risk are all types of factors which are beyond the control of the peasant household. Major categories of risk are natural hazards, that is, output or yield uncertainty, price uncertainties, insecurity of control of resources within the peasant community and institutional uncertainties.

Two approaches for treating subjective probability exist which can demonstrate the implications of risk avoidance. The 'income variance approach' conceptualizes risk as the probability of the occurrence of events which result in deviations from expected average income over several years. The logic of this approach is to assign probabilities to the occurrence of good and bad years over a specific time period. Total value product functions or output response curves for using different amounts of fertilizer in good and bad rainfall years, and the expected (probability weighted) outcome, are used to describe different operating production costs. Depending on which level of fertilizer is used, the margin of profit or the possibility of loss varies for each operating position. For example, using the maximum amount of fertilizer will yield the highest profit in a good year and the highest loss in a bad year. Conversely, a low fertilizer input produces lower profit margins in a good year but may still produce a profit in a bad year. Using an amount of fertilizer in between the previous two choices will produce less profit compared to the best year but contain the possible loss in a bad year at a low level. Clearly the operating choices involve trade-offs between income and loss. Each operating condition represents a specific risk position. A farmer choosing an operating condition which maximizes his profit, consistent with the production which can be obtained when the probability weighted outcome of bad and good years is assumed to occur, is called risk-neutral. Risk-averse and risk-taking farmers are described by production decisions which diverge from the risk-neutral operation decision. Risk-averse farmers choose a production point which is lower than their subjective judgment of the likelihood of occurrence of a bad year would suggest. In other words, the production decision is based on the assumption of the worst possible outcome. Conversely the risk-taking peasant is characterized by a production decision which aims at the largest possible profit, even though the probability of a good year is uncertain.

The second approach treats risk as the probability of disaster. Disaster in this context corresponds to a critical minimum or subsistence level of production or income which may be defined in terms of a poverty line or a food security concept. This risk concept brings into focus that avoidance of disaster is a central objective of poor peasant families. According to Lipton (1968), households struggling to survive are necessarily risk-averse. In terms of the central household objective of resource-poor households, self-sufficiency must be their principle objective. With regard to the examples used for the description of the income variance approach, farmers whose prime concern is food self-sufficiency, operate at the lower fertilizer input levels which minimize the risk of loss. The implication of risk-averse decision-making is simply that profit maximization is traded off against security concerns. The conceptualization and definition of risk can also be treated in the more general framework of utility maximization. However, this approach leads to the same conclusion in terms of the behaviour of risk-averse farmers, that is, utility is maximized with regard to uncertainty and not in relation to profit or income maximization (Ellis 1988: 88-93).

The empirical analysis of peasant risk behaviour has generally confirmed several main propositions. First, peasants are risk-averse. From the point of view of economic efficiency, the degree of deviation from efficiency increases with the riskiness of the crop. Secondly, risk-aversity as a production objective is related to cropping patterns which emphasize food security. This may be reflected in planting more land to subsistence food crops than what would be expected, given relative prices and profitability of food and cash crops, or by employing mixed cropping practices which can be designed to contribute to food or income security at the expense of higher output and income. Thirdly, risk aversion inhibits the diffusion and adoption of innovations. Adoption of innovations is also conditioned by access to credit and the cost of credit. Risk aversion is related to lack of information or its inadequacy, and peasant attitudes towards change are related to imperfect knowledge about innovations. Fourthly, risk aversion is inversely correlated with income and wealth. In combination with the previous propositions it can be inferred that higher-income farm households are expected to be more innovative, more efficient, more involved in cash crop production, better informed and to have better access to credit.

These propositions directly define indicators which can be used to test empirically the existence, and degree, of risk aversion. In order to ascertain the relative riskiness of crops indicators such as fluctuation in relative prices, yields and income have been mostly used. Related propositions which are often quoted in the literature with regard to risk-aversion, are that risk-averse households have high implicit discount rates and tend to exhibit short-termism. The notion of high discount rate is just another expression of the concept of risk aversity. It was noted above that a risk-averse peasant household chooses an operating position in terms of fertilizer input which is lower than his subjective probability of production outcomes. Hence, a risk averse peasant penalizes the subjectively expected production outcome, to account for the risk involved. When the peasant household is viewed as an investor, high risk aversity can be technically expressed in terms of a high discount rate. Short-termism is a reflection of risk-aversity because the resource allocation decision for investments having a long gestation period, are discounted at high discount rates. The more distant the returns, the lower the present value of the investment. When applying risk aversity to the farmers' decisions concerning the growing of trees, it has to be taken into account that the risk characteristics of trees cannot be isolated from the risk characteristics of other resource allocations or investments of the peasant household. Resource allocation decisions of peasant households can also be interpreted in terms of a portfolio of investments. A fundamental principle of modern portfolio theory[11] is that the risk of an individual asset can only be evaluated in conjunction with the portfolio of investments of which it forms a part. The rationale of this approach is that a seemingly risky asset may reduce the volatility of the entire portfolio of investments and therefore may be actually a low risk asset. Therefore, the analysis of household decision-making behaviour has to focus on the risk diversification properties of tree systems within the context of the degree of riskiness the household faces with regard to other sources of risks.

For policy purposes the concept of risk-aversity suggests that different types of farm households could be defined in terms of their risk bearing capacity to respond to opportunities which are provided by policy changes. Classification of households according to risk considerations thus facilitates targeting policies.

Policy implications of risk aversion are related to the source of risk which they are designed to overcome. Natural hazards such as drought may be addressed by crop insurance schemes or resistant crop varieties which have to meet other user-defined characteristics. Where goods market risks are a major concern, various pricing or price stabilization policies, can be employed. Naturally the design of pricing policies has to be based on an understanding of an adequate understanding of the functioning and the efficiency of markets. In this respect, the limited knowledge about both rural and urban fuelwood markets is a major impediment to woodfuel policy analysis (FAO 1989: 102; Boberg 1993: 474). Subsidized credit and subsidization of inputs, such as fertilizer and seeds, are a common response to risk aversion which is related to disaster avoidance (Ellis 1988: 98). Where inadequate information is considered as contributing to risk aversion, supply of information through extension networks and other measures, forms part of a risk mitigating policy.

The role of land and tree tenure insecurity has been discussed in Chapter 3. A related aspect which was also discussed in Chapter 3 is that the alienation of customary land contributes

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[11] The principles of modern portfolio investment theory are summarized in Bodie et al (1989).

to risk aversion because it creates uncertainty as to the future access and utilization of customary land resources. Access to other sources of income, particularly from wage employment, enhances the income security of a household. Thus, the degree of completeness of a rural labour market and differential access to this market, influence the degree of risk aversity (House 1991: 870).

Important issues for policy analysis and design, particularly for fuelwood policy, are gender-specific risk perceptions. The predominant role of women in the reproduction of the household suggests that women are more risk-averse than men. This issue, and its relevance for policy analysis, is linked to the broader issue of intra-household decision-making aspects which are discussed further below.

Risk aversion is not a theory of its own but rather a modification of the neoclassical farm model. Technically, the utility maximization of the latter model coincides with income maximization. Risk aversion or uncertainty enters as a separate goal of security into the utility function. Therefore utility maximization involves a trade-off between these objectives. An important aspect of both theories is that the analysis of how household decisions are made focuses solely on the production side. Neoclassical farm household theory views the firm as a production unit and the household as a consuming unit. In other words, production and consumption decisions are separable. This separation rests on the assumption of the existence of competitive or complete goods and factor markets. However, where this assumption is not fulfilled, separation breaks down. A breakdown of separation implies that consumption and production in peasant households become interdependent. The dual role of the peasant household as both a production and consumption unit has been identified as a common characteristic of African households, notably of poor peasant households (World Bank 1990a: 40-43). More complete peasant households have therefore to integrate these interdependencies which implies that explicit recognition is given to consumption goals.

Apart from market imperfections in land, capital and goods markets, the existence or partial existence of a labour market plays a crucial role in the predictions of peasant household theories addressing the aspects of interdependence of production and consumption. These models are discussed in the following.

The drudgery-averse peasant household

Household models which are discussed in this section, as well as a number of other models which have been used for the analysis of peasant households in Africa (House 1991), are partly based on the peasant household model which Chayanov[12] used for the analysis of Russian peasant households.

Chayanov's model is based on the assumption that no labour market exists, or at least that engagement in a labour market is quite limited or sporadic. The absence of a labour market in a farm household model has two important implications. First, the opportunity cost of labour is not determined by the labour market as in the neoclassical household theory and is therefore subjectively determined. Secondly, the household maximizes utility by allocating labour to farm production until the marginal utility of goods produced (income) equals the households' subjective evaluation of the disutility of work (drudgery). Thus the household is perceived to maximize utility with regard to the opposing objectives of income and leisure.

A second assumption of the model is that each household has a minimum acceptable consumption level. Other constraints are the availability of labour, which is determined by the family size and age composition of the household, and the production function which is a function of the market price of goods which can be sold or retained for self-consumption and labour input. Subjective wage levels are defined by the slope of the tangent at the indifference curves, which measure the amount of income the household needs to gain to compensate for the loss of a unit of leisure. The trade-off between leisure and income is constrained by the required minimum level of income which is determined by the size and age structure of the household and the available labour supply. A consumer/worker ratio (C/W ratio) describes the ratio of consumers to workers in the household. The solution to the maximization of utility, subject to the three constraints, is defined by the equality of the subjective wage and the marginal value product of labour when it is assumed that the production function is the binding constraint.

Because the production function is determined by labour availability and the minimum consumption level depends on the family size and age composition of the household, the latter defines both the required minimum level and the maximum level of output or income. The unique aspect of the theory is that the preferences of the household change in relation to the demographic structure and hence consumption needs of the household. As the household moves through the demographic cycle the C/W ratio also changes. For example, young children raise the minimum consumption level but do not enlarge the labour availability of the household proportionally. The impact of a higher C/W ratio is that the marginal utility of income increases and the marginal utility of leisure decreases. Lowering

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12 Chayanov's theory is described in a number of publications, for example, in the German translation of his theory (Tschayanow 1923) and in Chayanov (1966).

the subjective wage also implies that the household is intensifying its use of labour. Since the household model is solved where the subjective wage is equal to the marginal value product of labour, the latter also decreases. Subsequent changes in the demographic structure of the household change the preferences of the household accordingly.

Barnum and Squire (1979: 26-36) have shown that in farm household models without a labour market, responses in terms of labour allocation and farm production to market changes in prices and costs, are either indeterminate or negative. Ellis (1988: 110) concludes that the Chayanov model has no predictive power concerning farm households' labour allocation decision in response to policies which affect the production function, that is changes in prices, production technology and other resources used in farm production.

However, because changes of preferences in the household are entirely determined by changes in the demographic structure of the household, the model implies several testable predictions. First, the time devoted to farm work is strongly correlated with the C/W ratio. Secondly, the marginal and average products of labour should vary between peasant households corresponding to their demographic structure. Thirdly, farm sizes and the size of area sown to crops should be directly correlated with family size. Chayanov's model assumes flexible access to land. However, under conditions of constrained availability of suitable agricultural land, the direction of causality in the third proposition might change: land constraints might impose limits on the size of family which can be sustained to meet minimum consumption levels.

More complete farm household models which integrate the labour market are also based on concepts of the 'new home economics' which originates from the work of Becker (1965). Before these theories are discussed, the central features of the new home economics model (HEM) are introduced.

Concepts of the new home economics model

Compared to the standard assumption of neoclassical consumer theory where utility is derived from commodities, in the HEM utility is derived from the final consumption or use-values of commodities. The use-value concept is identical with the distinction used in the analysis of energy consumption, where it is assumed that households do not derive utility from the consumption of fuels, but from the delivered useful energy services.

In the HEM a distinction is made between purchased goods (X-goods) and goods or use-values produced in the household, which are referred to as Z-goods. The production of Z-goods requires both the use of household labour and of purchased market inputs. Thus the home production function is a function of these parameters. The utility function is a function of the Z-goods produced in the household. Utility is maximized subject to the production function, a total time constraint consisting of three components, that is time for the production of Z-goods (home work), wage work time and leisure, and an income constraint. Time required for the preparation of food, inclusive of time for the fetching of water, collection of woodfuel and for cooking is included in the time used for home work.

The main emphasis of this theory is on the decision behaviour of households with regard to their time allocation between wage work and the production of Z-goods. The latter may contain a whole range of goods and services including childcare services, nutrition, education and any other good which is produced in the household. Therefore the HEM can be used for the empirical analysis of household labour allocation in response to changes in exogenous variables.

The real opportunity costs of time of the household is determined by the wage rate and the general price level of purchased goods. Thus the model assumes a functioning labour market. When solving the model, the household is in equilibrium when the marginal rates of substitution (marginal utilities) between any pair of Z-goods, is equivalent to their marginal costs. As the valuation of labour in terms of market wages enters into the calculation of marginal costs, the actual opportunities of household members to engage in wage work are crucial for this calculation. The existence of a labour market for women, who carry most of the burden of home work in African societies (see below), is important in this respect.

The main predictions of the HEM are related to the impacts of changes in the real wage. A rise in the real wage increases the marginal costs of home time production relative to the marginal costs of purchased goods. Therefore some home produced Z-goods are substituted for purchased inputs. In order to explore further the impact of changes in the real wage on consumption, a distinction can be made between two types of Z-goods. Time-intensive goods are labour-intensive but require few market goods as inputs for their production, while money-intensive goods are characterized by the opposite attributes. Consumption of home-produced staple food, including time-intensive daily chores of water and fuel collection, represent an example of time-intensive goods. Changes in the consumption mix in these two types of goods are determined by the relative prices of X-goods and the market wage. If the real market wage rises, time-intensive goods will be substituted by money-intensive goods.

Selected farm household models

There are two important farm household models which are partly rooted in the concepts of the new home economics. The model developed by Barnum and Squire (1979), integrates the responses of farm households to both changes of the demographic structure of the household as well as to changes in market variables. However, this model is not further discussed here because is assumes fully competitive markets and other simplifying assumptions, which limit the relevance of central aspects of the model to peasant households in Malawi. Instead the model developed by Low (1986) for African countries bordering the Republic of South Africa, is based on assumptions which are more suited to the conditions in Malawi.

The central assumptions of the model are:

(a) In the labour market, wage rates vary according to different categories of labour, including gender-specific wage rates. This assumption states that some family members have a greater comparative advantage for participation in the labour market than others.

(b) Farm households have access to land according to family size. This assumption ensures that the usual assumption of diminishing marginal returns to labour (when land is fixed) is not applicable. Household members are additionally assumed to be equally productive in subsistence production. Both assumptions imply a linear production function.

(c) Semi-subsistence households can sell food crops at a producer price which differs from the retail price.

(d) Food-deficits are widespread and family labour can be hired out.

Assumptions (c) and (d) imply that for food-deficit households, the allocation of labour to food production does not depend on producer prices, but on the price ratio between wages and the retail price of food. This means that the real wage is expressed as the amount of food which can be purchased given a nominal wage rate and the retail price of food. Households are assumed to be income maximizing. Because the labour market is fragmented, the real wage or opportunity cost of time differs among household members. As long as the marginal physical product of each producing household member which is determined by the slope of the production function, exceeds the real wage, it is rational not to engage in off-farm wage work. However, for those individual household members for which the reverse situation applies, it is rational to engage in off-farm work. These members of the household are most likely adult males who have a comparative advantage in wage work. This explains why subsistence production tends to be carried out by other members of the household, notably women.

Low's model points to the important role of policies which affect the real wage for food-deficit households, that is a statutory minimum wage policy and its enforcement, and retail price policies for staple food items.

Aspects of gender-specific objectives, preferences and labour allocation constraints

All household models discussed above share the assumption of a single household utility function. This assumption is equivalent to analyzing the decision behaviour of households in terms of an aggregate unit or an income-pooling household, with the implicit assumption that the preferences of household members are identical. The assumption of a single utility function has been challenged both on theoretical and empirical grounds. Theoretically a single utility function within the neoclassical framework can only be derived from the assumption of altruism as a behavioural characteristic of household members (Ellis 1988: 175). As shown in Folbre (1986), the assumption of altruism is inconsistent with other central tenets of neoclassical theory, notably the pursuit of individual selfishness in markets.

Empirical aspects of peasant behaviour, which cannot be explained with the concept of a single utility function, are closely related to gender division of labour. In the models discussed above, specialization of household members with regard to certain tasks is explained by their relative comparative advantage. For example, men who command higher wages in off-farm work specialize in off-farm wage work, even if their productivity in all other household tasks is comparable to that of women. The explanation of the allocation of labour of household members between on-farm and off-farm activities is based on differential market prices for labour. However the impact of non-market aspects of intra-household decision-making, in the form of social constraints and aspects of unequal power or social subordination, cannot be explained in this theoretical framework.

A central issue of non-market related interactions within the household refers to the question of how labour inputs and income are distributed within the household (Jones 1985: 4-7). Concerning the allocation of labour inputs to different task areas, that is home production, market work, home work or leisure, several considerations and constraints have to be taken into account which can affect the households' time allocation to different tasks.

Social customs may preclude women from engaging in the production of specific goods and services. This may apply, for example, to the production of cash crops in general or specific cash crops. Women may also have differential access to, and control over, specific inputs required for production (land, credit, savings, information) of a particular crop or other activity. Thus the interaction of the peasant household with imperfect markets, and its risk-aversity implications, might be exacerbated for women. Where these constraints exist, both women and men specialize in the production of different goods and thus have different production functions. Socially determined specialization of production within the household does not preclude men and women engaging simultaneously or sequentially in the production of a crop which is traditionally under the control of men. Social customs may also constrain the availability of male labour for reproduction and maintenance activities of the household (home work or Z-good production). This constraint might be generally applicable or might refer to specific activities.

Socially determined rigidity of labour allocation between men and women across different activities, notably for the home work and farm work, represents a constraint which has several important implications for policy analysis. Such a constraint will imply allocative inefficiency and hence income losses when the allocation of labour, in accordance with the comparative advantage of the household members and in response to changing market prices of goods and services, is inhibited. The more rigid the allocation of labour to specific household activities, the more constrained women are in their options to engage in certain activities. An important aspect in this context is the absolute availability of women's time and the extent and possible combinations of labour resource allocation rigidities across the main categories of labour activities. These rigidities and their resulting labour requirements, determine the remaining amount of time use of which woman may be able to decide. The observed main responsibility of women for time consuming home work usually assumes a sizable budget of their daily available labour time. For example, fuelwood gathering and chopping and the carrying of water are two of the most time consuming activities.

To explore women's decision-making, given labour allocation rigidities, Ellis (1988: 179-82) has constructed a hypothetical example where a woman's responsibility for home work is coupled with the responsibility for food production. Hence, her production function for food crops is determined by the minimum time required for home work and a minimum food consumption requirement, which is equivalent to a minimum amount of time required for subsistence food production. Both constraints determine the remaining time which may be allocated for other activities. A woman in this simplified situation has the options either to use all her remaining time to increase food production, to produce the minimum food requirement and use the remaining time for leisure activities, or to allocate her time partly to both options. Within the framework of neoclassical utility maximizing theory, the woman would deploy the indifference curve between additional income and time. If, however, the additional income from surplus food production is retained and used by her husband, then it is unlikely that additional work will be provided by women for food production unless some altruism towards her husband is assumed. Hence the outcome is indeterminate. The underlying assumption of freedom of choice of women in the utility maximizing concept may however be seen as an unrealistic abstraction in relation to intra-household decision matters in peasant households.

Empirical evidence for this view is provided, for example, from a case study which has been carried out by Jones (1986: 111) in North Cameroon. The study addressed aspects of intra-household bargaining and labour allocation in response to the introduction of rice as a new cash crop. Three findings of the study are interesting for this discussion. First, the study found a strong statistically significant relationship between the number of days worked by women in the rice fields of their husbands and the amount of remuneration received from them. This finding contradicts the existence of altruism as a motivation for uncompensated labour supply of women. The second finding was that the remuneration women received for work in the rice fields of their husbands was considerably below the returns to labour in rice cultivation and the opportunity of costs of women's labour in rice production wage work. The reason why women continued to work for their husbands despite their inequitable share in income was found to be determined by the social norm, which was enforced by their husbands,[13] that married women are expected to supply surplus labour for production on the husbands' fields.

The women in this case study were to some extent constrained in working as hired labourers. This constraint shifts the comparison of labour income obtained from their husbands for involvement in rice production, with the opportunity costs of time, with their staple food production and other income-generating opportunities. In this respect a third finding from Jones's study is important. Even though women received only one-quarter of their value of labour in rice production, this amount was still higher than the opportunity costs of their labour in other activities. Thus despite an inequitable distribution of additional income within the household, women perceived and responded apparently to a net gain from allocating labour to rice production.

An important issue for empirical research in this area is that such opportunity cost comparisons rely on sufficiently good data concerning the timely coincidence of alternative agricultural activities, because market wages may be expected to vary considerably between slack and non-slack agricultural periods and also within these periods.

The most important aspect for the design of policy measures is that the aspects of intra-household gender-specific labour availability, labour rigidities and distributional issues have to be explored in connection with policies linked to the introduction of new crops or other interventions which require either the reallocation of existing time budgets or

[13] In Jones' own words (Jones 1986: 111): 'If they refuse to work on their husbands' fields, they risk a beating'.

additional deployment of labour. Wrong assumptions about the preferences or decision criteria of men and women with regard to the allocation of labour within the peasant household, and hence wrong assumptions about the amount of labour which may be forthcoming in relation to the labour requirements of certain policy options, are likely to result in the ineffectiveness of policies if not outright failures. Policy design becomes particularly precarious when agricultural policies, woodfuel policies[14] and demand-oriented household energy policies are concurrently pursued but not fully integrated in this respect.

The diversity of household decisions implies that household models are needed as a framework to analyze and properly understand policy effects.[15] Conclusions as to the stratification of smallholder households in Malawi and the implications for the role and specific design of energy related policies are drawn at the end of this chapter. The analysis of smallholder income is an integral part of this analysis. It also serves the purpose of evaluating the potential for an income-driven energy transition in the rural households of Malawi.

4.2 RURAL HOUSEHOLD GROUPS

The discussion in Section 4.1 has not differentiated between different household groups although the discussion of the characteristics of peasants and of farm household models implicitly refer to smallholders. The structure of the rural population in terms of main groups of rural households is discussed in the following.

The share of rural households in Malawi's total population has been fairly constant between 1980 and 1993, accounting for 92.8 and 89.3% of the total population in the respective years (MAS 1993: 1). Households can be distinguished into the sub-groups of smallholders, and permanent estate tenants and estate wage labourers. The share of each group in the total can be most reliably approximated on the basis of labour force statistics because available population statistics do not differentiate between these groups. Based on the most recent labour force statistics from a World Bank study of Malawi's labour market (World Bank 1993b: 7) and employment data for the estate sector from Mkandawire et al (1990: 30), the shares of smallholders, estate tenants and estate labourers in the total labour force were

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[14] It is emphasized that the distinction between agricultural and woodfuel policies is hardly ever clearcut. For example, agroforestry and farm forestry involve mainly variables which are central to agricultural policy.

[15] See, for example, the discussion of the role of household models and policy formulation in House (1991).

estimated to amount to 91.0%, 3.7% and 5.3% respectively in 1987.[16] Thus smallholders accounted for about 81% of the total population.

FHHs form an important economic sub-group within the smallholder sector. Depending on the definition of FHHs, they account for one-third to 40% of all smallholder households.[17] The distribution of FHHs across landholding size categories shows that they are highly concentrated in the lower landholding size ranges. While 76% of the smallholders have holding sizes of up to 1.5ha, 88% of the FHHs belong to this group. Within the landholding size of 1.5ha, FHHs are concentrated in the landholding size of up to one ha.[18] In general, FHHs share most of the characteristics of smallholders which will be discussed below. However, in several crucial economic aspects they are particularly disadvantaged. Data about long-term shifts in the composition of FHHs and MHHs are not available. However, such shifts are strategically important for policy interventions because of the issue of targeting policies by gender. Since increasing land fragmentation is one of the main reasons why men migrate from their holdings, the share of FHHs is likely to have increased in the past.

Tenants reside on estates, while the households of permanent estate labourers partly live on estates and partly live in areas adjacent to estates. The latter group blends into the smallholder group because the families of permanent estate labourers, who are predominantly male, belong to the smallholder group. Both tenant and permanent estate labourers are not further analyzed in this research, for two reasons. First, their income characteristics do not vary much in comparison to smallholders. Most of the labourers and households in these two categories belong to the low-income rural households because their wage levels and incomes are close to, and mostly below, the minimum wage level (UNDP

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[16] The World Bank data contained an estimate of the total rural work force and of the share of smallholders and other non-formal sector workers of the total rural work force, which amounted to 94.4% in 1987. The data from Mkandawire et al show a breakdown of estate labourers by tenants and permanent workers on tobacco and other estates for 1985 and 1989. The estimate was derived by taking the average of the latter data and by relating this average to the rural labour force estimate from the World Bank study. This calculation implies that the share of smallholders in the total labour force was calculated as a residual.

[17] FHHs are characterized in Malawi in different surveys and studies according to the presence/absence of their husbands into up to three types of households. These are commonly 'de jure' households, where an adult women is widowed or divorced; 'male absentee' households, where the husband has not been or is not present for at least six months and was engaged in employment in Malawi; and 'Teba' households, where the husband is a labour migrant. Relative to these definitions, about 30% of all smallholder households were estimated to be de jure FHHs (IFAD 1993, Annex 2: 2; Quisumbing et al 1992: 1). The share of households meeting the definition of the latter two types of FHHs were estimated to amount to about 10% of all smallholder households in Malawi by Quisumbing et al (1992: 1).

[18] 35%, 37% and 16% of all FHHs, and 19%, 29% and 20% of all MHHs existed on landholding sizes of up to 0.5, 1.0 and 1.5ha respectively (see IFAD 1993, Annex 2: 3). Thus about one-half of the smallholders with holding sizes up to one ha are female-headed.

1993: 9). Secondly, the available data base concerning issues addressed in this research refers to rural households, and in most instances, to smallholder households. Because there are no sub-group-specific data available, any specific household energy policy considerations which may be applicable to these sub-groups cannot be analyzed yet.

Circumstantial reasoning also suggests that household categories other than smallholders are unlikely to warrant special attention for the purpose of household energy policy analysis. Tenant families living on estates are likely to secure part of their woodfuel needs from resources available on estates. In this respect they are probably better off than most smallholders. With regard to other issues such as the impact of deforestation and depletion of forests on food security as well as income and resource availability, they are presumably in a situation which is comparable to the one of the poorer segment of smallholders. In addition, these groups only represent a minority of the smallholder households.

4.3 ANALYSIS OF HOUSEHOLD DECISION BEHAVIOUR AND CONSTRAINTS IN MALAWI

Section 4.1 has dealt with the conceptualization of peasant household behaviour in the context of rural household energy policy and farm household models which address farm household decision-making from a general perspective, that is with limited specific reference to household energy issues. Against this background, the objectives of this section are twofold. First, propositions of the farm household models which were discussed above are tested with regard to their applicability to Malawi, in order to investigate structural characteristics of farm household decision behaviour. This analysis inevitably involves the analysis of changes in agricultural conditions and parameters as well as the nature of the constraints under which households operate. The analysis is intertwined with the issue of how households can be stratified for targeting policies. In this context risk considerations play a prominent role.

The second objective is to derive from the above analysis implications for rural household energy policy. The underlying hypothesis is that interventions focusing on energy needs of farm households cannot be sensibly made without having a clear understanding of the objectives, constraints and characteristics of resource allocation decisions of specific households. Both supply-side and demand-side oriented energy policy options and interventions need to be embedded into the above characteristics of farm households to have any reasonable chance of success. More specifically, the main argument in this context is that the land, labour and cash resource mobilization requirements of woodfuel policy options are judged by rural households with regard to their perceived benefits within the specific decision framework of the household.

Land and labour productivity and access to labour and credit markets are important determinants of income generation of rural households. Income characteristics of households are analyzed with regard to two aspects. Levels of income in relation to subsistence requirements determine the expenditure behaviour of households, notably expenditure for food and non-food items. Real income changes and the composition of income influences their potential demand and consumption levels for commercial energy. Moreover, the composition of the sources of household income in terms of farm and off-farm income and particularly the composition of income in terms of cash and imputed income (income in kind) represents a second important dimension of income analysis, because the relative scarcity of cash has a bearing on the decision to produce certain goods and services within the household or to purchase such inputs.

As the following analysis will show the development of income, smallholder productivity, food security, cropping patterns, constraints to the access of credit and labour markets, labour constraints and land-use practices are all highly interdependent. A suitable starting point for the ensuing discussion is the food security situation and factors which have determined the trend of agricultural productivity in the smallholder sector.

4.3.1 Food security, poverty and risk aversity

Increasing agricultural productivity has been, and continues to be, the key development issue for Malawi's smallholder sector because population growth has outpaced growth in agricultural production. This development has led to a decline in per capita food production. Per capita maize and food crop availability declined in Malawi from 270kg in the 1970 to 1974 period, to 220kg and 211kg in the 1980 to 1984 and 1985 to 1990 periods respectively (IFAD 1993, Annex 1: 3).

Household food security is defined as 'the ability of the households to have adequate food throughout the year' (MOA 1991: 27). For this definition both private production and market purchases are accounted for. Comprehensive food security and nutrition monitoring surveys were conducted by the MOA in 1990. In June 1990, that is about three months after the harvest, the percentage of households who already had depleted their food stock varied between 3 and 34% between districts, while in December 1990, it ranged with few exceptions, between 75 and 90% (MOA 1991: 33). Although food security can be measured by several indicators, average annual food balances are a reasonably good approximation to ascertain the extent of food security. In constructing such balances, a minimum nutritional requirement in terms of the staple food maize, has to be assumed.

Per capita minimum requirements of maize are also used as a proxy for defining a poverty line. Opinions about where to draw this line under the conditions prevailing in Malawi do not differ much. A World Bank study estimated the composition of average household incomes for rural and urban income groups classified as 'core poor' and 'other poor' in 1989. Lacking sufficiently disaggregated income data for smallholders, these estimates were made on the basis of average incomes by landholding sizes. The resulting income estimates were compared to a poverty line estimate, serving as a benchmark to measure the incidence and intensity of poverty. This benchmark was set at roughly US$40.0 per capita per year, based on minimum nutrition requirements of 200kg/year for an adult, and assuming a food share of 65% in total expenditures (World Bank 1990b: 19-22). Another study (IFAD 1993, Annex 1: 4) refers to a per capita consumption level of 220kg per year as a recommended minimum requirement for a maize-based diet. The data shown in Table 4-1 refer to a year which can be regarded as average, and assume a per capita maize requirement of 220kg.

TABLE 4-1 Average annual food balances by landholding size (1987/88)

Holding size (ha)	*Household size (persons)*	*Percentage of households (%)*	*Maize requirement (kg)*	*Percentage of requirement (%)*	*Maize deficit/ surplus (kg)*
0.0 <0.5	3.9	26	858	37.7	-535
0.5 <1.0	4.4	30	968	75.3	-239
1.0 <1.5	4.8	20	1 056	103.5	37
1.5 <2.0	5.2	11	1 144	126.8	306
2.0 <2.5	5.6	5	1 232	139.4	485
2.5 <3.0	6.5	3	1 430	149.2	704
>3.0	7.4	5	1 628	173.9	1 204

Source: Annual Survey of Agriculture 1987/88, Several tables.

Table 4-1 demonstrates that landholding sizes, food security and household size are positively correlated. It further shows that, on average, households with a holding size of between 1.0 and 1.5ha are able to meet their food requirements, while households with holding sizes of greater than 1.5ha produce marketable surpluses. Smallholders with a holding size of between 0.5 and 1.0ha may meet their food needs in above average rainfall years but on average, experience food deficits. The smallest landholding size category consists of those households which are permanently in food deficit. For individual ADDs, the holding size range through which the poverty line runs differs regionally on account of variations in agro-climatical conditions. This implies that households run out of food at different times of the crop cycle in different regions. Therefore target interventions in general must have a regional element.

From the point of view of stratifying households for policy purposes it has to be taken into account that two opposing forces are influencing the pattern shown in Table 4-1. As shown in Table 3-6, continued population pressure will lead to further fragmentation of landholdings and hence to an increase in the percentage of food-deficit households, unless this development is compensated for by agricultural productivity gains. From the point of view of risk-taking, theory suggests that the smallholder sectors in Malawi are characterized by rather risk-averse households in the lowest holding size category and increasing risk-taking for smallholders belonging to larger holding sizes. Approximately two-thirds of the smallholders may be classified as strongly to moderately risk-averse. A factor which has to be assumed to reinforce risk aversity across landholding sizes is that the monomodal rainfall pattern throughout the entire country makes agriculture in Malawi generally a risky undertaking. The country has experienced several droughts since 1980, the most devastating of which occurred in 1992 when per capita GDP growth declined by 11.2%.

Risk-taking of farm households is closely related to several key variables and household-specific constraints. For the purpose of stratifying households for policy analysis, the ability of households to respond to changes in policy and to participate in labour and credit markets, appears to be conceptually an appropriate approach.

4.3.2 Declining agricultural productivity

Despite positive economic growth rates in the smallholder sector since 1980, production increases were outpaced by population growth. The poor performance of agricultural production has been due to a complex interaction of land scarcity, labour productivity, food insecurity, agricultural policies and constrained access to markets. The interaction of these factors and their implications for household energy policy are analyzed in the following.

Land constraints and land-use practices

Even though increasing land scarcity is a key constraint for increased food production and household income, low labour productivity has to be considered in Malawi as the main problem in smallholder agriculture. Peters and Herrera (1989) calculated that in Malawi only about 15% of gross margins[19] of crops could be attributed to land productivity *per se*, and the remainder to labour input. This implies that doubling the land available would have only a limited impact on income, given available labour inputs and production technology. Mechanization of agriculture in Malawi is extremely low because the main agricultural equipment available is the hoe.

One of the main contributing factors to declining agricultural productivity has been the fragmentation of smallholder land which was accompanied by a massive decline of land under fallow. In Chapter 3 it was shown that a drastic decline of the land under fallow was

[19] Gross margins are defined as gross income from crops less fixed and variable production costs. The term is typically used in the analysis of relative returns of crops in farm household production models and agricultural policy analysis. Labour costs are usually not included in variable costs. Returns to labour for single crops are normally calculated in terms of gross margins per man-day.

identified by the Land Resource Evaluation Study. The finding of this study has been invariably confirmed by several micro surveys. The extent of this decline is illustrated, for example, by the socio-economic survey conducted in preparation for the Lilongwe Forestry Project (LFP 1993, Appendix 1: Table 7) which found that 79.5% of the smallholders never leave their land fallow.

Continuous cropping of land has adverse impacts on soil fertility and on productivity unless nutrients are replenished by inorganic fertilizer. In addition, soil degradation tends to be compounded on small landholdings where the planting of maize on most of the land precludes the application of crop rotation.

Determinants and changes in cropping patterns

Changes in cropping patterns in Malawi are shown in Annex 4-1. The data demonstrate that overall, there have been only limited changes throughout the period 1982/83 to 1991/92. Maize varieties have occupied, with minor inter-annual variations, about 70% of the total sown area. The major permanent shift which occurred during this period started in 1987/88 when the share of groundnuts in the total area began to decline considerably on account of changes in relative producer prices. A fairly consistent increase was experienced for pulses, the hectareage of which has been doubled since 1982/83. The pattern shown in Annex 4-1 is subject to regional variations at the ADD level. As shown in Annex 4-2, distinct deviations from the average high share of maize existed in 1987/88 only in KADD and in NADD, where the shares of maize were below 50%. This difference is explained by specific agro-climatic conditions which favour the growing of other food crops, notably rice, sorghum and root crops, and the suitability of soils for the growing of cotton.

One remarkable feature of the national cropping pattern is that, except for cotton which assumes a share of 12 and 19% of total area cultivated in SADD and NADD respectively, no perennial crops or tree crops appear in the crop statistics. Firewood growing and gathering and depreciation of building in smallholder agriculture was, however, estimated in the National Accounts Handbook 1985 (GOM 1985: 51) to have contributed 4.2% of value added to smallholder production.[20]

Throughout Malawi there exists a strong positive relationship between landholding size and the share of the total area planted with maize and food crops. In general, the smaller the landholdings, the higher the share of land planted with maize and food crops. Table 4-2 shows that the percentage of food crops grown is inversely related to holding size and that

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[20] The report mentions that the estimate for 1978 was based on 1971 data when the value of firewood was estimated to have contributed 3.5% to total crop and livestock production.

household size is correlated with holding size. Data in Table 4-2 show that about 66% of the farm households which are food-deficit, plant between 78 and 93.3% of their land to food crops. For reasons discussed below, the share of higher-yielding maize varieties was negligible and correlated with holding size. The same relationship applies to cash crops. Results from a small-scale survey (sample size 210) which was carried out in LADD in 1986/87 (see Annex 4-3), are consistent with the findings at the national level. The survey also found that FHHs planted 9% more of their land with maize than MHHs.[21]

TABLE 4-2 Aggregated smallholder production levels by landholding size (1987/88)

Holding size (ha)	*0-<0.5*	*0.5-<1*	*1-<1.5*	*1.5-<2*	*2-<2.5*	*2.5-<3*	*>3*
Per cent of households	26	30	20	11	5	3	5
Average holding size (ha)	0.3	0.73	1.22	1.72	2.22	2.72	3.95
Household size (persons)	3.8	4.3	4.7	5.2	5.8	6.3	7.3
Household production (kg)							
All maize	331	773	1 258	1 692	2 265	2 583	3 487
All food crops (1)	406	905	1 427	1 943	2 549	2 997	4 032
Per capita maize (kg)	87	180	268	325	391	410	478
Per capita food crops (kg)	107	210	304	374	439	476	552
Crops (% of area cultivated)							
- food crops	91.4	86.0	78.0	72.0	66.0	66.0	60.0
- cash crops (2)	8.6	14.0	22.0	28.0	34.0	34.0	40.0
Crops (% of area cultivated)			*Annual Survey of Agriculture 1987/88*				
Maize & maize mixtures	81.9	78.6	73.9	68.0	67.0	65.1	58.1
- (% of hybrid & composite maize)	2.9	2.9	4.9	6.3	10.2	7.4	10.0
Other food crops	11.4	8.6	6.8	7.1	6.4	7.5	6.6
Total food crops	93.3	87.2	80.7	75.1	73.4	72.6	64.7
Cash crops (% of area cultivated)							
-tobacco	0.4	0.8	2.5	3.9	4.7	4.9	5.0
-cotton	3.0	5.3	5.4	5.8	5.8	6.9	10.8
-groundnuts	2.1	4.8	8.7	11.6	13.0	16.2	12.2
-beans	0.4	0.4	0.7	0.6	0.7	0.9	1.0
Contact with extension workers (% of households)	6	10	14	16	21	23	22

Sources: Conroy (1993), data quoted in International Fund for Agricultural Development (1993, Annex 2:4) and Annual Survey of Agriculture 1987/88

Notes: (1) Food crops include maize, rice, millet, sorghum and root crops; (2) Cash crops

The data shown in Table 4-2 confirm the validity of the hypothesis of the 'safety-first-principle' of food-deficit farm households in Malawi. The more the household is exposed to food insecurity, the larger is the area sown to food crops. The important implication for the

[21] In Annex 4-3, the area planted with maize for landholding sizes of 1.5ha and more, are higher than the corresponding data for food crops in Table 4-2. This difference is due to the considerable share of high-yielding maize varieties which are normally grown for sale.

choice of other crops, including tree crops, is that most of the allocation of land and labour resources for this group of households has to be considered as being largely price-inelastic. Moreover, the amount of land which can be allocated to other land uses is severely constrained and becomes smaller with declining landholding sizes. For individual cash crops, smallholders have shown considerable responsiveness to changes in relative producer prices, but this has only led to a substitution between crops rather than to increased production on account of land and other constraints (World Bank 1990c: 2). These findings are important for woodfuel policies insofar as they imply that most smallholders are facing tight competition of land for crops. This suggests that farm forestry options which are designed to compete with crops, such as woodlots, may primarily be evaluated by smallholders in relation to the relative returns from cash crops.

Nutrient depletion, soil erosion and productivity losses

Sufficient application of fertilizers can arrest nutrient-related declines of land productivity. Fertilizer sales to the smallholder sector increased by about 250% between 1982 and 1991.[22] However, increased utilization of fertilizer was not sufficient to arrest the decline in land productivity. As shown in Annex 4-1, the hectareage of high-yielding hybrid maize has increased since 1982/83 and has substituted the planting of local maize. It can be clearly gauged from the yield data for maize (MAS 1993: 9-10) that local maize yields have declined while hybrid maize yields have been increasing. The average yield from maize varieties has remained quite constant implying that labour productivity has declined because hybrid maize is significantly more labour intensive.[23]

A partial explanation why the productivity of local maize has declined is simply that the removal of nitrogen has been far in excess of replenishment through fertilization.[24] Productivity losses due to nutrient deficiency of soils are disproportionally borne by the poorer segment of the smallholders. Annex 4-4 shows that the use of fertilizer is positively correlated with landholding size.

An important structural feature of the smallholder cropping pattern which is important for

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[22] This percentage was calculated from the data of fertilizer sales to smallholders which are contained in Simler (1993a: 22).

[23] See also Simler (1993a) who comes to the same conclusions.

[24] Conroy (1993: 27) has demonstrated this effect with the help of a simplified example. Based on an average annual harvest of about 1.4 million tonnes of maize in Malawi and the assumption that 5% thereof (on a weight basis) consists of nitrogen, 70 000 tonnes of nitrogen are lost per year, not including nitrogen lost in the stover due to leaching or soil erosion. This figure is far in excess of the quantity of nitrogen sold to smallholders of, for example, 33 800 tonnes in 1991. A repetition of this calculation by the author, for the period 1973 to 1990, showed that a net nitrogen removal has occurred every year.

the analysis of trends in agricultural productivity is the development of the share of erosive crops, that is maize, tobacco, cotton and cassava. Annex 4-1 shows that erosive crops occupied 81.5% of the total area sown in 1982/83. Thereafter their share declined continuously until 1986/87 to 72.2% and then increased again to 78.9% in 1991/92.

Although the high share of maize in the cropping pattern of food-insecure households tends to increase soil erosion, the latter impact is somewhat moderated by the fact that smaller smallholders intercrop maize more than their wealthier counterparts with non-erosive crops such as pulses and groundnuts (World Bank 1992b, Vol. I: 21). About 75% of their local maize stands are estimated to be intercropped with other food crops (Peters 1992: 3-4).[25] The intercropping practices of smallholders which were researched by Peters in Liwonde ADD were found to be rather sophisticated in that they were based on intimate knowledge of factors such as shade, variations in soil quality, proximity to water and complementarities or competition between crops. Therefore they seem to reap the benefits of intercropping which are documented in the literature and which are also discussed by Peters (1992: 3-8).[26]

Returns to crops used for intercropping have been constantly lower than for non-erosive crops[27] but the latter type of crops serve several important objectives other than income maximization. According to research conducted by Shaxon (1990), these crops enhance food availability prior to the harvesting of the main crop, and hence spread risks, allow for more intensive land use through relay cropping, and some crops also allow labour requirements to be spread. These findings suggest that intercropping in Malawi is primarily pursued to maximize food production and to spread risks of crop failure.

Land shortage and the widespread lack of fallowing and crop rotation practices has also resulted in unsustainable farming practices which were reported by the World Bank (1992b, Vol I: 10) including little or no integration of trees and grasses in the cropping system; insufficient use of leguminous crops in intercropping and relay cropping; incorrectly aligned ridging with slope contours; and failure to control the formation of gulleys.

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[25] An estimate for the national adoption rate of intercropping in the smallholder sector of 93.5% in the National Sample Survey of Agriculture 1968/69, is quoted in Kydd (1989: 26). One explanation for the apparent decline of intercropping is that the agricultural extension service in Malawi has heavily promoted the planting of maize in pure stands.

[26] Peters' review of the literature shows that in addition to soil conservation benefits, intercropping entails crop diversification which minimizes crop failures and involves the sequencing of crops. Particularly the latter provides an additional degree of freedom to respond to changing conditions concerning productivity and market factors.

[27] Evidence for consistently higher returns of erosive, as compared to non-erosive, crops for the period 1980 to 1990 is shown in the World Bank (1992b, Volume I: 20-22). The same result can be gauged from the data contained in the data sheets entitled Indicative Smallholder Gross Margins (MOA 1993) which were made available to the author by the Chief Planning Officer of the MOA, Mr Gomani.

These deficiencies in farm management have also contributed to high average soil erosion rates and loss of agricultural productivity. The average economic income loss due to soil erosion was estimated to be in the range of MK10.0 to MK29.0 per ha[28] corresponding to MK54.0 to MK154.0 million per year, equivalent to 1.6 to 4.5% of GDP (World Bank 1992b, Vol I: 14-15). Absolute loss figures per ha appear to be small. However, the mean loss of MK20.0 represents a loss of income of 15.7, 9.7 and 4.7% for smallholders in the three lowest holding size ranges respectively.[29] Attributing these losses to single causes is difficult. The general policy implication is that policy measures, which can reduce such losses such as subsidies, have to be considered. Declining soil productivity, combined with constraints to purchase fertilizers, also puts agroforestry options on the policy agenda.

4.3.3 Relative returns of crops and risk aspects

In view of the factors discussed above, that is wide-spread food insecurity, declining agricultural productivity, and land constraints, agricultural policies in Malawi have focused on enhancing labour productivity and increased production of food and cash crops. Due to food security concerns, the adoption of higher-yielding maize varieties has been a key objective of agricultural policy, while the increased production of smallholder cash crops was an important complementary policy area. All options involve different levels of agricultural inputs, labour requirements and hence risks for smallholders.

Household-specific constraints in the access to credit, extension services, labour markets and differences in household labour capacity are important factors determining the cropping patterns and the relative returns to crops. Analysis of these constraints are thus important both to identify household-specific constraints and their relationships to household energy policy options. As concluded above, returns to crops in general and cash crops in particular, are important decision criteria for production decisions of households. Thus their returns serve as direct benchmarks for comparisons with returns from supply-oriented woodfuel policy measures, such as farm forestry options and agroforestry, and indirectly, of communal woodlots. For the purpose of policy analysis and implementation, a key question is the pattern and group-specific variations of relative returns because unrealistic benchmarks may simply lead to wrong conclusions about the relative attractiveness of woodfuel supply options. To derive such benchmarks and their variations, household-specific constraints contributing to them, need to be analyzed. Relative risks of growing crops add an important second dimension to crop production and, implicitly,

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[28] These estimates are conservative insofar as the cumulative impact of soil erosion over time was not included in this figure (see World Bank 1992b, Vol I: 14).

[29] These percentages were calculated using the income data given in Table 4-7.

labour allocation decisions.

Technical efficiency of smallholder production

The potential for yield increases in Malawi is large, as evidenced by the fact that smallholders are on average producing far below the technological production frontier. This is demonstrated by a factor of 3.0 to 6.0 for research yields as compared to estimated actual average crop yields.

Maize yields by region, holding size and gender of household head

Estimates for average national yields for maize including local maize varieties, composite maize and hybrid maize center around 1.1 tonnes per ha (Lele 1987), a figure which reflects approximately the average of maize yield time series. As shown by the World Bank (1990b: 25), realized average yields of local maize in the three major agro-ecological zones range from 800kg to 1 000kg per ha and show hardly any variation across landholding sizes, while average yields for hybrid maize are subject to larger variations both by region and holding size.

However, aggregate data for maize yields by landholding size mask important variations of yields by landholding size and gender of household. This is evidenced in Table 4-3 which shows the results of a micro-level survey of 210 households which was carried out by Peters and Herera (1989) in the vicinity of the city of Zomba.

TABLE 4-3 Sources of income by landholding size (1986/87)

Number of households	14	47	78	29	31	11
Landholding size (ha)	<0.5	0.5-<1.0	1.0-<1.5	1.5-<2.0	2.0-<3.0	>3.0
Mean total size (ha)	0.42	0.77	1.25	1.76	2.35	3.56
De jure household members	4.20	5.40	6.30	7.40	8.20	7.20
Total ha	0.42	0.77	1.25	1.76	2.35	3.56
Total HH income (MK)	**328.1**	**303.9**	**451.4**	**488.2**	**639.1**	**1 020.9**
Per capita income (MK)	**76.6**	**61.3**	**77.7**	**74.5**	**78.7**	**156.9**
Sources of income			*per cent*			
Home consumption	24.0	29.1	31.1	33.8	37.8	40.2
Market income	24.6	26.2	32.9	31.4	27.4	34.0
Off-farm income	51.4	44.7	36.0	34.8	34.8	25.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
Selected sources of income			*per cent*			
Remittances	5.2	6.4	5.4	4.7	2.4	0.1
Other transfers	11.7	10.0	7.7	9.9	15.3	9.6
Grain sales	21.6	23.1	21.4	21.3	12.7	8.6
Agricultural wages	14.7	14.2	6.2	4.2	2.7	1.5
Non-agricultural wages	4.6	5.4	3.0	5.4	2.4	0.1
Self-employment	11.8	3.2	9.8	7.0	8.9	3.7

Source: Peters & Herera (1989: Tables 3.6 and 3.7)

The data demonstrate five important intra-household and inter-household variations. First, MHHs households have higher per capita maize yields and fertilizer use than FHHs. Secondly, even within the group of FHHs there exist large differences in per capita maize yields and fertilizer use, most notably between Fteba households which receive larger transfer payments from their men and the other two groups. Thirdly, non-tobacco growing households have lower maize yields than tobacco growing households. Fourthly, per capita maize harvests are positively correlated with increasing ha size. Fifthly, there is a remarkable variation in per capita maize harvests within every household type. Therefore the conclusion for any attempt to define 'representative households' for policy purposes on the basis of parameters such as per capita maize harvests, landholding size, cropping pattern and other parameters has to consider the existence of large variations in key parameters across households.

Though yields of hybrid and composite maize are approximately three times higher compared to local maize in Malawi, the impact of the higher yielding varieties on the national average has been limited. The percentage of the total maize area planted with high-yielding maize varieties was subject to strong annual variations in response to changes in maize prices (Lele 1987) and has had an estimated maximum and minimum share of 9.7% and 4.3% in the growing seasons 1983/84 and 1986/87 respectively (Kydd 1989: 25).

Profitability of maize production

Assessments of the relative profitability of local and hybrid maize in Malawi, have always focused on the rationale of the fertilizer subsidy and the crucial technical issue of fertilizer response rates, which have an important impact on the profitability of fertilizer use. As a rule of thumb, benefit-cost ratios of at least 2.0 are hypothesized as being the practical minimum to make fertilizer attractive to smallholders in Malawi (Christiansen & Southworth 1988: 30), that is to compensate them adequately for the risks involved. Recent research of the profitability of fertilizer use has shown that the fertilizer response ratios assumed by the Ministry of Agriculture were considerably higher than those attained under practical farming conditions (Conroy 1993: 18-20). As a consequence, the relative profitability of using fertilizer is lower than previously assumed.

Recent farm modelling analysis, using more realistic response rates and various scenarios for producer and fertilizer prices, has shown that the break-even yields associated with a benefit-cost ratio of 2.0 could be achieved by about 50% of the smallholders by using high analysis fertilizer on local maize, and that only farmers in four to five ADDs are likely to achieve these yields (Conroy 1993: 25-27).

The important implication of the research on the relative profitability of applying fertilizer to maize is that any conclusion is sensitive to the accuracy of available yield data and subject to regional variations.

Relative returns of crops and risks

In Annex 4-5, estimates of gross margins for crops per ha from various sources are compiled for two consecutive growing seasons (1991/92 and 1992/93). Differences in the estimates of gross margins per ha are mainly due to variations in crop yield assumptions. Particularly the estimates of the MOA appear to be rather high. The gross margins per ha indicate that gross margins of fertilized local maize and of hybrid maize are significantly higher than for unfertilized local maize. Similarly, the gross margins for major cash crops which form part of the smallholder cropping pattern (see Table 4-2) are more attractive than the production of unfertilized local maize. However, the working capital required to finance the variable costs associated with crops other than non-fertilized maize are considerably higher. For example, in the growing season 1992/93, the variable costs per ha for unfertilized local maize, fertilized local maize, fertilized hybrid maize, groundnuts, cotton and burley tobacco were MK50, MK234, MK771, MK218, MK193 and MK2105 respectively. Thus fertilizing local maize and involvement in cash crops requires a cash outlay per ha which is at least four times higher than for the production of local maize. In particular, fertilizers make up 40% or more of total variable costs. It is therefore not surprising that surveys carried out by the Rockefeller Foundation and the MOA showed that 85% and 48% of the smallholders interviewed cited the lack of money and the lack of access to credit as the main reasons for not using fertilizer.[30]

It has also to be considered that the ratio between variable costs and gross margins of cash crops relative to unfertilized local maize, are substantially higher. For unfertilized local maize this ratio was 0.12 in 1992/93, while the ratio for all cash crops was at least 0.28 and notably higher for hybrid maize (0.42) and for burley tobacco (0.49).[31]

A benefit-cost ratio of 2.0 for all crops does not take into account the differential risk associated with the absolute size of the variable costs for each crop as well as the differential outlay intensiveness. The higher financial working capital outlays for crops other than local maize subject smallholders to considerably higher risks in case of crop failure. As will be discussed in the next section, these risks are closely linked to household labour constraints.

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30 Data from these surveys were shown in Conroy (1993: 4-5) but the names of the surveys were not cited.

31 These data were calculated from the data contained in the collection of agricultural data from the MOA (1993), Indicative Smallholder Margins.

The role of non-financial decision factors for the adoption of hybrid maize

In addition to financial and information constraints, consumer preferences have been responsible for the failure to increase the adoption of improved maize varieties by smallholders. Kydd (1989: 7-8) has argued that smallholders exhibit strong preferences for local maize varieties (so-called flint varieties as compared to hybrid or dent varieties) because they allow soaking (lactic fermentation), a property which hybrids do not possess. According to research results reviewed by Kydd (1989), soaking has several attractive features including enhanced higher nutritional value and digestibility, and less cooking energy requirements. Surveys conducted by the Rockefeller Foundation in Malawi and the MOA in the growing season 1990/91 with the objective of ascertaining constraints to the adoption of hybrid maize, found that the poor pounding and storage characteristics were the single most important factors after the 'cost of seeds' and 'no access to credit', inhibiting the growing of hybrid maize.[32]

The implication of this finding for policy interventions in the smallholder sector is that smallholders take the time requirements for food preparation into account because pounding of hybrid maize is more time consuming than for local maize. This may be explained by the seasonally tight layout budgets of farm households, especially of women during the agricultural season.

From a general policy point of view, it is also interesting to note that agricultural planners seem to have ignored these factors for a long time. This is evidenced by the exclusive emphasis of maize research on hybrid varieties with dent characteristics in Malawi (Kydd 1989). This supply constraint to the adoption of hybrid maize was only recently resolved by the introduction in 1990 of seeds for hybrid varieties with flint characteristics.

4.3.4 Constrained access to formal and informal sources of credit

The principle source of credit for smallholders is the Smallholder Agricultural Credit Administration (SACA) which provides credits to farmer clubs through extension officers who assess credit demand. Farmers clubs (also called credit clubs) mainly disperse seasonal credit for main agricultural inputs (fertilizer, hybrid seed and pesticides), repayable within nine months. Because the design of the loan policy stipulates that part of the individual loans to club members (borrowers) is retained in a fund, the club as a whole is liable for repayment failures, and access to credit for all members in the next production season is contingent upon high group repayment rates. Smaller farmers, whose credit-worthiness can be assumed to largely correlate with landholding size, represent higher credit risks.

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[32] See Conroy (1993: 24).

Therefore, for smallholders who are most in need of production credit, it is extremely difficult to receive credit from the clubs. The main reason for not receiving credit was found, in the comprehensive nationwide Survey of Women in Agriculture in Malawi conducted in 1989 by Culler et al (1990: 25), to be the fear of credit club default due to non-repayment of credits. The danger of losing access to credit in the following season upon repayment default of single members, has given rise to a self-selection mechanism within the credit clubs, which tends to exclude smallholders who are perceived as potential credit defaulters. The explicit exclusion of such candidate members is complemented by the harsh practices employed by clubs to recover and enforce the repayment of credit, which act as a strong deterrent to seek membership in credit clubs.[33]

Despite these strong barriers to entry to farmers clubs, the SACA lending scheme has overall slightly improved smallholders' access to credit. Between 1982/83 and 1990/91 the number of beneficiaries has more than doubled from 157 000 to 334 000 representing an increase in the participation level of smallholders from 12% to approximately 19%. During the same period the share of women members has increased from 15% to 31%. Among the specific factors inhibiting women's participation in farmers clubs are the socio-cultural tradition of not mixing with men, low education levels and more risk-averse decision behaviour (GOM/UNICEF 1993: 68).

Informal financial institutions (IFI) such as moneylenders, which charge high interest rates, and traders and grainmillers which charge no or only nominal interest rates were reported by Chipeta and Mkandawire (1991) to have extended credit amounting to MK281.5 million in 1990. This amount is considerably lower than the MK105 million provided by the formal and semi-formal financial sectors (Okidegbe 1992: 8), inclusive of MK23.65 million provided by the SACA in 1987/88 (Nwanna 1992: 42). No data are available to ascertain the extent to which smallholders with no access to credit from SACA have benefited from IFIs lending operations. Moneylenders, for example, are known to play a major role in providing credit to Malawians in the rural and urban sector without access to formal finance. However, on account of their lending criteria such as provision of collateral, personal knowledge of the borrower or existence of a reliable debt guarantor (Nwanna 1992: 25), it is doubtful that they extend much credit to smallholders who do not qualify for participation in credit clubs.

According to a small-scale survey (sample size 30) which investigated the characteristics of informal credit systems, loans given by moneylenders were of relatively small size (MK10.0 to 20.0), mainly for food purchases and associated with very high annual interest

[33] Culler et al (1990: 25) found that selling household assets such as hoes and livestock, as well as imprisoning credit defaulters, are common measures and consequences of not repaying credits.

rates, most of which ranged from 75 to 172% (Mkwende 1991: 13). The latter finding shows the high opportunity costs of capital in the informal credit market and illustrates that subjective discount rates employed by smallholders must be fairly high.

In view of the limited access of the poorer smallholders to credit, a new rural lending institution was created, that is the Malawi Mudzi Fund (MMF) which commenced operations in 1990. The MMFs lending principles rely on the effectiveness of group social sanctions to ensure acceptable loan repayment rates. Its lending principles do not require collateral and involve a group concept whereby several loan repayments have to be made by borrowers before other group members can borrow. The absence of collateral requirements underpins that its target group are the rural poor who do not have access to informal sources of credit. Given its short period of operation, there is only very limited documented evidence available as to the credit coverage of poor smallholders and the overall repayment rate which is crucial to the funds long-term survival.

Available experience of the MMFs operations until February 1992 when 146 male and 502 female borrowers had received loans, is discussed in Chilowa and Gaynor (1992: 27-28). They found that borrowing has been heavily biased towards trading and service-related income-generating activities rather than for agricultural inputs, and that repayment rates of women (83%) were higher than for men (65%). The future role of the MMF for poor smallholders in Malawi is difficult to predict, but it has to be taken into account that its operations are as well constrained by factors that are typical for other financial institutions in Malawi, notably high administrative costs (Chipeta 1990: 153).

In summary, the SACA credit scheme has contributed to mitigating the working capital squeeze of smallholders, but the overall coverage of smallholders remains relatively low. Access of the majority of smallholders to seasonal production credit from the informal credit market also appears to have been rather limited. High interest rates are reflective of the risks involved in lending to the rural poor and provide an indication that smallholders are likely to apply high subjective discount rates. The relative weakness of the rural institutional and informal financial system, severely limits access to credit for the majority of smallholders. As a result they are constrained to participate in the production of more remunerative maize and other cash crops, notably tobacco, all of which require the availability of substantial working capital. Considerably higher working capital outlays for cash crops also increase the potential risk of crop failure. Limited access to credit and high subjective discount rates impede the adoption of long-term investments in perennial crops and land management investments.

4.3.5 Household labour constraints, rural labour markets and food security

The analysis of rural labour markets in the context of household energy policy has several purposes. The discussion of farm household models has shown that where a functioning labour market exists, the opportunity costs of labour are not subjectively, but market-determined. Rational decisions to engage in off-farm labour employment are primarily determined by the comparative returns to labour from on-farm labour utilization or the marginal value product of farm labour and off-farm wage levels. Where the wage levels are higher than the marginal value product of labour, allocation of labour resources to off-farm employment is a rational choice. However, where the reverse situation combined with food insecurity exists, peasant households face a trade-off between attaining a higher income per labour-day which can also be expressed in terms of higher food security throughout the year and short-term survival requirements.

From the point of view of comparative advantage, the household member for which the opportunity costs of time are highest, is expected to engage first in off-farm work. In a fragmented labour market, which is characterized by gender-specific wage rates, males usually have a comparative advantage leading to a concentration of women's labour allocation to on-farm work and subsistence needs. However, a basic question is whether off-farm returns on labour are higher than on-farm returns. An additional factor which has to be taken into consideration is that even where no differential wages continuously prevail for males and females, culturally determined allocation of labour within the household, notably women's responsibilities for the reproduction of the household, may impose a labour supply constraint on the latter. From the point of view of risk-taking ability, the availability of off-farm labour employment opportunities reduces income and food security risk, provided that the availability of employment opportunities is not highly correlated with the risk of crop failure.

The empirical analysis of these factors provides additional insights into the rationale of labour allocation decisions within the peasant household with regard to the objectives of income maximization and food security. A second important issue refers to the question of whether households are subject to labour constraints, and if so, which smallholder groups are most affected and what are the economic implications? This discussion has a bearing on the determination of income in smallholder households. A third issue which is related to labour constraints is the implication of seasonal labour availability and constraints on the opportunity costs of labour. This issue is particularly important for women because the size and seasonal variations of their opportunity costs of labour have a bearing on their decisions to allocate time to the production of labour-intensive Z-goods, including woodfuel gathering, cooking, and so on or to purchase such goods partly or entirely. The analysis of these issues also provides the background for assessing the relative importance of time savings from the introduction of labour-saving technologies, including household energy policy options such as fuel-efficient cookstoves, and the potential for time-saving strategies which were discussed in Section 4.1.

4.3.5.1 Household labour supply and demand characteristics

Household labour supply capacity

In addition to land availability, access to credit, food security and other risk considerations, the labour requirements for crops are an important variable determining the cropping patterns and income of smallholders. Under the conditions prevailing in Malawi, agricultural economists assume a factor ranging from about 0.40 (Simler 1993a: 18; Annual Survey of Agriculture 1987/88: Summary Table 2)[34] to about 0.42 (Chipande 1986: 28) to convert household sizes into an estimate of the household labour capacity, in terms of equivalent adults who are available for agricultural work. Due to the relative lack of comprehensive household labour use studies in Malawi, some uncertainty remains as to the assumptions determining the amount of household labour supply. On account of other demands on time, Simler (1993a: 18) for example assumes that smallholders are able to provide 19 days of agricultural labour per month, while Chipande (1986: 48) estimates that each equivalent adult is able to provide five hours of labour for 25 days per month. Since there are no better data available, 22 working days were assumed for ensuing calculations.

Concerning the daily work-hours available for agricultural labour, the Annual Survey of Agriculture 1987/88 (ASA) assumes that agricultural labour available per day of an adult consists of four hours and that of children, two hours. With regard to gender and age, these assumptions are consistent with the finding from Culler et al (1990: 23) that males and females spent almost identical amounts of time on agricultural production tasks, while children spent about 80% thereof. Limited direct information is available from time-use studies about the average length of working days by gender. However, from available data gender-specific working times can be estimated. Data from Culler et al (1990: 33) show that the participation of males in all domestic activities, including fuelwood gathering and splitting and water collection, was about 6%[35], while children almost contributed the same time as an adult. Peters and Herrera (1989: Table 20) found in the Zomba district that men contributed only 10.7% of the time women spent on domestic activities. Since agricultural labour input by males and females is similar and taking into account time for other

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34 The factor 0.40 was calculated from data contained in the ASA by multiplying holding size categories by 30 (days) and dividing the result by the estimated available family labour.

35 This percentage was calculated using the data provided by Culler et al (1990: Table 25).

activities, total male labour per day (on-farm working hours) amounts approximately to 5 to 6 hours per day. In Culler et al (1990: 56) it was reported that extension staff of the MOA and village leaders estimated that women spend, on a daily basis, 46% of their time during the growing season in agricultural production.

Based on this estimate, and agricultural work of about 5 hours per day, the average daily working time of women during the growing season amounts to 10.9 hours per day. Estimates of average time requirements for fuelwood gathering and splitting and water collection alone amount to 2.5 hours per day (Culler et al 1990: 29-32). Thus a daily work time of females of between 10 and 11 hours during the agricultural season appears plausible. In comparison to daily work loads of rural women in various countries, ranging from 11.2 to 14.0 hours, which were compiled in Cecelski (1987: 45), the estimated daily work time of women in Malawi lies below the lower end of this range. However, when it is considered that the average absolute time for other domestic activities in Cecelski's sample is higher than the time of 2.5 to 3.5 hours, which is implied in the estimate of 10 to 11 hours, the daily workload of women in Malawi may be even higher by about an hour or more, resulting in about 12 hours per day. There is also empirical evidence that the latter estimate may be reasonable, because it coincides with the findings of a time-use study of 28 households in two villages of Malawi in 1981 (Engberg et al 1985), which found that the time spent daily on household work varied between 4 to 6 hours.

This time estimate for the agricultural growing season should not be considered as static, both in terms of the total hours worked and the daily time distribution of major tasks. In Chapter 5, it will be shown that food-deficit households employ time-saving strategies during the food-deficit period where time for household tasks is reduced to free time for other tasks.

As shown in Table 4-2, a positive correlation exists between landholding size and household size. Assuming a conversion factor for equivalent adult household labour supply to household size of 0.40, the average household sizes shown in Table 4-2 correspond to a labour availability of about 1.5 adults for the smallest landholding size category. For each consecutive landholding size range, labour availability increases by about 0.2 adults, except for the holding size greater than 3.0ha where the increment amounts to 0.4 adults. Thus the monthly labour availability for agricultural operations in the smallest landholding size category may be estimated to amount to about 33.4 person-days (167 person-hours) during normal months. The effective labour capacity in December and January is lower because of higher exposure to infections (malaria) and malnutrition. For example, Simler (1993a: 18) estimated a reduction of 24% during this period. Using this assumption yields a labour capacity of 25.3 person-days (127 person-hours).

Labour requirements for crop production and relative returns to farm labour

Annex 4-6 shows that estimates for total annual labour requirements for main crops vary considerably. They range from a low of 130 man-days per ha for unfertilized local maize to about 643 man-days for burley tobacco. However, the data for some crops also show substantial differences. Data from Annexes 4-5 and 4-6 were used to calculate the gross margins per man-day, that is returns to labour, which are shown in Annex 4-7. Because there are large differences in the estimates for gross margins as well as for labour requirements, the resulting returns per man-day are also subject to large variations. However, except for cotton and perhaps fertilized hybrid maize, the general conclusion which can be drawn from these data is that gross margins per man-day for crops are positively related to the total annual labour requirements per ha.

As shown in Annex 4-8, the seasonal distribution of labour demand for major crops is subject to major differences. The share of labour requirements during the period October to January, compared to total annual labour requirements for individual crops, is highest for the production of maize varieties. However, the estimates shown in the last column of Annex 4-3 may be considered as rather low in view of the findings of Werner (1987), cited in the World Bank (1993b: 45), who consistently estimated higher labour requirements for this season. For example, his estimates of labour requirements for maize production between October and January range from 69 to 75% of total annual labour requirements for this crop.

Estimates concerning the month(s) in which peak labour requirements by crop occur,[36] do not differ significantly. Overall it appears that for maize crops peak labour requirements are about similar in the months of December and January, with labour requirements in November being approximately 10% to 15% lower. Other crops which are featured in the cropping pattern of smallholders have peak labour requirements in December (groundnuts), January (cotton) or absolute labour requirements between October and January, except for rice, which are comparable to higher than peak labour requirements of maize crops. As a result, peak labour requirements for smallholder crops occur in December and January.

Using linear programming analysis, Chipande (1986) found that the availability of labour is likely to be a major constraint to higher farm production and incomes for most smallholder households. Particularly the labour availability in the months of December and January was

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[36] The comparison was based on the data shown in Annex 4-8 and estimates of monthly labour demands of crops by Chipande (1986: 46) and Werner (1987).

found to be a main factor determining the choice of crops. This is reflected, for example, in the very high shadow prices[37] for labour which were found to be about nine times higher in January than the then prevailing rural statutory minimum wage.

4.3.5.2 Food security and survival strategies

The Food Security and Nutrition Monitoring Survey (MOA 1991) included questions about what households will do to obtain food after their food stocks are depleted. This question was posed to households who had already depleted their food stocks (depleters) in November 1991 and those who did not (non-depleters). The results in terms of the relative importance of major coping strategies of food-deficit households are shown in Table 4-4.

Table 4-4 Most important smallholder strategies to acquire food (per cent)

Strategies	*Depleters*	*Non-depleters*
Ganyu (casual labour)	46.70	37.50
Sell or exchange food or beer	12.50	14.30
Sell livestock	3.10	15.40
Transfers	9.80	8.80
Sale of crafts, fuelwood & charcoal	8.20	4.00
Sell or exchange fish	4.70	3.20
Borrow money	0.90	2.60
Sale of household assets	1.10	0.80
Other	13.00	13.40
Total responding	100.00	100.00

Source: Ministry of Agriculture, Food Security and Monitoring Survey 1991, cited in and adapted from Simler (1993: 2)

Note: Depleters had no food left in November 1991, while non-depleters had food left but may or may not run out of food until the next harvest

The data in Table 4-4 show that 'ganyu' labour, that is casual labour which is performed predominantly on the farms of other smallholders against payments in cash but mainly in kind, is the most important source of income during the food-deficit period both for depleters and non-depleters. The most interesting information shown in Table 4-4 is the similarity of the relative importance of strategies for both groups. The only major difference exists for livestock which can be explained by two factors. First, depleters belong to the poorest households who also possess less livestock. Secondly, it is also possible that depleters had already disposed of some livestock. It is also interesting to note that twice as many depleters engage in the sale of crafts, firewood and charcoal compared to non-depleters.

37 Shadow prices from the dual solution of a linear programming model can be interpreted as opportunity costs of labour, that is the imputed value of one additional unit of labour at the margin.

In interpreting the information provided in Table 4-4, it has to be taken into account that farm households are motivated to engage in casual labour not only for food but also for non-food needs. One of the reasons why non-food needs also play an important role during this period is that sickness, and thus expenditures for health care and funerals, are considerably higher than throughout the rest of the year. For example, about 75 to 80% of all child deaths occur in the months of December and January.

From Table 4-4, it is apparent that receiving food from members of the extended family does not seem to play an important role as a survival strategy. In this respect, Mkandawire and Chipande (1986: 21-22) have concluded from several studies of this subject in the country, that the traditional social security role which existed in the form of mutual obligations among members of an extended family, has been declining.

4.3.5.3 Characteristics of the rural labour market

Permanent and seasonal labour demand

The available information about rural labour markets in Malawi has been largely compiled by a recent World Bank study which was carried out in 1993. According to the study (World Bank 1993b), about 75 to 80% of the paid employment in rural areas consists of short-term ganyu labour during the peak labour period November to February, which coincides with the food-deficit period. As may be expected, the amount of casual labour supplied by households was found to be negatively correlated with income and holding size, access to credit, and the proportion of cultivated area under hybrid maize and tobacco. According to results of the ASA, the amount of labour hired increased, though not linearly, by holding size. On average, even households in the smallest holding size category of up to 0.5ha hired eight labour-days, while those smallholders with holding sizes in excess of 3.0ha were hiring 90 labour-days of casual labour.

A survey conducted by Conroy, which was cited in World Bank (1993b: 48), showed that 35% of the sampled households provided at least 50 days of casual labour, while another 15% supplied an average of 136 days. This implies that during the period of peak labour requirements on their own farms, at least one-third of the households diverted about one-third, and probably more, of their available labour capacity to casual wage labour.

Gender-specific labour market participation and wages

Casual labour is provided by males, females and children. Data on wage levels are scanty. However, available evidence (World Bank 1993b; World Bank 1991: 12-13) suggests that males command higher wages than females and that regional wage levels are negatively correlated with population density and land pressure. On account of their household work, women are less mobile and therefore restricted to participate in more over-supplied markets for casual labour in villages. This tends to depress wage levels. Average wage rates for casual labour during the agricultural season may be up to 40% higher that the statutory minimum wage (SMW) and possibly even higher for short-term peak labour tasks. There is also evidence from a survey in Kavinga[38] that women in all income groups did more casual work than men and that women belonging to the smallest landholding group, which predominantly consist of FHHs, spent three to five times more days on casual labour than women in the better-off income groups. However, according to data from the ASA, the participation of men in off-farm work, including permanent off-farm labour, is five times higher than for women.

Economic implications of smallholders involvement in casual labour

Casual labour is performed by smallholders during the season which coincides with the peak labour requirements on their own holdings. A survey which was carried out in 1993 in Lilongwe ADD (LFP 1993, Appendix 1: Table 25), showed that 25% of the households surveyed reported severe food shortage in December. During the next three months severe food shortages were encountered by 72%, 94% and 91% of all households respectively. Withdrawing labour from agricultural tasks on their own holdings during the peak season has severe economic repercussions. During the food-deficit period, labour-intensive agricultural tasks such as weeding and transplanting, need to be performed which are critical for the performance of the crops. Withdrawing labour during this time has disproportionate effects on crop yields. For example, maize yields may be reduced by 25% if planting is delayed by one to two weeks (see MOA 1994: 45). Similarly, the yield differential increase between local maize which is early planted and weeded, and local maize which is only early planted amounts to about 16%.[39]

Female-headed households are particularly economically vulnerable to labour constraints because during the agricultural peak season they already have a 12-hour working day, but lack the labour input of males. Evaluation results of the UNICEF Agricultural Credit Programme which were reported in Conroy (1993: 22), demonstrate that only 24% of the female-headed households achieved the average yields realized by the participants of the scheme, because they could not mobilize sufficient labour to fertilize and weed in time.

As a consequence of having to provide food, poor farm households which are forced to seek casual labour employment are prone to lower crop yields which renew or even aggravate

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[38] Kavinga Annual Survey of Agriculture 1989, Credit Survey.

[39] This figure was calculated from yield data for different land husbandry practices which are shown in the ASA (Worktable 4D).

the poverty cycle of food insecurity, casual labour employment and below-average yields. Because of their labour constraints, getting involved in more remunerative crops is either unfeasible or associated with high objective risks. On the contrary, better-off farm households which have the financial resources to complement their labour resources by hiring labour, achieve higher yields and incomes and are therefore able to get involved in the production of more remunerative crops.

Seasonal income-generating activities and opportunity costs of labour

The evidence compiled above, that is opportunity costs of labour in the months of peak labour demand, which are a multiple of the SMW rate and average wage levels for casual labour that vary regionally but do not exceed the SMW rate by more than 40%, provide clear evidence that the returns to labour are considerably higher for on-farm activities. Since most of the holdings are predominantly cultivated with maize, the relative returns to maize are also higher than for casual labour. This conclusion can also be reached by comparing gross margins per ha for unfertilized maize with the SMW, plus the maximum wage premium of 40%. In economic terms, farm households engaging substantially in casual labour implicitly apply high discount rates, because these are required to equate the marginal value product of labour on-farm with wage levels of casual work.

During the agricultural slack season, there exists a general lack of permanent and temporary employment opportunities in rural areas, implying that the opportunity costs of labour must be very low. Judged by household responses in LADD concerning the question in which months labour shortages do not occur, this period ranges from March to October[40] which is exactly outside the peak agricultural growing season. Representative data concerning the relative returns of off-farm employment activities are not available. However, an indication about the relative returns of off-farm employment opportunities is provided by data from the Food Security and Nutrition Monitoring Survey (FSNM) in November 1991. These data which are shown in Table 4-5 have to be interpreted with care because they were based on a recall of one week prior to the survey.

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[40] During this period less than 3.1% of all respondents reported that they encountered labour shortages (LFP 1993, Working Paper 1, Annex 1: Table 22).

TABLE 4-5 Participation and income of smallholders in off-farm employment by expenditure quintile in November 1991

	Expenditure quintile				
	1	*2*	*3*	*4*	*5*
Participation rate of households	52.6	48.8	46.8	45.3	42.4
- Farm ganyu (%) (1)	23.3	13.2	10.7	7.3	7.3
- Non-farm ganyu (%)	6.9	8.6	8.9	6.6	7.1
- Self-employment/Other (%)	27.4	31.7	30.8	34.9	32.3
Income/household/day (MK)					
- Farm ganyu (%) (1)	0.8	1.9	1.7	52.6	2.25
- Non-farm ganyu (%)	1.3	1.7	1.4	52.6	3.68
- Self-employment/Other (%)	0.9	2.9	2.5	52.6	4.29
Characteristics of household heads					
- No education (%)	52.1	43.2	35.8	33.4	28.6
- Female-headed (%)	41.8	33.9	29.1	27.0	22.6

(1) Ganyu is the local term for casual labour.

Source: Ministry of Agriculture, Food Security and Nutrition Monitoring Survey 1991, cited in Simler & Quisumbing (1992: 10-11)

The data show that the incidence of farm ganyu labour is inversely related to expenditure, which can be safely interpreted as a proxy for income. Overall, returns to the 'self-employment/other' category is more remunerative than casual labour, except for casual labour on estates for the lowest income group. However, availability of estate casual labour is also only seasonally available and much smaller in comparison to farm casual labour employment opportunities. Except for the aberration in the data for the second expenditure quintile, returns to self-employment generally increase with household income. This may be explained by the fact that poorer households are typically engaged in trading small volumes of food and consumer goods because they lack the capital to participate in higher value-added activities. The data also show that the return of casual labour per day for the poorest households, is less than one-half the return of all other households. This suggests that the latter households can be more selective in seeking casual employment.

With regard to the coping strategies shown in Table 4-4, the question arises as to what are the relative returns to labour for fuelwood gathering? That a considerably smaller percentage of households are involved in woodfuel production activities on customary land than in ganyu labour, could be taken as an indication of a lower return to labour in the former activity. On the contrary, the higher returns in the income category 'self-employment/other' from Table 4-4 of which woodfuel production forms part, may imply that returns are higher. Data from Culler et al (1990: 43), which refer to the entire year, show that selling of wood was only a source of income from off-farming activities for 1.5 and 2.0%

of the sampled males and females respectively. The absolute amount of income generated from this activity for both groups was the lowest of all income-generating activities. Time-use data from the Zomba district show that only men in the lowest income group collected firewood for sale, but the absolute amount of time spent on this activity (0.05%) was low compared to total time spent on self and wage employment (9.7%). These findings suggest that the returns to labour from fuelwood collection and selling, do not represent an attractive income option relative to labour returns for maize and cash crops for smallholders. Extremely few data are available in Malawi on prices for fuelwood in rural markets. This is mainly due to the fact that permanent woodfuel markets do not exist in Malawi (see also Chapters 5 and 6). Estimates for returns to labour for collecting fuelwood and unfertilized maize which were made in 1984, showed that the return to the former of MK0.30 per day, was almost 60% below the return to the latter (see World Bank 1989b: 15). On the basis of data contained in Mhango (1992a: 32) a more recent estimate of MK1.25 per day can be derived. In comparison to the data in Table 4-8 it can be concluded that the relative returns estimated in 1984 have apparently not changed.

During the food-deficit season, the percentage of households participating in woodfuel production of 8% was about four to five times higher than the average participation rate throughout the entire year. This fact indicates that households are likely to engage in these activities primarily to generate incremental income during the food-deficit period, on account of constraints to generate sufficient income from other options.

It is emphasized that the available evidence concerning the relative attractiveness of collecting fuelwood for sale from customary land, relative to income from crops in Malawi, is inconsistent with findings for some other African countries. For example, deLucia (1990: 2-21) has pointed out that several authors found that woodfuel collection and charcoal production in Sierra Leone were at least as remunerative, if not more, than farming.

4.3.6 Aspects of gender-specific household decision-making responsibilities

The distribution of decision-making responsibilities for household resources and the distribution of income and expenditures, are two important issues for policy interventions directed at farm households. Several studies which have dealt with the role of women in agriculture have been conducted in Malawi, but virtually all were based on small-scale surveys. This applies also to the study conducted by Hirschmann and Vaughn (1984) in 1981 in the Zomba district, but this study has the advantage of having investigated in detail aspects of the issues which are discussed here. The only nationwide survey which focused on the role of women in agriculture was conducted by Culler et al (1990), yet the depth of analysis about gender-related aspects of household decision-making remained limited.

Production decisions

An important area of decision-making refers to the selection of the crop mix and thus the land use on the farm. Hirschmann and Vaughn (1984: 70) found that in 50% of the households surveyed, decisions to grow certain crops was taken jointly. Essentially, the same result was obtained by Culler et al (1990: 22). Although the latter survey had a national coverage, there is evidence of significant regional deviations from this finding. A survey conducted in LADD in 1993 (LFP 1993, Appendix 1: Tables 30-32), has shown that about 80% of both women and men agreed that men decide on the selection of crops, the purchase of agricultural inputs, credit matters, joining village organizations and on tree planting.

Data from Culler et al (1990: 22) for 25 individual crops clearly show that in 50% of households where crop decisions were not made jointly, females decided more often alone about the growing of food crops than men, with the opposite for cash crops. Unfortunately, this study did not address decision-making issues related to wood production on farms. Decisions about planting patterns of crops were found by Hirschmann and Vaughn (1984: 70) to be taken jointly or by females or males alone, in almost equal proportions.

Expenditure decisions

With regard to decisions about expenditures, Hirschmann and Vaughn (1984: 72) found a clear dominance of males with regard to the purchase of fertilizer and hiring of labour and that women in general appeared not to participate in decisions involving major expenditures. The considerably more disaggregated analysis of gender-related responsibilities by expenditure category by Culler et al (1990: 45), shows that wives and husbands agreed only in a few areas (6 of 23) with regard to who was the dominant decision-maker. Males were clearly dominant in taking decisions on expenditures concerning home improvement, school fees and clothing while only the decision for expenditures on grinding mill fees was dominated by women. The decision to buy food was regarded by over half of the families as a joint decision, while for the rest of the households, men were seen to take these decisions. More than 60% of smallholders' expenditures are spent on average on food, and it appears that women seem to have considerable influence on the control of this major expenditure category. They also have firm control over the utilization of home-produced maize.

It is also interesting to note that women regarded themselves as being the prime decision makers in buying firewood and household equipment (Culler et al 1990: 45). The survey conducted in Lilongwe ADD showed that almost 75% of wives and husbands agreed that the household head decided on the use of revenue from the sale of crops.

Overall, these findings suggest that men tend to dominate crop production decisions and decisions about major expenditures. From this pattern of responsibilities, and the above finding concerning males' responsibility for tree planting decisions, one may conclude that farm tree planting is firmly dominated by male household heads. However, there are exceptions to this rule. The survey conducted in Lilongwe ADD (LFP: 1993, Appendix 1: Table 13C) had two interesting findings. First, once a husband had allocated a piece of land to his wife, 61.5% of the respondents said that wives were allowed to plant trees without consent from their husbands. Secondly, once a woman had obtained land from her parents or other relatives, 77.2% of the respondents reported that they could plant trees freely.

4.4 INCOME DEVELOPMENT OF SMALLHOLDER HOUSEHOLDS

The analysis of the income development of smallholder households is important as a basis for further analysis with regard to three main aspects. First, the development of real income is an important variable for analyzing changes in household energy consumption levels and energy consumption patterns. Secondly, the composition of household income by sources of income and by cash and imputed income (private consumption of household produced agricultural goods) is of analytical interest. The latter differentiation serves to provide an answer to the question of whether cash incomes are limited so that households need to make careful choices on the expenditure side, particularly with regard to purchasing goods which can be produced by the household. Notably, the choice between the production/collection or purchase of woodfuels and other fuels, may be expected to be influenced by cash availability. Thirdly, the question arises whether there are significantly strong relationships between income, gender, landholding size and other variables, which may be used for developing woodfuel and other energy-related policy options and policies targeting specific segments of the smallholder households.

4.4.1 Development of real incomes of smallholders

Ideally, disaggregated time series data of sufficient length and quality are required to analyze the aspects of income development of smallholder households in Malawi which were mentioned above. However, as in many other developing countries relative to these requirements, the actual database in Malawi is characterized by a number of gaps and shortcomings. Because income data are scattered and were developed from different policy perspectives, the following analysis tries to integrate the available data consistently, although some uncertainties remain.

Because of problems associated with estimating household incomes from surveys, expenditure data are generally considered to be a better proxy of income than income data themselves, or are used to check the quality of income data. However, due to the general lack of representative household expenditure data for Malawi, the income analysis has mainly had to rely on available income data.

A major shortcoming of income data in Malawi is that, except for information from a few local surveys, no single database is available which provides information about all aspects of income development.

An aggregate approach to determine the real per capita income of rural households is to deflate nominal per capita agricultural GDP data by a cost-of-living index in rural areas. This approach has the disadvantage that agricultural GDP data for Malawi do not include income from off-farm and self-employment. Thus data estimated from agricultural GDP represent a lower bound estimate for average smallholder income. An additional problem is that no cost-of-living index is available in Malawi because household income and expenditure surveys, on the basis of which such indexes are established and updated, have not been carried out in the 1980s.[41] As no specific consumer price index exists for rural households, the question arises whether other indexes or proxy indexes may be used for deflating nominal incomes. Data provided in Chapter 7, Table 7-1 show that the average income of urban low-income households in 1990 of MK715.0 was approximately comparable to the average household income of MK732.0 (see Table 4-8) of smallholders, with a landholding size of between 2.0 to 2.5ha. Because the share of expenditures on food items of rural households for all expenditure groups do not differ considerably and are broadly comparable to the weight of food items in the low-income price indexes for the cities of Blantyre and Lilongwe, the latter may be used as a proxy for a rural cost of living index. In addition, it has to be considered that many of the urban low-income households are rural migrants. Therefore it may be hypothesized that their expenditure pattern is likely to have a strong affinity to the one of rural households.

As an additional, though limited, indicator of real-income development of smallholders, the rural statutory minimum wage (RSMW), deflated by an urban low-income price index, can be used. The RSMW is applicable because a substantial portion of off-farm employment consists of casual labour, and income from casual and permanent off-farm labour is closely related to the RSMW.

Expenditure analysis of the data collected in the FNSM survey has shown that the average food budget share in the first three expenditure quintiles of smallholder households was

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41 The NSO conducted a Household Income and Expenditure Survey in 1993. However, results from this survey were not published prior to the completion of this research.

67%, while households in the fourth and fifth quintile had shares of 60% and 50% respectively (Simler & Quisumbing 1992: 4). As purchases of the staple food maize are likely to be the main food expenditure item, the maize retail price index may also be used to express the development of the RSMW in terms of the real equivalent purchasing power of maize. The development of real per capita agricultural GDP is shown in Figure 4-1, while Figure 4-2 shows the time series for the other two measures of income.

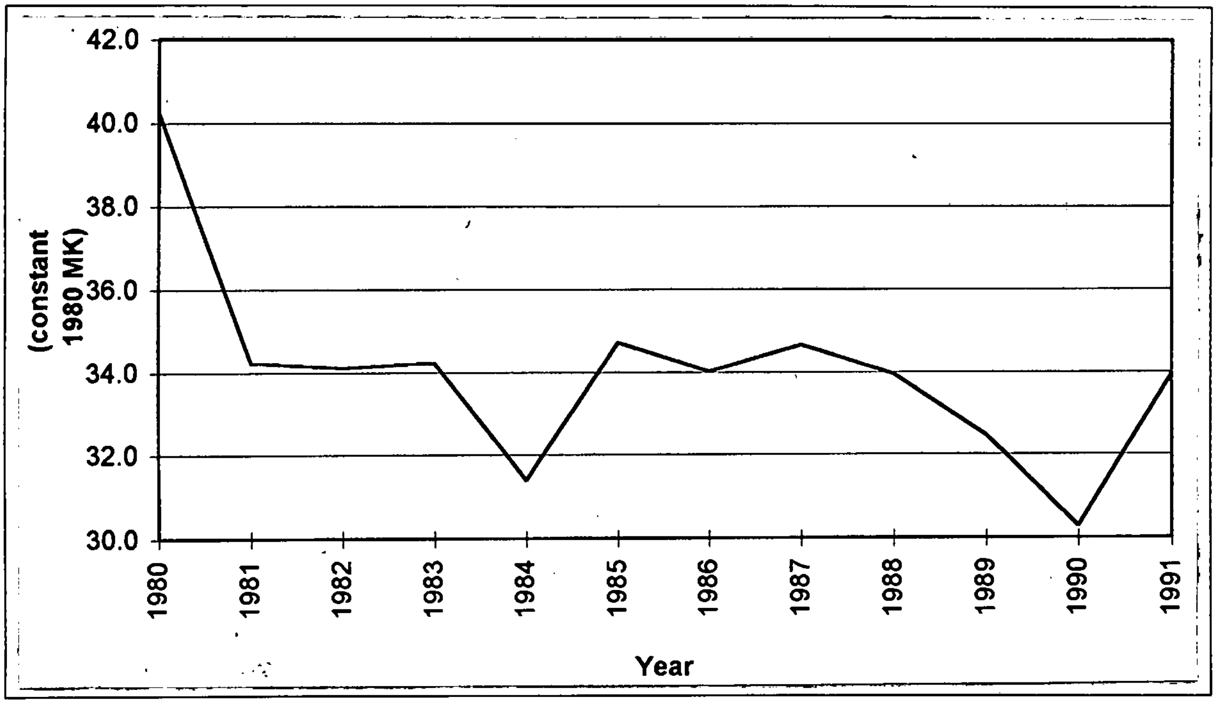

FIGURE 4-1 Smallholder agricultural gross domestic product per capita (in constant 1980MK)

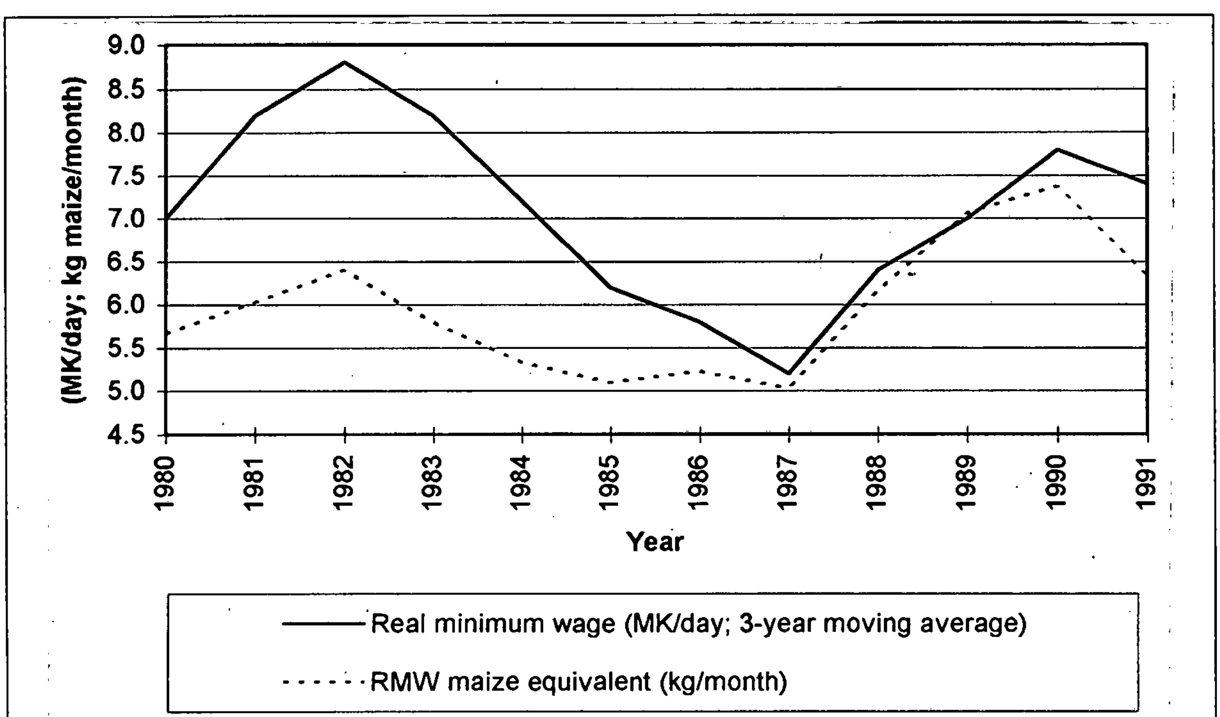

FIGURE 4-2 Rural minimum wage and its maize equivalent (in constant 1980MK)

Figure 4-1 shows that the per capita GDP fell in 1981 by 15% and remained thereafter fairly constant until 1987. Mainly the effects of drought entailed annual income declines (relative to 1981) of 5%, 12% and 16% in the years 1988, 1989 and 1992 respectively. From 1971 to 1979, the real RSMW declined by 61% from MK0.51 to MK0.31. From 1980 to 1982 the real RSMW increased by 42% to MK0.44. Thereafter the RSMW declined continuously until 1987 when it reached a level which was 59% lower than the 1982 value. This downward trend was reversed until 1990 when the 1981 level was approximately reached again. The movement of the RSMW in terms of maize purchasing equivalent follows the pattern for the real RSMW, but upward and downward swings were more moderate on account of the government's food security oriented maize retail pricing policy. Between 1980 and 1982 the increase was 12.9%. Thereafter a decrease of 21.4% was experienced until 1987. Subsequent increases until 1990 amounted to 46.5%.

Overall, the data suggest that from 1980 to 1984 real incomes were approximately constant. Until 1987 real incomes must be assumed to have declined because slight declines in per capita GDP were compounded by declines of the wage income component. For the smallholders as a group, the per capita decline of real income may be estimated to have been up to about 5% lower than indicated by real per capita GDP. Until 1990, in the years when the real per capita GDP declined, rising real wages smoothed this decline. In summary, between 1980 and 1991, the real incomes of smallholders in Malawi were fairly constant until 1984 and may have been between 3 to 7% lower thereafter until 1990. This decline is moderate, but considerably more favourable compared to the substantial decline of real incomes of urban households during the same period (see Chapter 7).

4.4.2 Composition and levels of income by landholding size and gender of household head

Data sources available to estimate the composition and levels of income by landholding size and gender, contain information about specific income components and for single years. Because overall income levels have only slightly changed from 1980 to 1990, recent annual data may still be regarded as fairly representative. Specifically, data available from the National Sample Survey of Agriculture 1980/81 (NSSA) only provide information about the composition of cash income. The World Bank has estimated income data for 1987 for three smallholder income groups, but these data are only partially useful for smallholder income analysis. The most comprehensive information about the level and sources of income, other than cash income, of smallholders is available from the data tables of the ASA.

Although the sample size of the NSSA was relatively limited (MOA 1981), and results have therefore to be treated with caution, the survey provides useful information about several relationships and income patterns by landholding sizes. The survey results show that total cash income was positively related to landholding size. However, relating mean holding sizes of the lower two holding size categories, that is a mean size of 0.35ha and 1.1ha for the holding size categories of 0.0ha to <0.7ha and 0.7ha to 1.49ha respectively, to their mean incomes, shows that cash incomes increased underproportionally. The share of cash income from agricultural produce (food sales, cash crops and livestock) was also positively related to landholding size, while the income share from business activities is declining with landholding size category. In the Northern and Central regions, the share of labour income is increasing from the lower to the middle holding size category and then again declining. In the Southern region, the share of labour income in the smallest landholding category is about three to four times higher than in the Southern and Northern regions respectively. Although the difference in these patterns is difficult to explain, it appears that in the Southern region, where the tightest land constraints exist, and where average landholding sizes for all landholding size categories are the lowest in Malawi, a considerable share of poor households may be approaching landlessness which induces them to seek off-farm employment.

A general observation from the NSSA data is that households in the smallest landholding size category derived percentage-wise, twice as much cash income from small-scale business activities and wage labour (60% combined), than their counterparts in the largest landholding size category. Notably, the income share of transfers (19%) of the former group, is twice as high as that of the latter group.

NSSA data reveal some marked differences in the level and composition of income by gender of household heads. First, the percentage share of FHHs in the smallest household size category (1-2 persons), is more than twice as high as in MHHs. Secondly, more than half of the FHHs cultivate an area of less than 0.7ha compared to 30% of the MHHs. Thirdly, the average annual household cash income of FHHs of MK85.3 amounted to just about 54% of that of MHHs. Thereof, the share of cash income from transfers (30% of the total) is almost three times higher than in MHHs. This figure demonstrates their heavy reliance on cash remittances from their absent husbands and other relatives.

The income analysis performed by the World Bank (1990b) had a focus on poverty issues. Thus, as can be gauged from the average holding sizes shown in Table 4-6, the smallholders who are classified as 'core poor' coincide closely with the smallest holding size category (0.0 to 0.5ha) which has been used in the statistics presented so far, while the category of 'other poor' includes smallholders who also lie below the poverty line, which has been discussed above. This group corresponds approximately to smallholders in the holding size range from 0.50 to 1.25ha.

TABLE 4-6 Per capita income and composition of income of smallholders in 1989

Smallholder category	*Core poor*	*Other poor*	*Non-poor*
Mean household income (MK/a) (1)	156	305	n.a.
Per capita income (MK/a)	41.1	72.6	n.a.
Composition of income (2)		*(%)*	
Own agricultural production	72.6	86.7	93.7
Food remittances	3.6	0.9	0.0
Cash remittances	4.2	1.8	1.8
Paid off-farm work	9.3	6.5	0.0
Paid agricultural employment	6.3	2.4	0.0
Self-employment	4.0	1.7	4.5
Average land holding size (3)		*(ha)*	
- per household	0.4	0.9	2.0
- per capita	0.1	0.2	0.4

Sources: (1) World Bank (1990b: Table III. A.2); (2) World Bank (1990b: Graph III, A1); (3) Annual Survey of Agriculture 1987/88

The data in Table 4-6 show two important relationships. Mean household income, per capita income and the share of private agricultural production is positively related to landholding size. This reflects the cropping pattern which is shown in Annex 4-2 and the higher contribution of cash crops to total income. The poorer the households, the more they rely on income from off-farm employment.

The most comprehensive information about levels and sources of income by holding sizes and regions is available from the ASA. Data in Table 4-7 confirm the pattern observed in the income data discussed above, that per capita income levels are positively related to holding size. However, no systematic relationship exists between the ratio of the highest and lowest income by holding size. The data also show that there are considerable differences between income levels by holding size across Agricultural Development Districts. However, if the data for NADD are neglected,[42] the data in Table 4-7 also show that there is no overlap between the highest and the lowest incomes for consecutive holding sizes across all ADDs within the holding size range of 0.0 to less than 2.0ha. For the next three holding size ranges, there are overlaps in three, four and five ADDs respectively. These data suggest that the smallest four holding size categories, which account for 87.3% of all smallholders, are in particular a fairly good proxy for income levels.

[42] The Ngabu ADD is widely known to be one of the lesser developed and comparatively poorer areas in Malawi. It is therefore possible that the survey sample has been biased towards higher-income households.

TABLE 4-7 Average annual gross household income by holding size and ADD in 1987/88

Holding size (ha)	*KRADD*	*MZADD*	*KADD*	*LADD*	*SLADD*	*LWADD*	*BLADD*	*NADD*	*Total*	*Per capita*
	MK	*MK*	*MK*	*MK*	*MK*	*MK*	*MK*	*MK*	*MK*	*MK*
0.0-<0.5	110	111	132	89	98	83	115	127	113	30
0.5-<1.0	265	238	238	182	214	137	219	243	217	50
1.0-<1.5	313	303	376	275	349	247	325	423	326	69
1.5-<2.0	502	392	515	386	528	406	551	522	463	89
2.0-<2.5	389	569	701	489	699	384	642	808	596	103
2.5-<3.0	643	547	840	540	1003	370	596	775	677	107
>3.0	883	850	1131	751	1197	794	995	1405	1017	139
Average	**230**	**352**	**535**	**248**	**315**	**176**	**233**	**471**	**310**	**84**

Source: Ministry of Agriculture, Annual Survey of Agriculture 1987/88

Statistics for average household sizes by region and district for rural households (GOM 1991: 21-22) show that within the regions variations for most districts vary by about 5%, but do not exceed 11.0%. The average sizes of rural households in the Northern, Central and Southern regions amounted to 4.8, 4.3 and 4.2 persons respectively in 1987. As there is no evidence suggesting that large differences exist between household sizes by holding size between ADDs, the higher average household size in the Northern region can be applied to the data in Table 4-7. When the average household incomes for all holding sizes in KRADD, MZADD and KADD are downwardly adjusted in proportion to the regional difference in household size, the above result of no overlap between the average income of consecutive holding sizes within the four lowest holding sizes and across ADDs, remains unchanged.

From Table 4-8 some distinct patterns of the distribution of sources of income by holding size can be observed. The share of income from crops in the lowest income category is 15.0% lower than for the next higher income category. Households who lie above the poverty line show little difference in the percentage of income derived from crops. Income from livestock hardly varies across income groups and is of limited importance as a source of income. The most important features which can be observed, are the heavy reliance of the poorest farmers on off-farm sources of income, and its role as the second most important income category. The negative relationship between holding size and importance of off-farm income reflects the above finding about the supply and demand characteristics of casual labour in the rural labour market. Remittances (transfers) are more important for lower-income households, but their contribution to income is rather limited. Overall, these patterns are consistent with the patterns observed in Table 4-6.

TABLE 4-8 Average annual household income of smallholders by source of income and landholding size in 1987/88

Holding size (ha)	*Crops*		*Livestock*		*Off-farm*		*Remittances*		*Total*
	MK	*%*	*MK*	*%*	*MK*	*%*	*MK*	*%*	*MK*
0.0 - <0.5	86	68.3	10	7.9	25	19.8	5	4.0	126
0.5 - <1.0	198	82.8	14	5.9	21	8.8	6	2.5	239
1.0 - <1.5	346	85.4	31	7.7	22	5.4	6	1.5	405
1.5 - <2.0	476	88.6	34	6.3	21	3.9	6	1.1	537
2.0 - <2.5	644	88.0	55	7.5	22	3.0	11	1.5	732
2.5 - <3.0	823	90.2	56	6.1	22	2.4	11	1.2	912
>3.0	1273	91.0	99	7.1	17	1.2	10	0.7	1399

Source: Ministry of Agriculture, Annual Survey of Agriculture 1987/88

More detailed information on sources of income is available from a few small-scale surveys that were conducted in different ADDs. Because of its level of detail, the most interesting survey is one carried out by Peters and Herrera (1989). This area had a relatively high population density and person-land ratio, reflecting conditions which are anticipated to be representative for the future situation in many rural areas of Malawi. The authors emphasized that the findings of their research are not in all respects directly applicable to national level statistics because the survey sample (210 households) had a bias towards farmers with larger landholdings. This implies, in view of the relationship between landholding size and level of income, an overrepresentation of better-off farmers.[43]

The survey sample was differentiated to control for the main parameters of the analysis, that is income, landholding size and cropping patterns. The summary data of the survey concerning composition of income for a period of 10 months, which are shown below in Table 4-9, distinguish between non-tobacco growing households, small tobacco growing households and tobacco specialist households.[44] For the purposes of their analysis, Peters and Herrera ranked the households by total income and grouped them into quartiles. To facilitate comparisons with data from other studies, it has to be considered that the average landholding sizes for the income quartiles 1 to 4, which are shown in Table 4-9, are 1.156ha, 1.176ha, 1.625ha and 1.743ha respectively.[45]

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[43] The cumulative percentage of households by holding sizes in the survey (which is shown in their Appendix C, Table C2), compared to the same data from the ASA (1986/87) is as follows (ASA data are shown in brackets): <0.5ha: 6.7 (26.0), <1ha: 29.2 (55.9), <1.5ha: 66.5 (76.3), 2.0ha: 80.4.

[44] Small tobacco households are defined as households deriving less than one-third of their crop income from tobacco, while specialist households earn more than one-third of their crop income from tobacco.

[45] The ha sizes per income quartile were calculated from data contained in Peters and Herera (1989: Table 2.1).

TABLE 4-9 Per capita income of smallholders by source of income and income quartile in Zomba district (1986/87)

Sample/household	*Sample size*	*Home production (1)* *(MK)*	*Market income (2)* *(MK)*	*Off-farm income* *(MK)*	*Total income* *(MK)*
Total Sample	210				
Household income		141.6	142.3	189.0	472.8
Per capita income		23.3	24.0	30.6	77.8
Non-tobacco	148				
Household income		133.0	97.2	187.0	417.2
Per capita income		23.1	17.4	32.3	72.8
Small tobacco	25				
Household income		160.9	208.9	196.0	565.8
Per capita income		23.6	39.7	26.5	89.7
Tobacco specialist	37				
Household income		162.8	277.4	192.3	632.5
Per capita income		26.5	48.2	30.3	105.1
Per capita income quartiles					
1 <MK 44	52	**36.6%**	**30.5%**	**32.9%**	**100.0%**
Household income		85.2	70.8	76.6	232.6
Per capita income		10.9	9.8	10.6	31.2
2 MK 44-62	53	**32.5%**	**28.9%**	**38.6%**	**100.0%**
Household income		105.4	94.0	125.3	324.7
Per capita income		17.4	15.2	21.0	53.6
3 MK 62-85	53	**31.9%**	**28.3%**	**39.8%**	**100.0%**
Household income		155.5	138.0	194.1	487.6
Per capita income		23.3	21.6	28.2	73.1
4 >MK 85	53	**26.0%**	**31.5%**	**42.5%**	**100.0%**
Household income		220.6	267.3	361.0	848.9
Per capita income		41.6	49.4	62.8	153.8

Source: Peters & Herrera (1989)

(1): Value of maize retained for home consumption

(2): Income from the sale of crops and agricultural products

The data in Table 4-9 show a total mean per capita income of the sampled households of MK77.8. This value for 1986/87 is close to the national average annual gross household income of smallholders for 1987/88 of MK84.0 (see Table 4-7). For the total sample, home consumption, market income and off-farm income have income shares of 29.9%, 30.8% and 39.3% respectively. According to Peters and Herrera (1989: 17) off-farm income is composed of transfers (15%), wages (11%) and the remainder of self-employment.

Growing of the single most important cash crop (tobacco) in the survey area contributed, on average, 16% to the total income of tobacco growing households. The participation in tobacco production and the level of specialization, is associated with higher per capita incomes, compared to households which do not grow tobacco. With increasing income, the value of retained maize for home consumption declines, while off-farm income continuously increases. With increasing income, the share of market income decreases within the first three quartiles and increases for the last quartile. This demonstrates that higher market income shares cannot be regarded *per se* as an indicator of higher income. The higher share of market income in the top quintile reflects higher earnings from tobacco, while for the lower quintile, it reflects a higher dependence on selling maize.

Analysis of the detailed composition of income by food crops and sold processed food, reveals that the bottom income quartile households derive 19.1% of their income from food crops as compared to 14.4% for the top quartile, and that the share of grain (mainly maize) sales is about twice as high for the first quintile compared to the other quintiles. Both findings show that higher incomes are associated with a higher retention rate of produced grain and the more constrained range of income options for the poorest households.

The survey has made two other interesting findings. First, the share of off-farm income was found to increase with income levels. This contradicts the patterns observed at the national level. Specific reasons for this difference could not be ascertained. Secondly, the composition of sources of income and per capita income data revealed the unexpected result that per capita income is not strictly positively correlated with landholding size, except for holdings which are larger than 3.0ha. This result is contrary to the findings of all other studies which have consistently shown that there is a strong correlation of household size with income. From such a small survey sample no general conclusion can be drawn. However, the results indicate that the variability of incomes across holding sizes may be considerably larger than suggested by the aggregate data in Table 4-7.

More recent data from the FSNM Survey also confirm that the correlation between income and landholding size is far from being perfect. Expenditure data[46] which were grouped by expenditure quintiles and landholding sizes, show that a significant number of smallholder households with small landholdings were in higher expenditure quintiles, while households with large landholdings appeared in lower expenditure quintiles.

Cash income and expenditure

As mentioned above, estimating the share of cash income in total income is complicated by the fact that no distinction is made in available income statistics between the share of imputed income (private consumption) in total income from crops.

For holding sizes up to 1.5ha the composition of imputed income can be gauged from their

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[46] The data were shown in Simler and Quisumbing (1992: 3).

cropping pattern. Because households with holding sizes up to 1.5ha are usually food-deficit or just able to cover their food needs, it can be quite safely assumed that the food crops grown are consumed. Gross margins of cash crops are higher than those of local maize, but for calculations the simplifying assumption is made that the share of land cultivated with cash crops may be used as a proxy for the share of cash income in total farm income, excluding livestock. To derive the cash income for holding sizes up to 1.5ha, which are shown in Table 4-10, the share of cash crops from the upper part of Table 4-2 were multiplied with the cash income available after expenditures on food[47]. The per capita figures in Table 4-10 were based on the average household sizes from the ASA.

For estimating the cash income of holding sizes greater than 1.5ha, it has to be taken into account that in addition to the share of cash crops which is shown in Table 4-2, with increasing holding size more surplus food crops are sold. As a proxy for this surplus, the excess production over household requirements (see Table 4-1) was used. To calculate the cash income share from food crops, the share of excess production was multiplied by the total share of food crops. A food budget share of available cash income of 60, 55 and 50% was assumed for the landholding sizes 1.5 to 2.5ha, 2.5 to 3.0ha and greater than 3.0ha respectively.

TABLE 4-10 Estimate of annual cash incomes of smallholders in 1987/8

Holding size	*Total income*	*Cash income*	*Food expenditure*		*Residual cash*	
(ha)	*MK*	*MK*	*MK*	*% of cash income*	*MK*	*MK*
0.0 - <0.5	126	47.4	31.8	67.1	15.6	4.1
0.5 - <1.0	239	68.7	46.0	67.0	22.7	5.3
1.0 - <1.5	405	135.1	90.5	67.0	44.6	9.5
1.5 - <2.0	537	264.7	159.0	60.0	105.9	20.4
2.0 - <2.5	732	428.0	257.0	60.0	171.2	29.5
2.5 - <3.0	912	547.0	301.0	55.0	246.1	39.1
>3.0	1 399	960.9	480.0	50.0	480.5	65.8

Sources and assumptions: see text.

The annual per capita availability of cash after food expenditures is very low and perhaps on the low side. However, even if the inverse composition of cash and non-cash income was assumed to be representative, an assumption which would roughly correspond to the pattern found by Peters and Herrera 1989 (see Table 4-9), the per capita cash income would

[47] For this calculation a food expenditure share of 67% was assumed.

triple, but the per capita cash available for non-food expenditures would still remain at or below MK2.5 per month for smallholders with less than 1.5ha. Thus the conclusion may be drawn that cash is extremely scarce for the vast majority of smallholder households in Malawi.

4.5 SUMMARY AND CONCLUSIONS

For the main issues which were discussed in this chapter the following conclusions are drawn. Because of the relative complexity of these issues, the conclusions are combined with a summary of the discussion.

Household energy policy and the conceptualization of peasant households

- Analysis of past failures of household energy policy interventions has given rise to the insight that a more comprehensive understanding of rural households and, notably, of rural farmers which form the large majority of the rural population, is required. The main problems identified as analytical shortcomings were that the responses of rural households to policy interventions were often misconceived, which leads to a closer look at the question of how decisions are actually made within these households. More specific shortcomings were that policies assumed that certain objectives and constraints, notably labour constraints, were considered important so that policy measures and programmes were implemented which were designed to maximize specific benefits or to relax specific constraints. That households responded in other ways than expected was largely due to the fact (not taking into account implementation problems) that the perceptions of the households were inadequately conceived.
- Attempts to conceive specific interventions by focusing on the most binding constraint, for example, labour availability, appear *per se* to be a rational approach because the opportunity costs of this constraint are usually high which may be considered as a prerequisite for positive responses. However, choosing a single constraint as the basis for designing policy interventions has the drawback that the effects of other constraints on decision-making behaviour are not addressed.
- The objectives and resource constraints of households, as well as the markets with which they interact, need to be drawn into the analysis to understand their framework for making decisions. The rationale of putting rural household energy policies, inclusive of woodfuel policies, into a broader conceptual framework is that virtually any intervention involves a household decision to mobilize cash, labour or land resources and to evaluate the trade-off between perceived benefits from such interventions and the utilization of these resources in other productive or consumption activities.

The relevance of farm household models and related concepts to household energy policy analysis

- Bradley (1991) has made an attempt to develop a broader conceptual framework for understanding farm households, whereby the definition of peasant households and the concept of risk, represent important building blocks. The concept of peasant risk, their interaction with markets and household objectives and constraints, can be integrated into farm household models. It is thus interesting to note that there is very little research which has tried to explore the utilization of these models more in-depth for the development of rural household energy policy. This is surprising in two respects. First, an important element of the discussion about a more adequate analytical framework, is the insight that understanding the livelihood systems of rural households requires, first of all, an understanding of household decision-making in the context of their agricultural systems and resource availability. Secondly, many options which tend to be addressed by energy planners or foresters as energy or energy-related options (farm forestry, agroforestry) are, from the perspective of the household energy or agricultural policy analyst, household production options. Since household decision-making about land allocation and crop choices, as well as the adoption of new cash crops, is the key theme of agricultural policy analysis it has to be realized that tree planting options fall *sui generis* into the traditional analytic portfolio of agricultural policy. Elements of farm household theories and related concepts are used by agricultural policy analysts to analyze the rationale for the allocation of household resources to various crops, taking into account the constraints under which specific households operate.

- The concept of peasants or smallholder households was discussed, to provide a background for the discussion of farm household models and economic concepts, which attempt to explain the resource allocation behaviour of farm households. Understanding farm household decision behaviour requires an understanding of dynamic changes in the resource availability of households and the markets they interact with. Inevitably, this requires an analysis of policies affecting changes in both areas and the opportunity of households to participate in these markets. Farm and peasant household theories address, partly the same, and partly selected aspects of this decision-making process. The theories vary in their assumptions with regard to the underlying objectives, and projected decision outcomes vary according to the assumptions made concerning the existence and the competitiveness of the markets farm households interact with. As a result of this, it is necessary to narrow down the theories and key concepts which may apply to particular country, regional or even household-specific circumstances. None of the main models discussed is able to predict the decision behaviour of farm households in their entirety, because some of the assumptions made do not capture the objectives or specific constraints of smallholders in Malawi, and the reality of how credit and labour markets work. However, certain features of these models are useful to conceptualize key aspects of smallholder decision behaviour which have a bearing on energy-related decisions. As such they are in many respects complementary and should be regarded primarily as tools for empirical analysis.

- Farm household theories do not explicitly address the choices of households concerning energy-related issues. However, this represents no drawback for the analysis of household energy policy options. One reason for this is that there is no *a priori* reason why rural households should perceive energy problems, as conceived by energy planners, as similarly important or as one of the most important of the problems they are facing. A second, and more important reason, is that energy-related problems of rural households and the extent of these problems cannot be defined and understood in isolation from their economic content. Hence resource allocation decisions to mitigate or to solve these problems form part of the household economy, because any solution requires the reallocation of household resources and hence trade-offs with other activities.

Income analysis

- The development of smallholder incomes in Malawi is a reflection of their interaction with and access to goods, labour and credit markets given specific household land and labour constraints. Given the trends in population growth, arable land availability and agricultural productivity, the only long-term feasible solution to cut through the poverty cycle is through enhanced agricultural productivity. The key to facilitate this is increasing access of smallholders to agricultural credit and the production of more remunerative cash crops and, indirectly, the development of more remunerative rural income-generating opportunities.

- As the development in the 1980s has shown, these challenges are formidable and little progress has been made to overcome the lack of income growth in the smallholder sector. For many of the resource poor smallholders, access to credit is unlikely to come forward because of their existing poverty status and the mechanisms of the poverty cycle. The scope for a massive increase in income-generating opportunities is rather mixed because these are driven themselves by increased agricultural productivity.

- Per capita income of most of the smallholder households in Malawi are very low. A large portion of their total income is accounted for by imputed income or home-consumed production, and excess cash has to be mainly spent on food. As a result, remaining cash resources are extremely limited in virtually all smallholder households. This suggests that most smallholders are likely to carefully evaluate expenditure decisions on consumption items and to favour low-risk production, particularly cash crop decisions.

- The overall development of real income in rural households suggests that according to the concepts and predictions of the energy transition (see Chapter 7), substantial interfuel substitution in rural households are unlikely to have taken place during the 1980s.

Stratification of smallholder households

- An important theme for the efficient design and implementation of rural household energy policy is related to the following questions. Are targeted policies required? Can households be suitably stratified for targeting policies? And, do we know enough about rural households to design and implement targeted policies? The approach which was taken in the empirical analysis of smallholder households in Malawi was to typify households in terms of their objectives, and the constraints and risks which they face. Their decision behaviour, and their opportunities to respond to changes in policies and to participate in markets, may then be defined.

- Landholding size was found to be either positively or negatively correlated with income, household size, food insecurity, intensity of land use (fallowing), land utilization for cash crops, participation rates in off-farm employment and some other variables which were discussed above. These relationships make landholding size an easily observable criterion for stratifying households. Income data suggest that holding size is also a good indicator for income across ADDs, particularly for holding sizes up to 2.0ha, which cover about 88% of all smallholder households. However, it has to be borne in mind that some correlations, notably the relationship between income and landholding size, were found in a smaller survey to be less strong than previously thought. This implies that additional indicators may have to be identified to better stratify households from an income point of view.

- A dividing line runs through the smallholder community which is defined by food security or the poverty line. This line runs through the holding category of 1.0 to 1.5ha. What is partly reflected in income data, but more so in regional maize production data, is that agro-ecological differences probably entail some upward and downward shifts in the holding size defining poverty at the regional level and, most likely, also at the ADD level.

- The study of the World Bank has identified smallholders with a ha size of about 0.4ha as being core poor. It is difficult to draw a precise line with regard to differentiations among the poor households. However, from the point of risk-bearing capability, it may be concluded that the households which are almost permanently food-deficit, that is the 56% of the households with approximately less than 1.0ha, have to be considered as strongly risk averse. Female-headed households are concentrated in this group. The smallholder group having a holding size between 1.0 to less than 2.0ha may be considered as being progressively less risk averse, although this group is still considerably constrained in their access to credit. However, since food insecurity is a major determinant of risk-taking ability, it has to be taken into account that the fairly high incidence of intercropping which may be regarded as a risk management strategy, is being pursued by about 75% of all smallholders. This percentage coincides with the percentage of smallholders having a holding size less than 1.5ha. Thus it may be hypothesized that strong risk-averse behaviour coincides with the smallholders in the holding size of between 1.0 and less than 1.5ha.

- Households with holding sizes in excess of 2.0ha appear to be less constrained in all respects and must therefore be regarded as those which possess sufficient resources to participate fully in markets and to seek market opportunities.

Implications for household energy policy

- The seasonal labour shortages in smallholder households in Malawi, suggest that household energy policy interventions have to deal with the problem that diverting labour from agricultural activities during the peak period of agricultural activities, involves high opportunity costs for all smallholders. This points to the need to emphasize supply options with low incremental labour demands during this season, and the promotion of options which allow a timely dispersed implementation.
- Overall, smallholders face tight and increasing land constraints. Hardly any land is being left fallow, which implies medium- to long-term declines of agricultural productivity. Permanent and temporary food-deficit households have planted between 7 to 22% of their land to cash crops, while the remainder is sown to food crops. The area used for food crops has to be regarded as being fairly insensitive to changes in input and producer prices. This imposes a physical constraint on the total available land for other land uses, unless land saving agricultural productivity measures become successful. Throughout the 1980s productivity of major crops has not improved, or even declined. Increased crop productivity hinges to a large extent on the access to, and utilization of, more fertilizer. Even though food deficit households grow cash crops on the remaining area, they are facing tough choices because of the high financial risks involved.
- The cropping patterns of smallholders clearly reflects that they diversified their cash crops towards those having a lower variable cost to gross margin ratio. This pattern

applies particularly to food-deficit households. This constraint becomes, of course, less binding with increasing landholding size. Because intercropping is widely practiced, the competition of trees with crops has to be assumed as being a particularly sensitive factor for those smallholders engaging in this practice. On the other hand declining yields, and constrained access to agricultural credit and fertilizer, make agroforestry options potentially more attractive to these farmers.

- Regarding the attractiveness of trees to smallholders in terms of a cash crop, there are some difficulties as to the question of which crop to choose as a benchmark for economic comparison purposes. The existing diversification of cash crops indicates that a weighted average of the cash crops could be a reasonable measure. However, it needs to be considered that despite the growing of cash crops by food-deficit farmers, they are still eager to increase their maize harvest which suggests that local maize be used as a benchmark. An additional consideration in this respect, is that the high interest rates in the informal financial market with credit maturities of less than a year, and high discount rates which are implicit in the trade-off between on-farm labour and casual labour employment, represent for those smallholders without access to credit a factor which inhibits the attractiveness of crops with a longer gestation period, notably tree crops. In addition to the higher discount rates which may thus be applied by the latter group, it can be hypothesized that smallholders in general will add a risk premium to the growing of crops, the returns of which will only materialize in the medium term. Food-deficit households particularly, with less risk-bearing capacity and the need to generate income for food purchases, have to be assumed to be especially interested in crops which generate income in the shortest time possible.

- The finding by Chipande (1986) that labour-constrained households were inclined to choose more labour-intensive cash crops (groundnuts) with lower returns (in comparison to crops with the opposite characteristics), because the former had a labour demand profile which minimized labour demand peaks, indicate that fuelwood supply options which are designed to replicate these characteristics are likely to have a better chance of success.

- Concerning the relationship between intra-household responsibilities for agricultural production tasks and expenditures which have a bearing on woodfuel options, available evidence suggests that the choice of cash crops and the purchase of agricultural inputs is largely dominated by men, while expenditures related to fuelwood purchase and household equipment seem to be more firmly under the control of women. In addition, where women have direct access to additional land from their relatives, they are relatively unconstrained by males concerning the choice of land-uses. That men dominate cash crops and purchases of production inputs, suggests that they are also the prime decision makers concerning the decision of growing trees. The empirical evidence also suggests that women who have the responsibility of collecting fuelwood for home use, may have some degree of freedom regarding the choice between collecting and purchasing fuelwood. However, the extreme cash scarcity of households suggests a strong trade-off between these options. Collecting fuelwood, water and cooking are all examples of labour-intensive Z-goods. Since men were found to hardly participate in the production of these goods, the trade-off is firmly determined by the seasonal time constraints of women. During the non-peak agricultural season, that is between February to October, the time budgets of women are less constrained because agricultural labour demands are considerably lower. Therefore more time is available for other activities including fuelwood collection. Even though limited off-farm income-generating activities have been available in the past, they are likely to have been of a more temporary nature. Thus it may be assumed that time budgets of women inclusive of the labour time of children, who participate heavily in the production of Z-goods, were not burdened too much with these activities because of labour demand constraints. From a time budget point of view, this points to the conclusion that it is unlikely that rural women have changed their procurement of fuelwood. In other words, why should a woman that has limited chances of finding off-farm employment and self-employment with a view to generating a cash income, use the little amount of cash available for fuelwood which she is able to collect herself together with her children?

- The same argument can be made from a different perspective. Real market wages have been declining considerably for an extended period of time in the 1980s. Since the entire period was characterized by fairly constant or partly declining per capita incomes it is also likely that real returns from off-farm income opportunities, including beer brewing as a major activity, have not increased. Thus, market wages and returns from other off-farm activities combined, that is the opportunity costs of time for women, may be assumed to have remained unaltered and to have perhaps declined. Therefore from the point of view of the HEM, a substitution of time-intensive goods such as the collections of fuelwood for home use by money-intensive goods, is unlikely to have materialized. This may be interpreted in the sense that demand of purchased fuelwood for household use is unlikely to have changed.

- It should be pointed out that the last statement does not imply that the household energy consumption pattern, or the level of energy consumption, may not have changed over time. As pointed out in Section 4.1, there are a number of possible alternative household responses to fuelwood shortages which do not require cash outlays. Hypotheses concerning such response patterns and the empirical evidence from Malawi are discussed in Chapter 5.

- From a woodfuel policy point of view, the implications of seasonal peak labour demands are also of interest. High opportunity costs of time during the peak labour demand period imply that households were found to forego high on-farm labour returns for considerably lower casual labour wages, in order to survive. Thus it could be hypothesized that the implied financial losses could provide a sufficient incentive either to purchase a fuel-efficient stove, if they were available, or to buy fuelwood. The drawback for options involving cash outlays is that at the time when the money is earned, it is needed for food. This renders the option to buy fuelwood a fairly unlikely proposition.

Chapter Five

WOODFUEL SUPPLY-DEMAND ANALYSIS AND DEFORESTATION

This chapter analyzes a whole range of issues and hypotheses which have been discussed in the literature in the context of the criticism of the fuelwood gap paradigm. An overview of the central issues of the criticism of the conventional thinking about the nature of the 'fuelwood crisis' and its policy implications is, for example, contained in Eberhard (1992). Some of the main criticisms and issues concerning fuelwood supply and demand gaps were briefly introduced in Chapter 1 and may be extended and summarized as follows. On the supply side, reliable data about woody biomass stocks and fuelwood supply and availability are typically rare and often quite unreliable. Large-scale regional aggregations of available woodfuel data mask large differences in local fuelwood supply and demand situations. As a consequence, fuelwood interventions cannot be designed on the basis of national or even regional supply shortfalls or surpluses, but have instead to be more location-specific. It has also to be taken into account that harvested woodland can also regenerate. On the demand side, data problems associated with unreliable supply data are compounded by unreliable data about energy consumption patterns and consumption levels which may vary considerably across regions and even within smaller geographical units. Under conditions of scarcity, household adopt various fuel saving of substitution options. Thus the fuelwood gap rarely widens to the crisis proportions conventionally predicted.

Supply- and demand-side uncertainties do not render energy and fuelwood balances obsolete as a planning tool, but such balances need to be developed at a suitable disaggregated level. The problem associated with this call for better data is that they are costly to develop. Cost-effective data collection approaches such as rapid rural appraisals may be employed. However, they cannot replace well designed comprehensive surveys to develop information about data items such as woodfuel consumption which preferably should have an impeccable statistical quality. Financial constraints often make the likelihood of developing such information an uncertain outcome. Consequently this leads to the general question of what this implies for the design of effective policy interventions.

Another important policy issue is under which intensity of woodland harvesting, post-harvest management and natural conditions deforested land actually ceases to regenerate. The assumption that clear-felling of forests inevitably leads to deforestation is contentious and may lead to an underestimate of available woodfuel supplies.

Within the discussion of determinants of woodfuel supply and demand, two crucial issues are of key importance for the development of sustainable woodfuel policies. The first issue relates to the question of which processes contribute most to deforestation. It is obvious that the formulation of an effective household energy strategy has, in the first instance, to be based on the identification of the causes of deforestation. The question of which processes and type of woodfuel consumption contribute most to deforestation has not been generally settled. Some empirical research has shown that agricultural land clearing is quantitatively the most important source of deforestation. Hence the assumption that household woodfuel demands are the prime cause of deforestation has been challenged. However, according to Teplitz-Sembitzky and Schramm (1989: 123) the issue of which forces drive the depletion of biomass resources remains controversial.

The issue of the quantitative role of deforestation due to land clearing, is a central concern for the design of sustainable woodfuel policies. As Leach and Mearns (1988a) have noted, the strategic outlook for woodfuel policy changes if the future supply of woodfuels from land clearing is bound to decline. The contribution of land clearing to deforestation is not only of strategic importance for the design of future woodfuel and household energy strategy but may also play an important role for the understanding of how woodfuel markets function and how woodfuel scarcity is reflected in woodfuel prices. For example, Hosier and Milukas (1992: 14) have noted that woodfuel supplies from agricultural land may have a dampening influence on woodfuel prices. Therefore, where substantial amounts of surplus wood from agricultural clearing flow into fuelwood markets, depletion effects may only be partially, or perhaps not at all, reflected in woodfuel prices. Consequently, in countries or regions which approach the agricultural frontier, the decline of fuelwood supplies from agricultural land clearing may produce ratchet effects in woodfuel prices.

The second major issue refers to the responses of rural households to woodfuel scarcity. The general view in the literature is that the level of woodfuel consumption is related to supplies (see, for example, Sinha et al 1994: 410). Consequently, in the context of diminishing physical woodfuel supplies and economic constraints of rural households, consumption will eventually decline. Several possible adaptive strategies, such as those outlined in Chapter 4, come into play and need to be considered in rural household energy consumption and household energy policy analysis. Within this context, a central question from a policy point of view is under which conditions and in which type of households are specific adaptations likely to occur, and particularly, in which sequence and combinations.

This chapter is sub-divided into seven sections. In the first section, the available data base on forest resources and woody biomass supply in Malawi as well as long-term deforestation estimates, are discussed. The main objectives of this analysis are to clarify the quality of the available data and to derive estimates of woodfuel supplies at the regional level. In Section 2, the contribution of agricultural land clearing to deforestation is analyzed. The results of both sections are used to support the analysis in subsequent sections.

Section 3 analyzes woodfuel supply and demand in the main woodfuel consuming sectors other than the rural household sector. The objective of the sectoral woodfuel consumption analysis is twofold. First, present consumption levels and sources of supply are estimated to determine the woodfuel supply and demand situation in 1990. Secondly, the analysis establishes estimates about the development of woodfuel supply and demand balances of major consumption sub-sectors for which sufficient data are available. This analysis tries to ascertain how much of the total deforestation which has been estimated to have occurred between 1972 and 1991 is attributable to single consumption sectors.

Section 4 starts with a summary of the main findings of the literature concerning the determinants of energy consumption patterns in rural households and their response strategies and adaptations to woodfuel scarcity. This outline follows an analysis of changes in the composition and consumption levels of fuels by end-use in the context of declining woodfuel resources. The main objective of Section 4 is to test the hypotheses and main findings which are outlined in the beginning of this section. The analysis of households' responses generally includes changes on the demand and the supply side. However, Section 3 deliberately leaves out the analysis of tree planting measures by smallholders. The analysis of supply-side adaptations is performed in Chapter 6 in the context of the analysis of the fuelwood policies which have been pursued in Malawi since the early 1980s.

The objective of the discussion in Section 5 is twofold. First, a woodfuel supply and demand balance on a regional level is constructed for 1990, based on the data developed in previous sections. The balance serves to indicate the severity and unsustainability of woodfuel consumption levels in Malawi. Secondly, the interrelated issues of harvesting intensity, woodland management and regeneration are discussed in relation to the major woodfuel consuming sectors in order to refine the quantitative estimates of sectoral contributions to deforestation from the first two sections of the chapter.

The objective of Section 6 is to estimate the economic costs of deforestation and to clarify the question of which groups are bearing these costs. This analysis is followed by a summary of the chapter and a discussion of policy implications in section 7.

5.1 ESTIMATES OF WOODY BIOMASS SUPPLY AND DEFORESTATION

Forest resource and biomass supply assessment

Several energy studies which have been conducted in Malawi in the 1980s and early 1990s have made an attempt to estimate woodfuel supply and demand balances for Malawi. A major limitation of these studies were information gaps, primarily about the growing stock of biomass resources, and uncertainties about yields and growth rates (mean annual increments - MAI). The data limitations on the supply side were mainly due to the fact that no comprehensive nationwide biomass assessment had been carried out until 1993. For planning purposes, an average annual deforestation rate of 3.5% has been used since the early 1980s, based on estimates of population growth and the expansion of agricultural land. Due to the lack of sufficiently reliable data, this assumption was accepted as the best educated guess for energy and forestry planning and policy purposes. As mentioned in Chapter 2, the Malawi National Energy Plan was subject to the same data limitations on the supply side but was also methodologically entrenched in the fuelwood-gap paradigm which was characterized by the assumption of a linear relationship between population growth and fuelwood consumption. As a result, the previously adopted rate of deforestation was maintained as the basis for planning purposes.

Two major studies have contributed to the enhancement of the forest resource data base and some aspects of the dynamics of deforestation, notably with regard to the role of agricultural land clearance. The Land Resources Evaluation Project study (LREP), the results of which are presented in Eschweiler (1993), provided new data about the distribution of forest resources by ADD and estimated the conversion of virgin customary woodland to agriculturally used land. The study Forest Resources Mapping and Biomass Assessment for Malawi (FRMBA) (Satellitbild 1993) which was completed in 1993, provided improved data for forest resources at the district level and ascertained losses of forest cover for undisturbed forest resources in Malawi.

For the objectives of this research, both studies have provided new data which are in several respects complementary. However, particularly the use of data from the LREP study in areas not covered by the FRMBA study rests to some extent on the reconciliation of its forest resource data and classifications with those of the LREP study. Unfortunately, the FRMBA study used forest and other land cover class definitions which were to a large extent different from those used in the LREP study.[1] The definition of land cover classes were

[1] In view of the scarcity of longitudinal data for forest and land cover and land use changes and the costs involved to carry out such studies, it is unfortunate that not much care was used in the FRMBA study to maximize its potential use for planning and policy purposes, by trying to define land cover classes in such a way that reconciliation with other data bases could be facilitated. Although the authors claim, in view of the data available from the LREP study, that the definitions

found to be comparable for forest plantations and *Brachystegia* woodlands.[2]

Growth rates and yields

The forest resources in Malawi are miombo woodlands which are characterized by the dominance of the species *Brachystegia, Julbernardia, Burkea africana* and *Pterocarpus angolensis.* As such the forests in Malawi form part of a larger ecosystem which covers seven central and Southern African countries. The general climate conditions, soil fertility status and soil moisture conditions for miombo woodlands are summarized in Chidumayo (1993: 586-7). The climate is characterized by a long dry and short rainy season, while the fertility of soils is determined by a low organic matter and nutrient content and low cation exchange capacity. The moisture content is subject to large seasonal variations, particularly in the topsoil, but mean daily and annual soil temperatures are rather constant. A review of soil fertility in Malawi (CODA 1993: Annex 4) confirms the low inherent fertility of soils which is mainly due to deficiencies in macronutrients and low soil water holding capacity. There exists considerable variation in agroclimatic zones[3] and the DOF has defined seven silvicultural zones for the country.

The World Bank (1992b) reviewed previous studies concerning growing stock and growth rates (MAI) for different types of forest resources in Malawi. Results from this study which are shown in Table 5-1 are also mostly used in ensuing calculations because they represent the best available estimates. An exception are MAIs for government plantations in Table 5-1 which essentially refer to pine plantations. As discussed below, MAIs for government fuelwood plantations are considerably lower.

Standing stock estimates for miombo woodlands by region and for extensively and

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of land cover classes was determined by the terms of reference and the requirement to make optimum use of the Landsat data (Satellitbild 1993: 40), the study neither made an attempt to demonstrate the impacts on data accuracy of adopting definitions of land cover classes more congruent with those of the LREP study, nor to reconcile the findings from both studies.

2 While the FRMBA study differentiated *Brachystegia* forests by the three categories 'evergreen' and 'forests in hilly and flat areas', the LREP study also used the land cover class 'evergreen' but differentiated three and four categories for forests in hilly and flat areas respectively. The comparison of *Brachystegia* woodlands which is shown in Annex 5-1 gave the following results. The hectarage of *Brachystegia* woodlands in hilly areas on a national basis varies only marginally (LREP: 1.66mln ha; FRMBA: 1.69mln ha). However, major differences exist for some ADDs, notably in NADD and MADD. For *Brachystegia* forests in flat areas, major differences exist both on a nation-wide scale (LREP: 1.14 mln ha; FRMBA: 0.73 mln ha) and for virtually all ADDs. Other major land cover classes instead were defined in such a manner that a reconciliation of the data was not possible in terms of the degree of accuracy required to draw reliable conclusions. This applies particularly to agriculturally used areas. The LREP study did classify croplands including customary and estate land in a very detailed manner, while the FRMBA study used only two land cover classes, that is extensive and intensive agriculture, and treated large plantations (>100ha) separately.

3 The LREP study distinguishes between 136 agroclimatic zones (see Coda 1993: Annex 4: 4-32/33).

intensively used agricultural land, have been developed by the FRMBA study. As shown in Table 5-1, the growing stock estimates for miombo woodlands compared to the World Bank data for forest resources are considerably higher. A biomass survey conducted by CODA (1993: Annex 24) assessed the volume of above ground biomass on croplands in the districts Karonga, Mangochi and Dedza which are located in the Northern, Central and Southern regions respectively. Due to the definition of the land classes in the FRMBA study, the volume estimates for the land cover classes 'extensive agriculture in forests' and 'intensive agriculture' include woodlands and on-farm biomass. Therefore the biomass estimates developed by CODA do not constitute a separate land cover class in the framework of the land use classification used by the FRMBA study, but they provide a clearer indication of the growing stock of woody biomass on farms in the smallholder sector.

TABLE 5-1 Estimates of average growing stock and mean annual increments by region and forest/land cover class

	Northern region		*Central region*		*Southern region*	
Forest/Land Cover Class	*Volume cu.m./ha*	*MAI cu.m./ha/a*	*Volume cu.m./ha*	*MAI cu.m./ha/a*	*Volume cu.m./ha*	*MAI cu.m./ha/a*
Plantations (1)						
Private (1)	71.0	10.0	71.0	10.0	115.0	20.0
Government (1)	202.0	20.0	84.0	12.0	84.0	12.0
Indigenous forests (IF)						
IF-Customary land (1)	120.0	1.0	40.0	0.8	30.0	0.5
IF-Reserves (1)	100.0	1.2	80.0	1.0	80.0	1.0
IF-Hilly areas (2)	122.3		122.3		81.4	
IF-Flat areas (2)	105.1		109.2		61.1	
IF-Evergreen (2)	224.3		n.a.		335.9	
Extensive agriculture(2)	77.2		35.1		61.2	
Intensive agriculture(2)	n.a.		20.2		7.6	
Croplands (3)	11.7		0.9		4.9	

Sources: (1) World Bank 1992b; (2) Satellitbild (1993: 30); CODA (1993: Annex 24)

Consequently, when subtracting the biomass estimates for croplands from the ones for the land class intensive agriculture, an estimate of the biomass available on woodlands in customary areas is obtained. However, this procedure is subject to some rather large uncertainties in volume estimates of the FRMBA which vary by type of land cover class.[4]

Estimates for volumes and mean annual increments on government and private plantations are indicative only. A recent study by deLucia & Associates (1992: 3-17/19) showed in

[4] Standard deviations were quite different for single land cover classes. For forest resources on hilly land, flat land, extensive agriculture and intensive agriculture the standard deviations were about 40%, 47 to 71%, 80 to 120% and 200% respectively (see Satellitbild 1993: 30).

stylized examples which were based on field observations, that yields may differ by a factor of 2 to 4 between technically efficient and inefficient producers, given comparable silvicultural conditions. These differences both exist within the estate sector, but of particular concern were the large differences in yields between efficient tree growers on estates (particularly the tea estates) and government plantations. In the approximately 15 000ha of woodfuel plantations which were established by the DOF between 1980 and 1987, the MAIs are estimated to be 4.7m^3/ha (Chitenje & Mkumba 1993: 5). One of the reasons advanced for such low MAIs is that government plantations were mainly planted on marginal soils. Such a policy is economically sensible in view of the scarcity of suitable agricultural land. However, the main concern with government fuelwood plantations is that yields are low due to technical inefficiencies. These inefficiencies are not a problem originating from a lack of silvicultural expertise but are associated with deficiencies in properly managing the establishment of forest plantations.

Distribution and availability of forest resources and woodfuel supplies

The preceding analysis has shown the uncertainties involved in estimates of the available forest resources concerning standing stocks, by type of forest and land cover category and the MAI estimates. Given these uncertainties, estimates about annually available supplies naturally differ considerably. The role of reliable data on woodfuel supplies for woodfuel policy planning has already been discussed above. The ideal requirement for policy purposes would be to have accurate supply data on a fairly disaggregated area level combined with information about the actual accessibility of rural households to the woodfuel resource base. However, as the following discussion will show, the existing data base allows one only to approximate regional supply levels. These data are still helpful as an indicator of relationships between regional supply availability and population densities and for the discussion of interactions between woodfuel supply and demand of rural households.

Estimates of total annual increments of wood

Two recent studies (CODA 1993; World Bank 1992b) have estimated total annual increments of wood in Malawi. A common assumption underlying them is to exclude the forest resources within the national parks and game reserves which are not available for harvesting. The latter resource covers an estimated 0.968 million ha (Eschweiler 1993: 20) or about 36% of the indigenous woodlands. Forest reserves comprise another estimated 0.718 million ha (Eschweiler 1993: 20) and serve primarily the protection of water catchment areas. It was assumed that 50% of the MAI is available as woodfuel supply. The remainder is not harvested mainly because of the ecological functions of the forests.

The World Bank (1992b, Vol II: 42) estimated a total annual increment from all forest resources including plantations of 5.7 million m^3. However, for this estimate the information from the LREP and FRMBA studies were not available. The study also included the rather high MAI from government plantations based on the data shown in Table 5-1, which accounted for 27% of total woodfuel supply and did not consider access constraints to woodfuel resources on government forest reserves. A more recent analysis of woodfuel supply estimated a considerably lower total annual woodfuel supply of 3.7 million m^3 of which 2.4 million m^3 were estimated to be available for woodfuel consumption (CODA 1993: 24-27). The lower estimates of this study are partly due to slightly lower assumptions concerning yields on government and private plantations, which account for 0.3 million cu.m. of the total difference of 2.0 million m^3. Most of the remainder of this difference is accounted for by the assumption of a higher proportion of forest resources on customary land, and particularly the assumption that 86% of the forests on customary land are nearly depleted (CODA 1993: 24-27). Due to the reduced productivity of most forests on customary land, a MAI of 0.3 instead of those shown in Table 5-1 was used. However, there are some doubts as to the validity of this assumption because of its unclear empirical foundation.[5] To derive a total estimate of annually available woodfuels, a supply of 1.35 million m^3 from croplands on customary land was added to forest supplies.

The disadvantage of the CODA estimates is their aggregation at the national level which makes them unsuitable for analytic purposes requiring more disaggregated data. Disaggregated data about standing stocks of woody biomass are available from the FRMBA study at the district level. In Table 5-2 the per capita availability of standing stocks of biomass in 1990 and population densities by district are shown. Although the per capita availability of the growing stock of biomass per capita declines strongly from the Northern to the Southern region, population densities and per capita biomass availability are not closely correlated.[6]

The FRMBA stock data included forest reserves in national parks and game reserves and croplands (agricultural land in forests and forests in agricultural land). The estimate of the regionally available woodfuel supplies in 1990, which is shown in Table 5-3, is based on calculations performed in Annex 5-2. The underlying assumptions are as follows. Since the

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5 This assumption was based on the results of a national forest resource inventory which was reported by CODA to have been carried out in 1992 (see CODA 1993, Annex 24: 26-27). However, the quoted report was not referenced. Possibly, the authors were referring to the FRMBA study, which was the only national study of such nature which was undertaken in 1992. However, the FRMBA study does not discuss this issue and the data on standing stocks per ha for forest land cover classes and agricultural land classes, which are interspersed with forests, do not support this assumption.

6 Linear regression of the data yields a coefficient of determination (R^2) of 0.43.

FRMBA biomass stock data were not broken down by tenure categories, the MAI data for *Brachystegia* forests which are shown in Table 5-1 were averaged to capture the mixture of forests covered. Based on data in Eschweiler (1993: 20), annual supplies from natural parks and game reserves and 50% of the estimated supply from forest reserves were deducted. Supplies from private and government plantations were added based on available area estimates (World Bank 1992b, Annex 3: 14) and the MAI assumptions shown in Table 5-1. While the supplies from government plantations are probably somewhat overestimated, supplies from private plantations in the Southern region are probably underestimated. An important forest category for which MAI estimates are uncertain are forests on croplands. For these areas which contain 40.5% of the total biomass volume estimated by the FRMBA study (Satellitbild 1993: 28), a perhaps conservative MAI of 0.3 was assumed.

TABLE 5-2 Woody biomass availability by district (1990/91)

	Land area	*Population*	*Biomass volume*		*Population*
District	*ha*	*1991*	*1000m^3*	*m^3 per capita*	*density*
Chitipa	350 400	108 520	33 126	305	31
Karonga	296 500	168 540	34 788	206	57
Nkhatabay	408 800	163 135	32 658	200	40
Rumphi	595 200	105 574	35 069	332	18
Mzimba	1 043 000	498 257	81 855	164	48
North	**2 693 900**	**1 044 026**	**217 496**	**242**	**39**
Kasungu	787 800	394 659	34 541	88	50
Ntchisi	165 500	148 029	5 999	41	89
Dowa	304 100	367 147	7 867	21	121
Mchinji	335 600	277 939	7 495	27	83
Lilongwe	615 900	1 125 039	20 545	18	183
Salima	219 600	215 407	7 909	37	98
Ntcheu	342 400	429 476	10 716	25	125
Dedza	362 400	467 080	13 417	29	129
Nkotakota	425 900	189 193	33 260	176	44
Central	**3 559 200**	**3 613 969**	**141 749**	**51**	**103**
Mangochi	627 200	603 594	32 831	54	96
Machinga	596 400	605 109	13 046	22	101
Zomba	258 000	483 667	3 144	7	187
Blantyre	201 200	633 131	6 822	11	315
Mwanza	229 500	140 520	12 595	90	61
Thyolo	171 500	530 089	3 214	6	309
Mulanje	345 000	715 360	8 092	11	207
Chiradzulu	76 700	236 463	812	3	308
Chikwawa	475 500	383 526	14 650	38	81
Nsanje	194 200	260 951	6 569	25	134
South	**3 175 200**	**4 592 409**	**101 775**	**27**	**180**
Malawi	**9 428 300**	**9 250 404**	**461 020**	**106.5**	**107.1**

Sources: Land area: MAS (1993: 2); Biomass volume: Satellitbild (1993: Annex 26)

Population in 1991: Data from NSO (1987: 21-22) were escalated using the intercensal population growth rate (1977-87) from NSO (1987: 19)

TABLE 5-3 Woody biomass supply in 1990 (cubic metres)

		Region		
Supply	*Northern*	*Central*	*Southern*	*Total*
Sustainable supply	2 667 742	1 733 142	1 651 538	6 052 422
Unavailable supply	1 403 950	525 850	353 500	2 283 300
Net supply	**1 263 792**	**1 207 292**	**1 298 038**	**3 769 122**

Source: Annex 5-3

5.2 THE CONTRIBUTION OF AGRICULTURAL LAND CLEARING TO LONG-TERM DEFORESTATION

Estimates of the long-term rate of deforestation

Forest change cover for evergreen forests and *Brachystegia* woodlands were estimated in the FRMBA study for the period 1972/73 to 1990/91 at the district level. The estimation of average annual deforestation rates from these data are only indicative because it can only be assumed that annual deforestation rates varied during this period. As estimated in Chapter 3, of the total expansion of agricultural land of 1.109 million ha between 1967 and 1990, 56.6% (0.628 million ha) and 43.6% (0.481 million ha) accrued to the conversion of customary land into estates and increased land use in the smallholder sub-sector respectively. While the increase of customary land used for agricultural production in the smallholder sub-sector can be safely assumed to have been a continuous process in response to population pressures, the conversion of customary land to estate land occurred in distinct phases. Leasehold estate expansion data from Mkandawire et al (1990: 13) show that most of the leasehold estate expansion took place in the 1980s. Of the total expansion of estate land between 1967 and 1990, only 30% accrued to the period 1967 to 1979.

Table 5-4 shows the estimated average annual deforestation rates of Brachystegia forests, based on data by district from the FRMBA study.[7]

[7] For this calculation, forest stock data for 1972/73 and forest change data for the period 1972/73 to 1990/91 from the FRMBA study (Satellitbild 1993: Appendix 30) for the 24 districts in Malawi, were aggregated to ADDs by using the area definitions contained in Eschweiler (1993: 6-7). Deforestation rates were calculated by dividing the annual average loss in forest cover by the standing stock for each category in 1972/73.

TABLE 5-4 Average annual deforestation of miombo forests in Malawi (1972/73 - 1990/91)

ADD	*Ever-green forest*	*Hilly areas*	*Flat areas*	*All areas*	*Ever-green forest*	*Hilly areas*	*Flat areas*	*Hilly areas*	*Flat areas*	*All areas*
	ha	*ha*	*ha*	*ha*	*Share of total forest loss*			*Deforestation rates*		
Karonga	11.9	-4 081.5	-5 972.8	-10 042.4	-0.1%	40.6%	59.5%	0.9%	4.7%	1.7%
Mzuzu	-131.3	-10 468.6	-5 315.4	-15 915.2	0.8%	65.8%	33.4%	1.7%	2.0%	1.7%
Kasungu	-3.2	-5 074.4	-22 956.0	-28 033.7	0.0%	18.1%	81.9%	3.2%	3.7%	3.6%
Lilongwe	-28.0	-3 444.8	-2 419.3	-5 892.1	0.5%	58.5%	41.1%	1.8%	2.7%	2.1%
Salima	-10.7	-1 926.0	-3 141.1	-5 077.7	0.2%	37.9%	61.9%	0.6%	2.1%	1.1%
Liwonde	-82.1	-3 139.8	-14 449.3	-17 671.3	0.5%	17.8%	81.8%	1.0%	4.3%	2.7%
Blantyre	-63.1	-5 881.7	-3 462.1	-9 406.8	0.7%	62.5%	36.8%	2.8%	3.1%	2.8%
Ngabu	-3.4	-3 995.4	-3 755.7	-7 754.5	0.0%	51.5%	48.4%	2.7%	1.7%	2.1%
Total	**-309.9**	**-38 012.1**	**-61 471.7**	**-99 793.7**	**0.3%**	**38.1%**	**61.6%**	**1.6%**	**3.2%**	**2.3%**

Sources: Calculations were based on data from Satellitbild (1993: Annex 24)

The data show two interesting patterns. First, the deforestation rate in flat areas which are more suitable for agricultural production and generally more easily accessible, is twice as high as in hilly areas. Total rates of deforestation by district are shown in Annex 5-3. These data suggest that there is no consistent pattern with regard to a time-phased relationship between deforestation in flat and hilly areas in the sense that deforestation in flat areas was succeeded by deforestation in hilly areas. In most districts deforestation in hilly areas was also sizable. Secondly, differences between interregional deforestation rates are high, notably for flat areas. Moreover, the average annual rate of deforestation of 2.3% is approximately one-third lower than the previously adopted planning assumption of 3.5%.

The contribution of land clearing to deforestation

Table 5-5 was constructed to ascertain the question of how much of the total deforestation estimated in the FRMBA study may be attributed to agricultural land clearing. For this purpose land use data from the LREP study contained in Eschweiler (1993: Appendix 3) concerning total area cultivated in 1967 and 1990, were used to calculate the annual average increase in total cultivated area. As discussed in Chapter 3, it can be safely assumed that the total increase in area cultivated represents conversion of customary land. Based on this finding, Table 5-5 shows that the share of total deforestation attributable to agricultural land clearance amounts to 44.9%.

TABLE 5-5 Loss of forest cover due to agricultural land clearing (1967- 1990)

	Cultivated area		*Change*	*Average annual change*		
	1967	*1990*	*1967-90*	*Land*	*Forests*	*DDTFC(1)*
ADD	*ha*	*ha*	*ha*	*ha*	*ha*	*per cent*
Karonga	147 700	220 700	73 000	3 174	-10 042	31.6%
Mzuzu	429 600	683 500	253 900	11 039	-15 915	69.4%
Kasungu	476 400	968 100	491 700	21 378	-28 034	76.3%
Lilongwe	749 700	797 100	47 400	2 061	-5 892	35.0%
Salima	252 200	429 000	176 800	7 687	-5 078	100.0%
Liwonde	658 200	737 100	78 900	3430	-17 671	19.4%
Blantyre	589 500	566 600	-22 900	-996	-9 407	0.0%
Ngabu	229 500	220 900	-8 600	-374	-7 754	0.0%
Total	**3 532 800**	**4 623 000**	**1 090 200**	**47 400**	**-99 794**	**44.9%**

Notes: (1) Deforestation due to forest clearing for agricultural use

Sources: Land use data are from Eschweiler (1993: Annex 3); Average annual deforestation: from Table 5-4

Large differences of deforestation rates due to land clearance for agriculture exist between ADDs. Since the expansion of agriculture in the ADDs Blantyre and Ngabu in the Southern region was even slightly declining, total loss of forest cover must be accounted for by uses other than agricultural expansion. This is particularly interesting because of the relatively high rate of deforestation of 2.8% in BADD. At the opposite end of the spectrum lie the Mzuzu, Kasungu and Salima ADDs. Their high share of deforestation due to agricultural expansion is explained by their high share of estate land of total suitable agricultural land. Moreover, a substantial portion of the increase in estate land seems to have materialized between 1986 and 1989 when the number of estates increased fivefold in MADD, threefold in SLADDs and by 19% in KADD. The total estate area in these ADDs increased by an estimated 27.9%, 19.3% and 5.3% respectively.[8] It should however be noted that the calculated expansion of agricultural land in the SADD was higher than the loss in total forested area. Given the differences in the time periods used for estimating changes in forest cover (18 years) and agricultural land use (23 years) and the comparison on the basis of annual average land use changes, no specific explanation can be advanced for this aberration in the data. Despite these simplified assumptions, it appears that the conclusion can be drawn that agricultural expansion has had a sizable impact on the loss of forest cover in the 1970s and 1980s, although in some districts other factors seem also to have had a significant impact on deforestation.

8 The calculation of additional estate land was derived from the number of newly registered estates from 1986 to 1989 (Mkandawire et al 1990: Table 1.3) and the average size of estates (30.8ha) registered during that period which was calculated from Mkandawire et al (1990: Table 1.2).

5.3 WOOD SUPPLY-DEMAND ANALYSIS OF AGRICULTURAL CONSUMERS AND RURAL INDUSTRIES

5.3.1 Wood demand of the tobacco industry

The tobacco industry in Malawi is the major agricultural consumer of woodfuels in Malawi. The structure of the tobacco industry was dichotomized in terms of the type of tobacco produced by the estate and the smallholder sub-sector until 1990 when smallholders were allowed to enter into the production of burley tobacco. Until then estates produced flue cured and burley tobacco, while smallholders were producing dark-fired, oriental and air-cured tobacco varieties. The production of flue cured tobacco since 1978 (see MAS 1993: 31) has been fairly stable. Annual production was 21.7 thousand tonnes in 1978, which peaked in 1980 at a production level of about 26.0 thousand tonnes and has been fluctuating since then between 19.0 and 26.0 thousand tonnes. Burley tobacco production instead has experienced dramatic growth rates between 1978 and 1992 which is reflected in the annual production for these years of 11.6 and 118.0 thousand tonnes respectively.[9]

Woodfuel consumption characteristics

The processing of flue cured tobacco is most energy intensive, followed by dark-fired and burley tobacco. Specific fuel consumption (SFC) for flue cured tobacco was estimated at $42m^3$ (stacked) per tonne of tobacco cured (ESU 1986: 19). Estimates from other studies put the SFC at $40m^3$ (stacked) for 1986 (IFSC 1986: 17) and $22m^3$ (stacked) in 1988 (deLucia & Associates 1992: 7-17). This SFC is still considerably higher than the lowest average SFC for flue cured tobacco of $11.9m^3$ per kg of tobacco cured which has been reported for Brazil (IFSC 1986: 17). Improvements in energy efficiency were partly due to the research and extension work carried out by the Tobacco Research Institute of Malawi (TRIM) in connection with the Tobacco Industry Energy Efficiency Project. For 1988, TRIM estimated that one-third of the flue cured tobacco growers had implemented fuelwood conservation measures (see CODA 1993: 24-35). Another study (IPC 1989) has identified several complementary furnace and barn modifications which are financially attractive to flue cured tobacco growers. However, further declines in SFC cannot be reliably estimated because no recent data are available about the type and scale of fuelwood saving barn modifications since 1988. For ensuing calculations a SFC of $20m^3$ (stacked) was assumed for 1990.

Estimates for the SFC of curing dark-fired tobacco are $30m^3$ (stacked) per tonne of cured tobacco, while annual wood consumption in the form of poles for constructing barns are estimated to amount to $5.0m^3$ (stacked) for burley tobacco to construct drying sheds. For

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9 Tobacco production data are based on data from the Tobacco Control Commission of Malawi.

other quantitatively less important tobacco varieties such as oriental and sun/air cured tobaccos, a SFC of $2.0m^3$ (stacked) was assumed.

As tobacco exports are the major foreign exchange earner (see Chapter 2) and the industry has supported the income of almost 50% of all households in 1992 (Tambula 1993: 5), the GOM has been concerned about the sustainability of the tobacco industry. One of the main concerns has been related to the industry's impact on the deforestation of customary woodlands and the question of how long their exploitation may continue without disrupting the industry. Estimates about the past contribution of the tobacco sub-sectors to deforestation rest, in addition to the development of their fuelwood consumption, on the share of woodfuel consumption which has been met by supplies from forest resources on customary land. Longitudinal data about the degree of fuelwood self-sufficiency of the tobacco industry are not available. Therefore estimates have to be derived from more recent data and economic considerations.

Woodfuel and pole supply and demand in the estate sub-sector

Fuelwood consumption estimates for curing flue cured tobacco between 1975 and 1990 are shown in Annex 5-4. These estimates were calculated from tobacco production figures and assumptions about the development of SFC which are in line with the data discussed above. Average yields for flue cured tobacco for five-year periods between 1970 and 1990 have been fairly constant[10] so that land area requirements for fuelwood plantations on estates to meet fuelwood demand can also be considered as constant except for possible changes in yields on plantations. Flue cured tobacco is mainly produced in districts located in the Central and Southern regions (see the map of major tobacco producing areas in Malawi in Annex 5-5).

Standard estimates of plantation yields from Table 5-1 suggest MAIs in the range between 10 to 20. However, according to a survey carried out by EEST (1992), estates in general have only rather limited expertise about silvicultural practices and generally do not adhere to the recommended application of fertilizer, resulting in actual MAIs in the range between 5 to 8 (Tambula 1993: 8). Based on the assumptions of an average MAI of 6.5, a rotation period of 8 years for Eucalyptus species[11], an average tobacco yield of 1 311kg/ha and an SFC of $42m^3$ (stacked) per tonne of tobacco cured, 5.34ha of *Eucalyptus* plantations per ha of flue cured

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[10] Average yields (kg/ha) reported in MAS (1993: 31) for consecutive five-year intervals between 1970 and 1990 were 1 212, 1 289, 1 466 and 1 279.

[11] The DOF recommends *Eucalyptus* species for woodfuel plantations. Gossage et al (1992: 23) found in their estate survey that 97% of the estates prefer *Eucalyptus* species.

tobacco are required to secure woodfuel self-sufficiency.[12] This example corresponds approximately to the situation in the flue cured tobacco industry until 1986. How much wood was obtained from plantations on flue-cured tobacco estates in the past cannot be directly ascertained because land use data for estates are only partly available.

A fairly accurate regional estimate of woodfuel self-sufficiency can be ascertained, for example, from data available for the flue cured tobacco growers in the Namwera area (DOF 1991a) which accounted for 12.5%[13] of the national flue cured tobacco production in 1991.

The SFC per tonne of cured tobacco for 60% of the growers was considerably lower (12cu.m. stacked) than the assumed national average (20cu.m. stacked) in 1990, because they had introduced highly efficient venturi furnaces. Based on these data and the above assumptions concerning average tobacco yields and average MAIs, the average land area equivalent (ha of fuelwood plantation/ha of tobacco planted) to secure fuelwood self-sufficiency, amounts to 1.93ha.[14] The total area planted to tobacco was 2 456.8ha requiring an equivalent of 4 742ha of Eucalyptus plantations to achieve woodfuel self-sufficiency. The actual area of fuelwood plantations in 1991 was 788ha, implying a self-sufficiency rate of 16.6%. Apparently the estates in this area have adopted a two-pronged strategy to secure their fuelwood supplies, that is the adoption of improved furnaces and some expansion of the plantation area. This implies that the self-sufficiency rate prior to the introduction of the improved curing technology must have been very low, most likely below 5%.

The methods of tobacco growers in the area to secure fuelwood supplies from forest resources are vividly illustrated in the survey of the DOF (1991a: 4). According to this survey, 250ha with an estimated volume of 25 000cu.m. stacked were clearfelled in 1990 in a proposed forest reserve, at a distance of about 110km from the Namwera area, on the pretext of establishing tobacco growing estates. This happened in response to the ban of fuelwood utilization from two other forest reserves which were previously supplying the Namwera tobacco growing area, but which were deliberately overcut.

Comparably detailed data are not available for other flue cured tobacco growing areas in Malawi. However, some data are available which provide indications about the extent of fuelwood and pole supply problems on estates and efforts to establish plantations. A survey

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[12] The formula used to derive this figure is: (1.311(t/ha)*42 (st. m^3/t)* 0.63 (m^3/st. m^3))/6.5 (m^3/ha/a).

[13] This figure was derived by dividing the total production of flue-cured tobacco in the Namwera area from DOF (1991a: Appendix 1) by total annual production from MAS (1993: 31).

[14] This figure was calculated as a weighted average of the specific fuel consumption using the formula: ((1.311 (t/ha)*12 (st. m^3/t) *0.6) + ((1.311 (t/ha)*20 (st. m^3/t) *0.4))*0.63 (m^3/ st. m^3/)/ 6.5 (m^3/ha/a) .

of flue cured tobacco estates (EEST 1992) found that about 15% of the estates had fuelwood supply problems. In some areas, for example, in LWADD considerably more estates (40%) indicated to have fuelwood supply problems. In response to these supply problems, 69% of the estates reported to have planted trees, but most had planted less than 1ha.

The extent of woodfuel supply problems on estates has also been studied by Gossage et al (1992) who found that 55% of all estates (sample size 39) faced moderate to severe woodfuel supply problems for curing and poles. However, the level of tree planting was found to be largely inadequate for meeting the fuelwood demand of flue cured and burley tobacco. Only 26% of the estates were found to have afforestation plans which, after implementation, would be sufficient to meet woodfuel demands, while another 16% and 58% were judged to be approaching their needs or to meet less than 50% of their needs respectively. Since these data refer to planting plans rather than to actual achievements, they imply that at least 58% of the estates had to resort to off-estate sources of supply to meet more than half of their consumption needs. The survey of estates (sample size 144) conducted by Mkandawire et al (1990: 63) found that woodlots of any considerable size were only planted by very few estates. This result supports the finding by Gossage et al (1992) that, despite widespread supply problems of wood and poles for tobacco curing, the establishment of plantations has been relatively limited.

As to the composition of woodfuel supply sources of estates, there is little information available other than from Mkandawire et al (1990: Tables A12/13). According to their findings, the most important single source of poles and fuelwood supplies were woodlots and natural woodlands on the estates themselves, followed by customary woodlands and government forest reserves. About one-third of the sampled estates were reporting to use their own woodlots. Since multiple answers were allowed, no firm indication can be derived from these data concerning the quantitative composition of supplies from different sources.

Overall, the available data base is rather limited to ascertain the degree of past and present woodfuel self-sufficiency of the flue cured tobacco industry in Malawi. Judged by the experience from the fuelwood supply situation in Namwera, the degree of fuelwood self-sufficiency must have been rather low in the past. The finding that silvicultural expertise on estates is rather limited and that planting of fuelwood plantations is a relatively recent development, also support this view.

A financial analysis of comparative financial costs of energy supplies for tobacco curing in the major flue cured tobacco growing districts of Kasungu and Mchinji which was carried out by deLucia & Associates (1992: 7-18/20) can be used to illustrate the economic decision behaviour of estates with regard to the options of establishing plantations, or to use wood from customary woodlands or forest reserves. Total energy costs for tobacco curing using indigenous wood from forests on customary land were estimated to be 2.9 times higher compared to the use of estate-grown Eucalyptus. The main cost components of indigenous wood are the gazetted stumpage fee (54%) and transport costs. However, collection rates of stumpage fees were estimated by deLucia & Associates (1992: 3-12) to range from 5 to 15%. Based on the data from deLucia & Associates, the break-even distance for fuelwood supplies from customary land compared to estate-grown Eucalyptus was calculated to be 21km, assuming that stumpage fees are not paid. In other words, it is financially attractive for tobacco estates to clearfell forests on customary land in a radius of 21km around their estates. However, for estates which are inefficient fuelwood producers, this distance may be twice as high or even higher. An additional factor which has to be considered in the wood procurement decision of tobacco estates is that the remuneration of estate managers is linked to net revenues. Thus they are provided with incentives to cut wood illegally in order to maximize their income.

Several estimates have been made in the literature about the wood self-sufficiency for flue cured tobacco growers and for the entire tobacco industry. For example, deLucia & Associates mention that the flue cured tobacco growers possibly met 25% of their wood consumption in 1990. Tambula (1993: 6) estimates for 1992 that tobacco estates met 40% of their demand from plantations, while the remainder was assumed to have come from indigenous woodlands. However, all these estimates are conjectural because they are not based on any supporting analysis.

Another approach for estimating the development of woodfuel self-sufficiency on tobacco estates, is to calculate the area required to obtain wood self-sufficiency in the tobacco industry, and to compare it with available data about the percentage of the actual forested area on estates. These calculations are shown in Annex 5-6. They rely on the assumption that the average percentage of land used for tobacco production on estates in 1990 from Mkandawire et al (1990: 53-64) has been approximately the same in the past.[15] Of the sampled estates, 44%, 35% and 21% had woodlands covering between 5 to 10%, 10 to 20% and 20% or more respectively of the total estate area. The corresponding weighted average share of indigenous woodlands and plantations of the total estate area was calculated to

[15] It should be noted that although the survey did not include coffee and sugar plantations, the actual percentage of land used for tobacco production was likely to be higher because not all estates surveyed are mainly tobacco producers. Additionally, it has to be taken into account that estate tobacco production is still heavily concentrated in Malawi. In 1990, 110 growers accounted for 50% of the flue-cured tobacco production. The same growers are also the largest burley tobacco producers. About 300 growers (4.1% of the total) accounted for about 50% of burley tobacco sales in 1990 (see Mkandawire et al 1990: 40-43).

amount to 13.8%. However, not all woodlands on estates are available for fuelwood production because some areas serve ecological functions.

The calculations in Annex 5-6 indicate that in order to achieve woodfuel self-sufficiency during the periods 1975-80, 1981-85 and 1986-90, 44.3%, 33.3% and 17.9% of the total estate area respectively should have been covered by woodlands or plantations. The decline in the figures is mainly due to the reduction of the SFC for flue cured tobacco production and the rapid growth of burley estates. Taking into account that the establishment of plantations has been triggered in response to supply shortages, which must most likely have emerged in the mid-1980s when energy conservation measures were rapidly implemented, the average self-sufficiency rates of approximately 30% and 40% which were calculated for the periods 1975-80 and 1981-85, have to be considered as the maximum. Comparable calculations for the period 1986-90 suggest a self-sufficiency rate of about 75%. However, in view of the fact that the calculated land area equivalents are downward biased, and in view of the above findings about woodfuel supply problems on estates, a self-sufficiency rate of about 60% in the early 1990s appears to be more appropriate.

All available evidence suggests that the tobacco growing industry in the estate sector has relied heavily in the past on the exploitation of woodfuel resources from off-estate sources, notably from forests located on customary land. Based on the self-sufficiency rates cited above, the land area in terms of customary forest land required to meet the past annual woodfuel and pole supply deficit for tobacco curing has been calculated for the period 1975 to 1990 (see Annex 5-7). A critical assumption for these calculations is the composition of fuelwood supply by source. From the available information about deforestation and land use changes, the distinction between indigenous forest reserves and forests on customary land is blurred. Because the yields from both type of forests vary considerably, the resulting deforestation estimates in terms of land area equivalents depend on the assumption as to which type of forest was actually being used. As this question could not be resolved, calculations were carried out for both type of forests. Using the yield levels for indigenous forests results in a lower deforestation estimate.

According to these estimates, the average annual land area equivalents for indigenous forests and customary land forests (shown in brackets) in the Northern, Central and Southern regions are 207 (173)ha, 2 216 (4 432)ha and 1 375 (3 666)ha respectively. The regional cumulative land area equivalents are 3 520 (2 934)ha, 37 673 (75 346)ha and 23 372 (62 326)ha respectively. Because no reliable longitudinal data are available for the supply from government forest reserves, these land area equivalents represent a maximum deforestation estimate.

Woodfuel and pole demand of the smallholder sub-sector

Until 1990, the production of tobacco in the smallholder sector was confined to Oriental tobacco in the Northern region, dark-fired and Sun/Air cured tobacco in the Central region and dark-fired tobacco in the Southern region. Based on the above SFC data for these tobacco varieties and land area and production data for the period 1977 to 1990, land area equivalents for indigenous forests and customary land forests (shown in brackets) were also calculated for all three regions (see Annex 5-8). According to these estimates, the average annual land equivalents in the Northern, Central and Southern regions are 4 (3)ha, 2 556 (5 113)ha and 210 (562)ha respectively. The regional cumulative land area equivalents are 53 (44)ha, 35 789 (71 577)ha and 2 949 (7 864)ha respectively. Curing of dark-fired tobacco accounts for 98% of total wood demand.

Data for the average growing stock on croplands suggest that a large percentage of this demand must be supplied from off-farm resources. The maximum tree stocking level found on croplands of $12m^3$/ha yields an estimated annual supply of $0.15m^3$/ha when stocking with indigenous trees is assumed, and a supply of $1.5m^3$/ha if a woodlot planted with exotic trees is assumed. The former assumption is more realistic, because most of the trees found on the croplands sampled by CODA (1993) were indigenous. Average yields of fire-cured tobacco between 1969 and 1992 were 0.363 tonnes per ha (see MAS 1993: 30), implying a demand of wood for curing of 6.5cu.m. The area planted to dark-fired tobacco seldom exceeds 25% of the total cropped area, resulting in a woodfuel demand of 1.63cu.m./ha. Thus, it is unlikely that more than 10% of the total woodfuel demand is supplied from on-farm tree resources. This would be the maximum self-sufficiency rate, if other household woodfuel demands are not taken into consideration. Hence, it must be assumed that at least 90% of the woodfuel required for tobacco curing originates from off-farm supply sources, notably from natural woodlands.

The total woodfuel demand of the tobacco industry and deforestation in terms of land area equivalents is shown in Table 5-6. The underlying assumption for the smallholder sector is that all woodfuels and poles used are harvested from forests, while for the estate sector it is assumed that all off-estate wood supplies originate from forests other than forest reserves.

Table 5-6 Deforestation impact of the tobacco industry between 1975 and 1990 and woodfuel consumption in 1990

	Region				
	Northern	*Central*	*Southern*	*Total*	*% of Total*
Sub-sector	*ha*	*ha*	*ha*	*ha*	
Average annual smallholders (1)	4	2 556	210	2 770	42.2%
Average annual estates (1)	207	2 216	1 375	3 798	57.8%
Total	**211**	**4 772**	**1 585**	**6 568**	**100.0%**
Average annual smallholders (2)	3	5 113	562	5 678	40.7%
Average annual estates (2)	173	4 432	3 666	8 271	59.3%
Total	**176**	**9 545**	**4 228**	**13 949**	**100.0%**
Cumulative smallholders (1)	53	35 789	2 949	38 791	37.5%
Cumulative estates (1)	3 520	37 673	23 372	64 565	62.5%
Total	**3 573**	**73 462**	**26 321**	**103 356**	**100.0%**
Cumulative smallholders (2)	44	71 577	7 864	79 485	36.1%
Cumulative estates (2)	2 934	75 346	62 326	140 606	63.9%
Total	**2 978**	**146 923**	**70 190**	**220 091**	**100.0%**
	Woodfuel consumption in 1990 (solid cubic metre)				
Sub-sector				*Total*	*Percent*
Smallholders	202	199 603	7 254	207 059	30.4%
Estates	45 276	318 938	109 366	473 580	69.6%
Total	**45 478**	**518 541**	**116 620**	**680 639**	**100.0%**

Note: Data for the smallholder sector refer to the period 1977-1990.

Sources: Woodfuel consumption based on data from Annexes 5-5 and 5-9

(1), (2) Land area equivalent based on yield data for indigenous forests (see Table 5-1)

When the regional deforestation data from Table 5-6 which are based on the lower annual land area equivalents are combined with the deforestation data from Table 5-5 (aggregated to regions), the deforestation attributable to land clearing for agriculture and to woodfuel and pole consumption of the tobacco sector for the Northern, Central and Southern regions are 56%, 92% and 10% respectively. At the national level, the share of deforestation attributable to the tobacco industry amounts to 9.1%. This represents a conservative estimate because the national deforestation rate attributable to land clearing and woodfuel consumption in the tobacco sector would increase to 64% if the higher deforestation figures from Table 5-6 were used.

Policy implications of forest destruction by the estate sector

Despite some remaining uncertainties, it is very likely that approximately 10% of the deforestation between 1972 and 1990 can be attributed to the tobacco growing estates in Malawi. Deforestation proceeded unabatedly due to several reasons.

First, except for the introduction of the Tobacco Industry Energy Efficiency Project in the second half of the 1980s, no policy measures were introduced which specifically addressed the circumstances of the tobacco industry. This was not due to a lack of policy options.

Given the important role of tobacco exports as the most important export crop, concerns about the impact of raising and enforcing stumpage fees on the profitability of tobacco growing naturally arise. However, such concerns were unwarranted both for tobacco estates and smallholder tobacco farmers.[16] Such a policy was designed in 1986, but largely failed to produce tangible results because of problems encountered in the collection and enforcement of stumpage fees. The imposition of a tax at the auction floor, which would have circumvented the administrative problems of revenue collection, could have been considered, but was never seriously discussed within government circles.

On the supply side, the government also lacked the administrative capacity to enforce the stipulation of the leasehold covenant to maintain 10% of the estate area under forest cover. Policy discussions always focused on this issue. However, as the following discussion will show, enforcement of this covenant would have been at best a crude stop-gap measure rather than an appropriate policy instrument.

The previous analysis in this chapter has shown that the land area required to achieve woodfuel self-sufficiency on estates depends on the mix of fire cured and burley production as percentage of the total land area, the specific fuel consumption for tobacco curing and the relative efficiency of the fuelwood producer. The analysis has also shown that the land area requirements for fuelwood and pole plantations were far in excess of the required 10% covenant. Thus enforcement of the covenant would not have contributed much to reduce deforestation. Moreover, the formulation of the covenant in terms of forest cover was inappropriate because estates who maintained a forest cover of 10% consisting of indigenous trees would, compared to fuelwood growers with Eucalyptus plantations, effectively have an equivalent fuelwood supply of one-tenth due to the differences in MAIs.

The difficulty of estimating an appropriate fuelwood plantation cover covenant can be easily demonstrated for a flue cured grower in the Namwera area. A grower who planted on average 14% of his land area under tobacco, and who was at the same time both an efficient tobacco curer and fuelwood producer would have to use 13.5% of his land for *Eucalyptus* plantations, while a less efficient curer and fuelwood producer would instead need to plant plantations on 34.6% of his estate land. The option to use a target land cover constraint has several practical drawbacks for implementation. First, a minimum target may imply several economic inefficiencies. The local availability of woodfuel resources may

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16 The World Bank (1986: 35) calculated that a tripling of the stumpage rate in 1986 would still make tobacco production relatively profitable.

differ leading to different least-cost solutions for the individual farmer, both in terms of his mixture of woodfuel resources and the adoption of woodfuel-conserving furnace and barn technology. Secondly, setting a target would imply making assumptions about the suitability of agricultural land. Enforcing a target covenant may imply that on farms where suitable agricultural land has to be used to meet the covenant, the resulting stumpage cost inclusive of the foregone net returns from the agricultural crop, may raise the fuelwood cost above the least-cost supply level. Both type of inefficiencies are associated with a target covenant which is set too high.

Alternatively one could argue that such rigidities in implementing a workable policy have to be accepted on a trial basis subject to later revisions. The main critical point of this approach is whether the resources needed to implement the enforcement of a target cover scheme, perhaps combined with stiff penalties for non-compliance, will work in practice. The experience in the past, as measured by the collection efficiency of stumpage fees, does not lend strong support to the assumption that such a policy will be effective.

5.3.2 Wood demand and supply in the tea industry

The tea industry in Malawi is mainly located in the Thyolo district in BADD. The industry is dominated by the estate sector who accounts for 88% of the total tea area planted. Since 1980 the total tea growing area has remained virtually constant (see MAS 1993: 36) on account of unavailability of suitable land for expansion. Woodfuel consumption of the industry is almost entirely for the curing of tea. The average specific fuel consumption in terms of tonnes of fuelwood per tonne of cured tea has declined between 1982 to 1986 from 3.26 to 3.11 (Price Waterhouse 1987).

A tea industry energy survey (TIES) which was carried out in 1990/91 showed that the SFC had further declined to 2.9 in 1989.[17] Based on this figure, total estate woodfuel consumption for tea curing and coffee processing in 1990 amounted to 130 000 tonnes or about 220 000m^3 of wood. The survey also found that overall tea estates were self-sufficient in fuelwood. Temporal shortages within the industry which may arise due to exceptionally good tea production years are met by inter-estate fuelwood trading. Tea estates are mainly freeholds with much longer tenures (99 years) compared to leaseholds (21 years) for other estates. The striking difference in self-sufficiency rates of wood between tea and tobacco estates is attributed by most tea estate managers, many of which have been operating for more than 30 years in Malawi, to the relatively short land tenure of tobacco estates, which

[17] The survey was conducted by the author through a mailed questionnaire. The results of the survey and of subsequent research on tea estates concerning woodfuel production costs and other issues were integrated in the article entitled *Energy conservation and fuel substitution in the Malawian tea industry* (see Romahn 1991a).

encourages sub-optimal land use practices.

The TIES showed that the mean fuelwood production costs on the stump, as estimated by the estates, were about MK4.5 per m^3. Subsequent analysis of fuelwood production costs on tea estates (see Romahn 1991a) which were based on detailed estate costs and harvesting records confirmed these results. Fuelwood production costs on the stump were found to be in the range of MK3.0 to MK8.0 per m^3, corresponding to a range of growing conditions from 'good soils with good rainfall' to 'relatively dry conditions with poor soils'. These production costs which are related to MAIs between 28.0 and 64.0 for a nine year production cycle, suggest that tea estates are the technically most efficient fuelwood (*Eucalyptus*) producers in Malawi. This result was confirmed by deLucia & Associates (1992: 3-17/20). The latter also found that the technically less efficient woodfuel producers in Malawi such as government fuelwood plantations are characterized by poor seedbed preparation, poor control of spacing and poor management of the stands.

Several estates were found to have fuelwood surpluses relative to their projected fuelwood requirements. In addition, some estates have surplus land which could be used for the establishment of fuelwood plantations in order to supply the urban fuelwood market in the city of Blantyre. Based on accounting data of two tea estates, the costs for felling, transport, cutting (to pieces of 1m length) and stacking were estimated at MK5.0 per m^3 (in 1990 prices). About 60%, 15% and 25% of the existing fuelwood plantations are grown on land classified as unsuitable, marginally suitable and suitable respectively for tea or coffee production. Foregone benefits from production of these crops were estimated to range between MK15.0 and 25.0 per m^3 (Romahn 1991a: 8). Hence, production costs of wood on marginal soils are in the range between MK5.0 to MK8.0 on the stump and amount to MK10.0 to MK13.0 stacked. Stacked costs of wood produced on better soils including foregone benefits from tea production range from MK20.0 to MK28.0 per m^3.

5.3.3 Woodfuel consumption of rural industries

No study has analyzed in detail the woodfuel demands of rural industries in Malawi. According to NEP (1990: 247) brick production, for which the traditional wood-fired clamp kiln is used, is the major fuelwood consuming rural industry with an estimated annual demand of 58 000m^3, while all other rural industries were estimated to consume about 132 000m^3 per year. Another important category of woodfuel consumption are poles for construction purposes which are mainly used by rural and urban households. In-depth studies about the volume and price characteristics of this market, as well as sources of supply, have also not been carried out in Malawi. The annual consumption has been estimated (World Bank 1992b, Annex 3: 13) to amount to 563 000m^3.

5.3.4 Urban household woodfuel demand and deforestation

In comparison to estimates of the impact of land clearing for agricultural and tobacco industry uses on the loss of forest cover, an estimation of the impact of urban woodfuel use on deforestation is considerably more difficult on account of several factors. First, as discussed in Chapter 7, consumption estimates for woodfuels in major urban areas of Malawi are only available for 1983 and 1990 and a sizable substitution of charcoal by fuelwood has taken place during this period. Both the limited availability of longitudinal data and the absence of any information as to how the relative shares of woodfuels in the urban consumption mix have changed during this period make it difficult to judge the precise composition of interannual demand. In addition to uncertainties on the demand side, major uncertainties exist with regard to the composition of supply sources for fuelwood over time and the harvesting practices of charcoalers.

The first aspect is discussed in Chapter 6 in the context of woodfuel supply chains and markets. Based on Chapter 6, it was assumed for ensuing calculations that in 1983 and 1990, 35% and 65% of fuelwood sold in Blantyre originated from government plantations respectively. Whether substantial amounts of fuelwood sold in urban markets have originated from woodland clearance for agricultural purposes remains unclear. As far as estates are concerned, the government policy of charging a stumpage fee for wood cleared may have discouraged many estate owners to sell surplus wood. Field observers have reported that many estate owners therefore seem to have preferred to burn surplus wood from land clearing.

The analysis of woodfuel prices in the main urban markets (see Chapter 7) shows that real price increases have been higher in Blantyre compared to Lilongwe, and that there are slightly stronger indications for wood depletion effects in the Blantyre woodfuel market.

No systematic study of the production system for charcoal has been carried out in Malawi. Field observations suggest that traditional charcoal kilns are used for which a weight-based yield of 12% may be assumed. Available information suggests that charcoal is entirely produced from miombo woodlands on customary land. For example, the 1990 Urban Household Energy survey (Ng'ong'ola 1991) indicates that charcoal producers operate in specific forest areas in the vicinity of Blantyre. In addition, the opening of a new road to Blantyre in 1989 has created access to a well-stocked woodland area and induced intensive charcoal production activities. The same reaction occurred in response to the construction of a network of forest roads in an indigenous forest area close to Blantyre which was earmarked for natural woodland management under the auspices of the Blantyre City Fuelwood Project (BCFP 1993: 43).

Given the described uncertainties in the data, calculations of the impact of woodfuel consumption in urban areas on deforestation were confined to the city of Blantyre for which comparatively better information is available. As discussed above, it was estimated that no major land clearing for agriculture in the Blantyre and the adjacent Ngabu ADDs took place during the period under consideration. This development necessitates a clearer discernment of the quantitative impact of urban household woodfuel consumption on deforestation. The average annual forest area equivalent needed to meet the woodfuel demands between 1983 and 1990 has been calculated in Annex 5-9, and amounts to 4 132ha. Due to the massive decline of charcoal consumption in the city since 1983, the forest land area equivalent has declined from 7 827ha in 1983 to 3 650ha in 1990.

In comparison to the average annual forest loss in the BADD of 7 754ha and taking into account that fuelwood demands of the city were lower between 1972 and 1983, the data suggest that urban woodfuel consumption in Blantyre may account for 50 to 60% of the total calculated loss of forest areas. Considering that it is likely that most of the woodfuel supply areas are located in the Blantyre district, the contribution to deforestation in the district is likely to have been even higher.

5.4 ANALYSIS OF ENERGY DEMAND AND SUPPLY IN RURAL HOUSEHOLDS

5.4.1 Determinants of household energy consumption patterns

The review of a substantial number of household energy surveys carried out by Leach and Gowen (1987) has shown that the level of energy use or consumption and the choice of fuels is generally dependent on several interrelated supply and demand variables. Among the variables determining consumption, household income and household size have been found to play the most important role. Other important demand variables are, for example, temperature and precipitation which have an impact on demands for space heating and drying needs, variations in cultural factors which exert influence on energy demand in terms of differences in diets, the numbers of meals cooked or other regional or even local habits concerning cooking and lighting behaviour and the relative costs and thermal efficiency of end-use equipment. Particularly the latter three factors will exert a major impact on relative consumption levels in different locations for comparable income levels and household sizes.

Concerning the relative importance of income and household size in determining the level of energy consumption in rural households, conflicting trends have been found in empirical research. In general, energy consumption and income were found to be positively correlated, albeit with decreasing income elasticities of demand. Due to economies of scale in energy consumption, increasing household sizes have been found by several researchers (Cline-Cole et al 1990; Fleuret & Fleuret 1978) to be associated with lower per capita energy consumption. As household sizes of rural families tend to be positively correlated in some countries with household income, two countervailing influences are exerted on per capita energy consumption. Which of these two variables has a stronger impact is essentially an empirical question. Leach and Gowen (1987: 47), for example, have found little variation in per capita energy consumption across household income groups for selected South Asian countries. A similar finding was reported by ERL (1985: 15) for rural households in Botswana. The average daily per capita consumption of fuelwood was found to be only 19% higher for poor as compared to rich households. A substantial part of this difference in consumption was ascribed to higher fuelwood use for beer brewing, an income-generating activity in which more middle and low income households are engaged.

The same study found a negative correlation between household income and size in most of the villages surveyed (ERL 1985: 13). Since economies of scale of fuelwood use were also found to be high,[18] but consumption in lower income groups was higher due to additional demand for beer brewing, the average per capita woodfuel consumption turned out as discussed above.

Contrary to the findings of Leach and Gowen (1987) and ERL (1985), Down (1986) has found in a study of energy consumption in five villages in West Sumatra (Indonesia) that household size had a much stronger impact than income on the amount of useful per capita energy consumed for cooking. However, a study carried out in a Phillippine village (Manibog 1979)[19] found that wood consumption for cooking increased slightly with increasing household size.

In connection with the criticism of the fuelwood gap methodology, the negligence of accounting for the impact of household size on energy consumption has been implicitly criticized by rejecting the notion of a linear relationship between population growth and energy consumption. However, when the distribution of household sizes within the rural population remains fairly constant over time, the linearity assumption can only be dismissed on account of changes in the energy consumption behaviour of households in response to changes in the availability and access to traditional woodfuels, petroleum products and electricity. In general, the share of biomass fuels in total energy consumption has been found to maintain a considerably higher share with increasing incomes in rural

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[18] The average annual per capita consumption of fuelwood of the household size categories 5 to 8 and greater, 9 members were found to be 57 and 71% lower compared to households with 1 to 4 members (ERL 1985: 11).

[19] This result was quoted in Down (1986: 552).

areas as compared to urban areas (Leach & Gowen 1987: 43).

The relatively high inertia of energy consumption patterns in rural areas has been mainly attributed to differential access to liquid fuels and electricity between urban and rural households. However, intra-rural differences in the energy consumption mix for the same income groups may also be codetermined by differences in access. Access may be subdivided into two interdependent factors, that is differential access due to the different spatial coverage of, for example, liquid fuel supply infrastructure in rural areas and price effects. The spatial coverage of petroleum product supplies in rural areas may be fairly homogeneous (though this is hardly the case in many developing countries, particularly the low-income ones) but a supply-cost oriented pricing policy of liquid fuels is likely to result in different local supply costs in different locations. Alternatively, and more realistically, the spatial coverage of liquid fuel supplies in rural areas may differ considerably between regions but may be combined with uniform prices throughout the country. In this case differential prices may still be encountered at the end-use level, on account of margins of traders who enter the supply chain between typical rural supply points such as filling stations and final consumers.

In order to relate the discussion of the determinants of energy consumption and utilization levels in rural households to the past development and present situation in Malawi, two previous results of the above discussion have to be taken into account. First, as discussed in Chapter 4, real incomes of smallholders have increased slightly between 1980 and 1983 and declined thereafter by 12% until 1990. Secondly, these fairly modest income declines have been paralleled by deforestation and restricted access to customary land alienated by the estate sector. Even though the latter two developments varied considerably by district, overall the conclusion may be drawn that the availability of woodfuel resources in rural areas has significantly declined. Real income declines were limited and gradual, and liquid fuels other than kerosene for lighting, were not consumed in rural households in Malawi in the early 1980s. Thus one would expect that consumption levels of paraffin have not experienced significant changes unless prices have declined in real terms to such an extent that they distinctly overcompensated income declines. However, expectations concerning the responses of rural households to the changed availability of woodfuel supplies are much more difficult to predict because of the complexity of such response patterns, and less reliable results and firm hypotheses concerning patterns of such adaptations.

Concerning demand adaptations in response to woodfuel scarcity, it has been argued that the assumption of a linear relationship between woodfuel consumption and energy consumption represents a sweeping generalization because coping strategies come into play. Coping strategies can be subdivided into supply and demand responses. Supply responses include essentially, all woodfuel supply enhancing measures by smallholders such as farm forestry, agroforestry and community forestry efforts. These responses are separately discussed in Chapter 6, where they are analyzed in the context of the woodfuel policy of the GOM. Single demand-side responses were categorized in Chapter 4 as energy saving strategies subdivided into consumption strategies, implicit and explicit fuel saving strategies, and substitution strategies. The latter strategy is characterized by involving either movements down the energy ladder by increased use of less preferred, but more readily available woodfuels or agricultural residues, and increased purchases of woodfuels. Common to all demand-side related responses is that they are primarily motivated by attempts to save time for the gathering of woodfuels. Hence the adoption of these strategies is conditioned by labour constraints, or more precisely, by the economic considerations of households in allocating household labour.

Several common hypotheses about the adaptation of households to woodfuel scarcity in terms of consumption strategies or food-related behavioural changes and the reallocation of female labour which have been discussed in the literature, were recently reviewed by Fleuret (1990). The author comes to the conclusion (Fleuret 1990: 33) that most of the hypotheses advanced in the literature with regard to the woodfuel-food link are backed by inconclusive empirical evidence.

A central issue for policy analysis is whether such adaptations are likely to occur in a distinct sequential pattern and whether certain responses occur simultaneously.

In the literature there is no generally accepted knowledge with regard to a typical sequential pattern of all conceivable single types of responses to fuelwood scarcity. Rather there are some broad suggestions concerning the sequencing of responses with regard to some of the more important types of adaptations. Leach and Gowen (1987: 52-54), for example, suggest that with increasing fuelwood scarcity, the normal sequence of adaptation starts with the use of lower quality woodfuels and is then followed by fuel economization, increased use of crop residues and animal wastes, employment of food-related consumption strategies and purchasing of fuels. Concerning the entire process of such responses, Soussan et al (1992: 139) have pointed out that in the beginning they may be gradual and therefore go unnoticed, while at advanced stages 'more dramatic adjustments' will take place. The authors also suggest that more efficient fire management is one of the first responses. Other responses which are related to increasing woodfuel scarcity such as changes in cooking practices, reduction of meals cooked or the increased use of agricultural residues are mentioned by the authors, but they refrain from suggesting that these responses will occur.

Rather they cautiously indicate that these responses may occur.

Even though the existing knowledge with regard to the timing of a number of responses such as adaptations in cooking practices is limited, there is also some other evidence available. For example, rural households in Mozambique engaged in woodsaving practices before a switch to agricultural residues occurred. Concerning the alternatives of moving down the energy ladder by using inferior woody biomass and agricultural residues or starting to grow trees for firewood, Foley (1988: 65) suggests that many, if not most, rural households would choose the former option.

For the ensuing discussion, it is worthwhile to note that the mere use of agricultural residues does not indicate fuelwood scarcity *per se*. The more important issue is whether rural households systematically increase the utilization of residues, and especially, whether they use them increasingly as a primary cooking fuel. This difference is important because agricultural residues may be used as secondary fuels just because of their availability, despite their relative inconvenience.

An important issue with regard to the responses or response patterns of households to fuelwood scarcity is that responses themselves are often interpreted as scarcity indicators. This interpretation is partly due to the problem that the quality of available woodfuel supply and demand data is often so poor that contradictory results concerning the existence or non-existence of fuelwood scarcities may be the outcome.[20] For example, the absence of certain responses such as the reduction of woodfuel consumption levels or the lack of an emerging rural woodfuel market, has been interpreted by economists according to Goodman (1987: 114) as evidence that claims of woodfuel scarcity, or even scarcities amounting to crisis proportions, are either non-existent or have been largely exaggerated. However, the absence of an existing rural fuelwood market may be due to other factors. For example, Hosier (1985) has pointed out that fuelwood in Kenya continues to have a usage value rather than an exchange value. Therefore, it appears to be a good on which rural households spend money last.

Intrinsically linked to this interpretation is the fact that under circumstances where the rural economy is relatively poorly monetized and cash is scarce and difficult to obtain from farming and other income generating activities, rural households primarily save cash to cope with the exigencies of life rather than to spend it on a good which still can be obtained

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[20] See, for example, Eberhard (1992: 19) who cites the results of a study carried out by Hosier et al (1990) which compared four independent studies estimating fuelwood supply-demand balances for Tanzania. According to Eberhard, the study found that for half of Tanzania's districts it could not be ascertained whether fuelwood deficits or surpluses exist.

for free. In other words, relatively poor households who are risk-averse manage their limited cash resources accordingly. Taking these arguments into account, the non-existence or limited development of rural fuelwood markets may mask existing physical fuelwood scarcities. As a consequence, it could be argued that the emergence of a rural fuelwood market is likely to indicate the very existence or onset of tangible fuelwood shortages. This view is, for example, expressed by Soussan et al (1992: 139-40) who assume that commoditization of fuelwood is an acute indicator of fuelwood scarcity which is likely to become far worse. When put into relation to other scarcity indicators, it appears that commoditization of woodfuels, particularly fuelwood, occurs most likely after other adaptations have materialized.

5.4.2 Analysis of energy consumption patterns in rural households

5.4.2.1 The available database and its limitations

Information about relevant aspects about the energy consumption of rural households has been compiled mainly in two surveys with a national coverage which were conducted by the DOF. The 1981 survey (DOF: 1981) had a sample size of 2 408 households, while the 1985 survey (DOF: 1985) had a sample size of 3 958 households. Both surveys covered a range of relevant issues for household energy policy analysis but also omitted to address several issues which should normally be addressed in comprehensive nationwide surveys.[21] The most important drawback of both surveys was that they did not include questions to ascertain the energy consumption of rural households! More recent rural energy surveys were conducted by CODA (1993) and Nyirongo and Mhango (1993). While the surveys conducted in 1981 and 1985 provide a true national coverage, the rural energy survey conducted by CODA focused on selected districts. The actual sample size of about 800 households was about half of what was required for a representative national survey. Therefore, it cannot be excluded that the data available from the survey, which were presented on a regional basis, are not representative. This caveat has to be considered in the subsequent analysis.

The survey conducted by Nyirongo and Mhango had a limited regional coverage in that it was only conducted in 9 out of 24 districts. Moreover, the survey addressed a rather limited scope of issues compared to the other surveys. In addition to the analysis of aspects of rural household tree planting, which was the main focus of the survey, only fuelwood consumption levels and marketing aspects for fuelwood and poles were covered.

In summary, even though data on rural energy use patterns in Malawi are relatively scarce

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[21] For the scope and level of detail which should be addressed in such surveys see, for example, Bhatia (undated).

and incomplete, they provide a longitudinal picture which is probably more complete than in many other countries, notably in sub-Saharan Africa.

5.4.2.2 Development of energy consumption patterns

The fuel utilization by type of end-use in rural households in 1985 is shown in Table 5-7. The data are largely self-explanatory, but some data warrant some more detailed discussion. The overall consumption pattern is dominated by fuelwood consumption as the primary fuel for all end-uses. For cooking as well as for other end-uses only insignificant amounts of charcoal were used. Crop residues as a primary fuel were used only by 5% of the households for cooking purposes. Slightly higher use levels are associated with water and room heating end-uses. This indicates that crop residues are not a preferred fuel for all end-uses. However, a large percentage of the responding households indicated that agricultural residues are used as a secondary or complementary fuel for all end-uses. About 62% of the sample used kerosene but exclusively for lighting. Other fuels including electricity, candles and animal dung were not used as a primary or secondary fuel to any significant extent.

TABLE 5-7 Pattern of fuel utilization by end-use in rural households in 1985

End-use	*Type of fuel use*	*Fuel-wood*	*Char coal*	*Crop residues*	*Grass*	*Paraffi n*	*Other (1)*	*No. of households*	*% of sample*
Cooking	Primary	94.8	<0.5	4.9	<0.5	0.0	<0.5	3 958	100.0
	Secondary	5.9	1.3	89.1	1.6	<0.5	1.9	2 380	60.1
Making tea	Primary	95.0	0.0	4.1	<0.5	0.5	0.0	1 289	32.6
	Secondary	5.5	3.9	85.3	1.9	<0.5	3.0	695	17.6
Bathing	Primary	92.5	<0.5	7.0	<0.5	0.0	<0.5	3 748	94.7
water	Secondary	7.4	1.5	86.9	2.3	<0.5	1.8	2 175	55.0
Lighting	Primary	22.2	0.0	1.9	12.8	61.7	1.3	3 896	98.4
	Secondary	20.4	<0.5	8.0	55.3	7.8	8.2	2 726	68.9
Heating	Primary	80.3	0.9	13.7	4.5	<0.5	0.5	3 591	90.7
	Secondary	11.5	2.4	62.8	21.7	<0.5	1.3	2 008	50.7
Fish/meat	Primary	94.9	1.6	2.2	<0.5	0.0	1.1	1 166	29.5
smoking	Secondary	9.2	8.8	77.7	1.7	0.0	2.6	422	10.7

Source: Malawi Rural Energy Survey, DOF (1985: 13)

Notes: (1) Other includes electricity, candles and dung

A comparison of energy consumption patterns at the national level between 1981 and 1985 shows hardly any significant changes. Compared to 1981, only the percentage of households using crop residues for cooking as a primary fuel had increased from 2.0 to 4.9%. Differences in utilization levels of fuelwood for other end-uses which were limited to a maximum increase of 11%, can be largely attributed to shifts in the seasonal distribution of energy consuming activities such as beer brewing or fish smoking and the different time periods during which the surveys were implemented.[22] The utilization level of paraffin had declined by 11% in 1985. This change cannot be explained by seasonal factors because daylight hours during the months when the 1985 survey was conducted were about on hour less than during the period when the 1981 survey was carried out. Consumption levels of kerosene in 1981 were apparently very low and just covered bare minimum lighting requirements.[23]

A comparison of the fuel utilization patterns and levels by end-use between 1993 (CODA 1993, Annex 24: 9) and 1985 shows the following changes. The utilization of fuelwood for cooking remained unchanged, while the use of wood for lighting and space heating declined by about 15% and 16% respectively. The latter decline can be most likely attributed to the fact that the survey was conducted in the October when night temperatures are considerably higher than during the period of the 1985 survey. Changes in charcoal use are insignificant. Compared to 1985, only the use of charcoal slightly increased by 3%. However, because the CODA survey did not differentiate between primary and secondary fuels, the change more likely amounts only to 1.5% because in the 1985 survey 1.3% of the households used charcoal as a secondary fuel.

The use of crop residues was not integrated by CODA into the presentation of the fuel consumption pattern by end-use, but was treated separately. However, concerning the most important point in this context, that is the changes in the role of agricultural residues as a primary fuel, the fact that 98.5% of the households did not mention residues as a fuel used for cooking suggests that it is predominantly used as a complementary fuel. Overall 92% of the households were found to use residues for cooking, while 73% and 68% were found to use residues for water and space heating respectively (CODA 1993, Annex 24: 103). An interesting pattern in the data is that the use of residues for all end-uses in the Northern region is about 50% less than in other regions. Overall the utilization level of fuelwood for cooking was unchanged. There were also no significant changes in the utilization levels of fuelwood for space heating and water heating combined which showed compensating changes compared to 1985.

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[22] The 1981 survey was conducted at the end of the rainy season in March and April, while the 1985 survey was implemented during May and June, that is after the post-harvesting season and in colder months.

[23] Even though no quantitative estimates are available, the supervisors of the 1981 survey reported that paraffin consumption is very limited because households light their lamps only for a few minutes when preparing for their bedding (DOF 1981: 4). Field observations of the author during the period 1989 and 1991 confirm that this practice is unlikely to have changed: paraffin lamps burning at night in houses are the rare exception from the rule.

5.4.2.3 Consumption of agricultural residues

The maximum availability of agricultural residues was estimated to amount to 4.3 million tonnes in 1993 (see Annex 5-10).[24] Thereof, maize stalks and cobs had a share of 93.6%. Field observations during the 1985 survey (DOF 1985: 39) showed that for cooking mainly cotton and tobacco stems were used, while groundnut halms and maize stalks were rarely used for this end-use in isolation. The main reason why the use of the latter two residues is constrained are their fast-burning characteristics. A more extensive utilization for cooking purposes would require the modification of the three-stone fire-place which is almost exclusively used in rural households in Malawi (see below). The 1985 rural energy survey gives some indications that agricultural residues were primarily used for open fires outside of dwellings.

For agricultural residues, an average utilization period of 3.5 months and an average per capita consumption level of 0.64kg per day were found by CODA (1993, Annex 24: 103). In relation to the estimated total supply of residues of 4.3 million tonnes, these consumption characteristics imply a total consumption of 0.57 million tonnes and an overall utilization rate of 13%. Taking into account the constraint on maize residue utilization for cooking which is exerted by the type of stoves used, and assuming that the entire amount of cotton and tobacco stems available were used for cooking and were mixed with maize and groundnut stalks in equal proportions, the daily per capita wood equivalent of all residues used for cooking during the period of use amounts to 0.28kg. In relation to the average per capita consumption of fuelwood in 1993 of 678kg, which was found by Nyirongo and Mhango (1993: 19), agricultural residues used for cooking would have contributed maximally 14% of daily wood requirements during the utilization season. On an annual basis, agricultural residues account for about 4% of the total energy consumption for cooking.

Half of the total amount of utilized residues, which mainly consist of maize residues, were available for other end-uses. Quantitative estimates of fuelwood consumption by end-uses are not available for rural households in Malawi. However, the share of energy consumption for non-cooking end-uses rarely exceeds 15 to 20%. During the period of use of agricultural residues, the amount consumed for non-cooking end-uses amounts to 14% of total fuelwood consumption. As a result, the CODA data imply that about 75% of the energy consumption for non-cooking end-uses would be met from agricultural residues.

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[24] The estimation of non-woody biomass supply including cotton stalks, groundnut shells and stalks, maize stalks and cobs and tobacco stems is calculated in Annex 5-10. All other data quoted subsequently in the text in connection with the check on the consumption data of agricultural residues ascertained by CODA are also calculated in this Annex.

This share appears to be very high and implies that probably an even higher percentage of total energy consumption for water and space heating would be met by residues during the period of utilization. However, this result is broadly in line with the observation made during the 1985 rural energy survey that agricultural residues were largely used for open fires. On an annual basis, the total use of agricultural residues amounts to slightly less than 8% of total fuelwood consumption. Inclusive of residues, the total annual per capita consumption would amount to a fuelwood equivalent of 732kg.

5.4.2.4 Consumption of paraffin

The level of utilization of paraffin for lighting in 1993 (88.1%) was about 26 and 15% higher than in 1985 and 1981 respectively. This increase is consistent with the 15% decline in the utilization level of fuelwood for lighting purposes. That the utilization level of kerosene had increased since 1985 to approximately 80 to 90% in 1989 can also be gauged from data reported in Culler et al (1990: 36).[25] In addition, the utilization of paraffin for cooking which was less than 0.5% in 1985 was found to have marginally increased to 1.3%. The consumption level of kerosene for lighting in 1993 was calculated to be equivalent to 2.7 hours per day.[26] Compared to the observations from the 1981 survey, this consumption level is considerably higher. However, expenditure data available from a representative national survey (Culler et al 1990: 44) cast some doubt about this utilization level. Assuming that the consumption of kerosene was only half of the one found in 1993, would imply at prevailing prices for kerosene in 1989 (MK1.06/l), that rural households spent on average MK15.3 per year on kerosene.[27]

The expenditure data were disaggregated into 23 categories and showed that the majority of the households surveyed reported average expenditures on single expenditure items as low as MK4.0. Eight per cent of the households reported average expenditures for firewood

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[25] The data show ownership levels of tin lamps and hurricane lamps, both of which are wick-type lamps, of 70.6% and 35.9% respectively. If ownership is assumed to be a reliable indicator for actual utilization levels and it is taken into account that some of the larger and better off households own more than one lamp, the estimate of an overall utilization rate between 80 to 90% appears reasonable.

[26] Survey data from Coda (1993: Annex 24-108/10) show that most of the households used wick-type kerosene lamps. From data contained in deLucia & Associates (1992: 7-11) for kerosene use in urban households in Malawi using wick lamps, a consumption equivalent of 1 litre kerosene for 40.5 lighting hours was calculated. The average price for kerosene paid by rural users was MK1.84/l and the uniform pump price of kerosene at filling stations was MK1.6/l. According to the survey data, the bulk of kerosene is bought at rural shops (72%), petrol stations (24%) and the remainder mainly by other private vendors. The composition of supply suggests a mark-up by other vendors of 20.8%. Hence, one litre of kerosene which was reported to last on average for 15 days, is equivalent to 2.7 hours/day.

[27] The expenditure was calculated as follows: Annual consumption (12l) * MK1.06/l * 1.208 (Average mark-up) = MK15.4.

amounting to MK19.0 which is equivalent to 4.4% of their average income, but no expenditures were reported for kerosene. Conversely, if an expenditure of MK4.0 is assumed as a cut-off point for the reporting of expenditures and it is assumed that expenditures for kerosene were just slightly below this threshold, the implicit hours of lighting can be calculated to amount to 0.35 hours per day.[28] The result of this hypothetical calculation is in line with the observations about kerosene utilization levels in 1981.

An additional consistency check, using the kerosene consumption data from the 1990 energy balance of Malawi, indicates that a lower average annual consumption figure of 4.6 litres per household, equivalent to half an hour of lighting per day, represents a more reliable figure.[29] This estimate suggests that the consumption of kerosene may have increased compared to 1981, albeit only marginally.

The change in utilization levels of kerosene over time is difficult to attribute to any single factor. Though no precise data are available, the construction of new roads in the country and the associated opening of new filling stations has certainly improved the access to paraffin. The development of real prices of paraffin is difficult to ascertain, due to the problem (see Chapter 4) that no entirely satisfactory cost of living index is available for rural households in Malawi. For the purpose of gauging the development of paraffin prices in real terms, nominal prices of paraffin per litre were converted to real prices (using 1982 as the price basis) by using the nominal daily minimum wage rates as an index. The result of this calculation shows that kerosene prices, relative to the minimum daily rural wage, increased by 67% in real terms between 1981 and 1985. After a small increase in 1986, paraffin prices showed a strong declining trend and were about 13% lower in 1993 compared to 1981.

The development of real prices of paraffin in relation to real income changes (see Chapter 4) shows a similar trend. In 1985 the calculated index was 1.52 and declined to approximately 0.81 to 0.86 in 1993. In other words, at constant consumption levels, the share of kerosene expenditures of total disposable income has considerably declined. The change between 1985 and 1981 could explain the observed drop in utilization levels by 12%. Because paraffin

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[28] The daily lighting hours were calculated as follows: ((MK4.0 (maximum assumed expenditure on kerosene)/ (MK1.28/l))/365 (days)) * 40.5 (hrs/l) = 0.35 hours.

[29] Consumption figures for kerosene in the 1990 energy balance which were prepared by the author were based on a detailed analysis of kerosene consumption in all end-use sectors except for household consumption, based on oil company sales statistics. The residual consumption (11.06mln litre) less the estimated consumption of urban households in 1990 (see Ng'ong'ola 1991: 70) of 2.8mln litre was divided by rural household population in 1990 from MAS (1993: 1). Assuming an average household size of rural households in 1987 of 4.2 (NSO 1991: 21) yields an average annual household consumption of 4.6 litre. The conversion to average daily lighting hours was based on the assumption that 1 litre of kerosene is equivalent to 40.5 lighting hours.

used for lighting in 1981 was just covering the bare minimum lighting needs, there was no scope for further reductions of kerosene consumption. Hence, some households are likely to have stopped using paraffin. Conversely, the increase of households using kerosene for lighting in 1993 as compared to 1981, could be explained by the lower real price of kerosene (13%) and the likely lower share of kerosene expenditures as a percentage of disposable income. The latter may also explain the estimated slight increase in kerosene consumption.

In summary, the comparison of fuel utilization patterns by end-use between 1981 and 1993 shows no significant changes. Particularly, there is no evidence of a significant increase, if any, in the percentage of households utilizing agricultural residues as a primary fuel for cooking purposes. The high utilization levels of agricultural residues in 1981, when the fuelwood supply situation was judged to be relatively unconstrained (see the discussion below), suggests that the use of agricultural residues has been largely determined by their availability. The utilization levels of residues as a secondary or complementary fuel recorded in 1993 also show no significant change in comparison to 1981. The very high share of non-cooking end-use demand which is seasonally met by residues, may imply that the assumptions made for the utilization of residues for cooking were too restrictive because the consumption of residues for non-cooking uses was derived as a residual. However, even if the assumptions are too constrained, the overall amount of residues used for cooking cannot be assumed to have increased substantially, given the overall utilization rate of residues. Since quantitative consumption data for residues are not available, quantitative changes cannot be ascertained. However, a consistent interpretation of the available data and information suggest that the possibility of an increased use of agricultural residues as a complementary fuel cannot be ruled out. Overall, it can be concluded that agricultural residues have not substituted fuelwood by any significant amount.

Therefore, the main question for further analysis of the energy consumption patterns in rural households is whether the consumption level of fuelwood or the composition of supply has significantly changed.

5.4.2.5 Estimates of changes in fuelwood consumption levels

Kronen (1988: 8) has noted that the average annual per capita fuelwood consumption figure of 0.85 solid m^3 (equivalent to 680kg, assuming a density of 800kg per m^3) which was commonly used in relevant studies in Malawi, had no solid empirical foundation. Findings of this research confirm that there is no single source or survey which has reliably estimated this figure prior to 1993. Several studies, for example, World Bank (1992b: Vol II, 3-3) assume the validity of this figure without quoting its origin. Nyirongo and Mhango (1993: 19) derived from their survey an estimate for the average per capita fuelwood consumption of 678kg and point out that this estimate coincides with the per capita consumption estimate of 680kg per capita which was estimated by the Malawi Urban Energy Survey in 1984 (MUES 1984). Similarly, CODA (1993, Annex 24: 8) states that the average annual per capita consumption of 0.84 solid m^3 which was found in their study, coincides with the estimate from the 1984 Malawi Urban Energy Survey. However, the latter study (MUES 1984: 25) to which other studies always refer, only assumed this per capita consumption figure without quoting any source, or supporting their assumption by any empirical analysis. CODA's original estimate was measured in kilogrammes, and amounted to 476kg. Apparently, the density factor used (0.56) to make their estimate consistent with the cited figure in m^3, differs largely from the one used by other authors. Different assumptions about the density of indigenous hardwoods add to the difficulties of estimating fuelwood consumption in Malawi.[30]

The use of empirically unsubstantiated per capita consumption figures for fuelwood has striking similarities with the use of other key data used in household energy analysis. For example, Gill (1987) found that assumptions about thermal efficiencies of various types of cookstoves were often cross-referenced in the literature but had in fact only a very limited empirical foundation (see also the discussion in Chapter 7).

To derive an estimate for the average annual fuelwood consumption for 1981, Kronen (1988: 8) has suggested that from the absence of indications for the adoption of fuelwood-conserving measures in rural households and the low percentage of households buying woodfuels, the conclusion can be drawn that a severe fuelwood supply situation did not exist in 1981. Based on figures of a FAO study (FAO 1983), a World Bank[31] study concluded that the average per capita fuelwood consumption in sub-Saharan countries in highlands (>1500m) and humid lowlands was in the range of 1.4 to 1.9m^3 and 1.2 to 1.5m^3 respectively. Since about 60% of Malawi's land area is located in highlands, Kronen had suggested a conservative average annual per capita consumption of fuelwood in rural households of 1.2m^3 (960kg) for Malawi.

This figure may represent a reasonable order of magnitude in view of the findings of a survey (sample size 600) which was conducted in 1991 by Mhango (1992b). The survey was conducted in four refugee camps in different districts, where households were regularly supplied with food and other daily necessities but collected their own fuelwood. Under

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30 Solid densities (kg/m3) for air dry indigenous hardwood which are explicitly assumed or were calculated from several studies are as follows: 678 in NEP (1990: 9); 600 (Gmelina) in IPC (1989: 139); 682 in Kronen (1988: 32); and 675 in deLucia & Associates (1992: 11). For subsequent calculations the latter density is used.

31 The World Bank study referred to by Kronen was not cited.

these conditions, where effects of food security and of seasonal agricultural labour demands must be assumed not to have constrained fuelwood collection and consumption, an average annual per capita fuelwood consumption of 993kg was estimated.[32] However, extreme caution has to be used in interpreting this consumption level as approximately representative of fuelwood consumption levels under unconstrained conditions in Malawi on account of two reasons. First, the household sizes of the families in refugee camps were not available. Hence the impact of household size on fuelwood consumption is not known. Secondly, as the ensuing discussion will show, there is only limited evidence that the average consumption of fuelwood in Malawi has indeed substantially declined between 1981 and 1993.

For comparison purposes, the average annual per capita fuelwood consumption in Botswana, which can be classified as a dry lowland country, was estimated by ERL (1985: 10) to amount to 657.7kg (0.82m^3). This consumption level was associated with a considerably higher percentage of households which exclusively bought, or bought and collected fuelwood, than in Malawi. This fact may partly explain the lower consumption levels in Botswana relative to the average consumption levels cited above. Other per capita woodfuel consumption figures for sub-Saharan countries which were compiled in Bradley (1991: 195) range from a low of 288kg in districts of Kenya, under conditions of very high population densities (about 800) and a commercialized woodfuel market, to a high of 1 405kg in Tanzania.

Other per capita fuelwood consumption data are available, for example, for the SADCC countries in 1988 (SADCC 1988). The data which include rural and urban households also show large differences between countries. Lesotho had the lowest per capita woodfuel consumption, amounting to 0.72m^3. Other countries including Swaziland, Botswana and Angola had a per capita consumption ranging from 0.79 to 1.0m^3. Zimbabwe and Malawi with a per capita consumption of 1.13 and 1.39m^3 respectively were still considerably below the total average per capita consumption of 1.7m^3 for all countries. Tanzania and Zambia instead were significantly above the average with values of 2.12 and 2.21m^3 respectively. Based on the data shown in Table 5-11, the estimated per capita woodfuel consumption in Malawi amounted to 1.16m^3 in 1990.

Kaale (1991: 23) has pointed out that SADCC data are difficult to compare because different

[32] The consumption estimates of Mhango (1992b: 8) which were stated in solid m3 were calculated using a conversion factor of 0.675 tonnes of fuelwood for 1 solid m3 of indigenous hardwood. Variations from the mean were 14% and 6% respectively. Due to the relatively high consumption (1,134kg) in one of the camps, the mean was correspondingly higher. Consumption in the other tree camps with a mean of 945kg varied only by 1.5 to 3.0%.

sampling and measuring techniques were used in the surveys from which they were derived. National average per capita woodfuel consumption data have particular limitations because they mask not only interregional differences, but are difficult to interpret because different shares of urban and rural populations in individual countries and their associated different per capita fuelwood consumption, are aggregated into one figure. In general, the problem remains that the comparison of per capita fuelwood consumption levels in individual countries with data from other countries or country averages, provides a rather rough indication about the severity of the woodfuel supply-demand situation in a specific country, unless the precise conditions with which the data are associated with are taken into consideration. Unfortunately, such information which would allow more meaningful and accurate comparisons, is hardly ever available.

5.4.2.6 Analysis of factors influencing energy consumption levels

Household size and income distribution

The surveys cited above did not analyze the impact of household size and income levels on fuelwood consumption. The analysis in Chapter 4 has shown that average income, landholding size and household sizes of rural households are highly correlated. NSO data show that average household sizes and size distributions at the district level were fairly constant between 1977 and 1987. Therefore, it is unlikely that demographic factors had a major impact on per capita consumption levels of fuelwood used for cooking.

Cooking system parameters

Types of cooking devices used were not covered in the 1981 and 1985 surveys. However, the survey data from CODA (1993, Annex 24: 13), which show that 97.3% of all rural households used the traditional three-stone open earth stove, clearly indicate that this stove type has been the predominant cooking device in the past. In this context it should be noted that only one stove programme targeting rural households has been initiated during the period under discussion. This programme which was started in the early 1980s by the Energy Studies Unit (ESU) of the DOF aimed at the introduction of improved mudstoves and was based on the assumption that a 20% efficiency gain may be achievable (Kronen 1988: 9). In outdoor cooking tests wood savings of up to 50% were achieved (French 1986: 534). However, as experienced elsewhere, efficiency gains of improved stoves obtained under laboratory conditions seldom materialize under practical conditions of use. Because actual wood savings under field conditions were only 5% (French 1986: 534), the project was finally stopped because such low efficiency gains were considered to be too low to justify a large scale dissemination programme.

The remaining 2.7% of households used other types of stoves such as mudstoves, and the two types of improved stoves which have been distributed in large quantities to Mozambican refugees located in districts of the Southern and Central regions,[33] and which are also marketed in the urban areas of Malawi.

Data contained in CODA (1993, Annex 24: 85) show that in 1993 most of the wood used for cooking has been dry wood. Time-use data for rural households from Culler et al (1990), field observations by the author and discussions with agricultural extension workers suggest that households predominantly use cut pieces of wood.

Concerning cooking practices, survey data from CODA (1993, Annex 24: 115-18) show that most households cook outside (75%), while the remainder cook inside (21.4%) or both inside and outside (3.6%). Since cooking outside is less fuel-efficient than inside, reasons for cooking outside were asked. About 89% of the households cooking outside did not respond, which may be interpreted as an indication that they either did not know about the impact of outside cooking on fuel use, or did not care. The reasons given by the remainder for not cooking inside were inadequate inside space for cooking, inadequate light and too much smoke. Concerning the rationale of cooking inside, French (1986: 534) reported that the ESU found that women were cooking indoors in order to protect their fireplace from wind and thus to use wood more efficiently. Also two-thirds of the households interviewed in the CODA survey said that they were dousing their embers and about 93% of the households were covering their pots during cooking.

The typical composition of meals in rural households in Malawi consists of tea and porridge for breakfast, maize meal (nsimsa) combined with small amounts of vegetables for lunch, and vegetables and beans for dinner. For the preparation of lunch and dinner, households were found to use on average 1.9 pots for cooking purposes (CODA 1993, Annex 24: 113). Survey data from Culler et al (1990: 36) show that all households owned both clay pots (99.5%) and metal pots (94.4%).

Dry beans and other dry food were found by CODA (1993: 12) not to be soaked by most households (89%), mainly because soaked foods are considered as tasteless (59%).

Changes in the variables defining the cooking system over time are difficult to ascertain, because there is very limited longitudinal information available. However, the existing cooking practices and other qualitative information and circumstantial evidence provide hardly any indication for the assumption that rural households have introduced fuel-

[33] See, for example, the review report on the fuelwood efficient stove distribution programme by Chitenje (1993) who reported that about 145 000 stoves have been distributed in Malawi since 1989. Since refugees are known to have occasionally resold the stoves, it is actually surprising that only 10 households (1.3 %) of those surveyed by CODA reported to use an improved stove.

conserving measures to any significant extent other than cooking indoors. According to informal interviews of the author with a number of women, covering pots and dousing ambers are to some extent traditional practices rather than recently introduced changes. Given the typical composition of meals, where most of the cooking energy is used for the boiling of maize meal, there is genuinely limited scope for reducing cooking times by changing food preparation practices. The largest energy saving potential in this respect would be the soaking of beans or cereals, a practice which has not been widely adopted in Malawi. In addition, for those households soaking dry foods, there is no evidence that this practice can be interpreted as being motivated primarily to save fuelwood.

Other relevant behavioural factors which have not been discussed above but which are known to affect cooking efficiencies (see, for example, Leach & Gowen 1987: 66), are careful fire tending and the use of new stoves. Concerning the former practice, there are no data available to evaluate changes, but the boiling of maize meal itself requires a rather constant heat output so that fire tending practices which come into play in connection with energy saving behaviour when required heat outputs are variable, are *per se* not a major saving option. As noted above, virtually all rural households use the traditional three-stone stove.

Perhaps the most important single source of woodfuel savings has been the increased use of metal pots. According to Leach and Gowen (1987: 69), the cooking efficiency of open fires using metal pots is about twice as high compared to clay pots. Although no comparable data are available, it appears reasonable to assume that the ownership of metal pots is likely to have perhaps doubled since the early 80s. Given the above data for the ownership of stoves and numbers of pots used for cooking of the main two meals, and assuming that these account for 64% of the total fuelwood demand, a doubling of the ownership of metal pots may account alone for fuelwood savings of 16%. The corresponding average per capita consumption of fuelwood without these savings would amount to 807kg, based on a consumption level of 678kg in 1993.

Changes in the number of meals cooked

Changes in the number of meals cooked are not commonly discussed in the literature as a fuelwood scarcity indicator because it is generally assumed that as far as food related strategies to reduce fuel consumption are concerned, small-scale adaptations of the type discussed above, are introduced first. Moreover, this indicator is fraught with measurement problems which are very difficult to resolve, and the causal effects are difficult to identify. One of the major problems in this respect is related to the question of whether food supply or fuelwood scarcity may have constrained the number of meals cooked, provided there has been a change. In addition, where widespread food insecurity exists such as in Malawi, it has to be considered that even when the number of meals cooked has remained constant, the amount of food cooked may have changed. Despite these general difficulties which suggest that changes in the number of meals cooked are a weak indicator of fuelwood supply problems, some results from surveys conducted in Malawi are presented below.

The 1981 survey (DOF 1981) found that the number of meals cooked the previous day was completely invariant with regard to the subjective judgment of households concerning ease of collecting fuelwood and collection distance. Similarly, the 1985 survey (DOF 1985: 34-35) found that despite significantly different cross-regional collection times for fuelwood, no significant variance in the number of meals cooked was detected. Such findings are extremely sensitive to the period of survey implementation because of the seasonal pattern of food insecurity in Malawi. Evidence from a survey carried out in the Zomba district shows that food deficit households employ various coping strategies which suggest that food, and not fuelwood, is the limiting factor. According to the survey findings (see Peters & Herrera 1989: 18-19), a clear pattern existed in December and January, especially in poorer families, to share food with other relatives and to double the consuming units. Even within households, the number of meals and thus of cooking places, were reduced.

The reasons for employing these strategies are a mixture of two factors. First, food availability constrains the amount of meals cooked. Secondly, energy and time expenditures are reduced because households have to free time for seeking casual labour employment. Therefore, it can be concluded that during the food deficit months in Malawi, lower consumption of woodfuels is a consequence of food availability and household income strategies, rather than an outcome of woodfuel scarcity.

The data presented in Chapter 4 about the decline of per capita food availability during the 1980s suggest that the corresponding reduction in fuelwood consumption may have been maximally 4.9%.

Fuelwood collection distances, time requirements and other indicators of fuelwood scarcity

The key objective in rural household energy surveys incorporating questions about collection distances and time requirements is to ascertain the time required to obtain a certain amount of fuelwood. The relationship between time, distance, and quantity is often difficult to ascertain. Leach and Gowen (1987: 39), for example, point out that there are instances where distance and collection time may not be directly related, that is a short distance may involve more time when the terrain is more difficult, or a short distance may require more time per unit of fuelwood collected than collection at longer distances.

Results from the 1981 and 1985 rural energy surveys which are shown in Table 5-8 indicate that fuelwood collection distances vary by region. This pattern is broadly in line with the regional availability of biomass. However, there are some noteworthy exceptions which show that short distances are not invariably a reliable indicator of wood availability. The 1981 survey found (DOF 1981: 9) that within the same area women were walking distances up to 6.5km to collect fuelwood, while others were gathering inferior biomass such as twigs, roots, barks and bamboo in the vicinity of their homes. Particularly women who could not afford to be absent from home for a long period because of their young children were found to be among those gathering inferior woodfuels.

TABLE 5-8 Changes in fuelwood collection distances by region

	Percentage of households travelling up to					
		1.6km			*3.2km*	
Region	*1981*	*1985*	*Change*	*1981*	*1985*	*Change*
Northern	59.0	51.8	-7.2	85.0	79.9	-5.1
Central	60.0	43.4	-16.6	85.0	71.9	-13.1
Southern	55.0	41.5	-13.5	76.0	66.2	-9.8
Malawi	**57.0**	**46.4**	**-10.6**	**80.0**	**71.3**	**-8.7**

Sources: 1981 data - DOF (1981: 7); 1985 data - DOF (1985: 21)

Changes in collection distances among regions between 1981 and 1985 in Table 5-8 illustrate that there has been a successive decline in the cumulative percentage of households collecting fuelwood at distances up to 1.6 and 3.2km respectively. Relative to the wood resource availability estimated for 1990, the pattern of relative changes in the Northern and Southern regions is consistent based on the assumption that a higher per capita availability of wood resources is expected to be reflected in a more moderate decline of the percentage of households collecting within a specific distance. The pattern of change in the Southern region as compared to the Central region does not fit fully into this general model because changes during this period are smaller. However, a possible partial explanation of this pattern could be that with increasing distances for fuelwood collection, a decreasing percentage of households gathers fuelwood at longer distances. This pattern would be consistent with the claim made by Foley (1988: 66) that with increasing pressures on wood reserves, people successively switch to lower quality fuelwood and other woody biomass, the abundance of which is assumed to be inversely proportional to the quality of biomass. This statement implies that with increasing collection distances for fuelwood of preferred quality, people successively collect inferior biomass at shorter distances. What supports this claim is that in the Southern region deforestation rates were higher than the average national deforestation rate and the region also experienced the strongest land pressure.

However, since there are no longitudinal data available for changes in the composition of woody biomass gathered, no final conclusion can be drawn.

The regional data mask strong variations of collection distances at the district level. Deviations from the mean of the regional data shown in Table 5-8 in excess of 10% for collection distances greater than 3.2km were found in both surveys, notably in the Northern and Southern regions. This supports the experience from elsewhere that fuelwood shortages are area-specific.

In Table 5-9 weighted average distances and collection times from various surveys are shown. Weighted average distances for 1981 and 1985 were calculated from the survey data and therefore reflect the regional pattern of collection distances from Table 5-8. Inspection of the data showed that there was no distinct relationship between population densities and collection times on a district basis. In comparison to 1985, the 1993 data show slightly lower collection distances for the Northern regions and considerably lower collection times for the Southern region. These data have to be interpreted with care because the methodologies employed to ascertain distances (and collection time) were different.[34] An interesting aspect of the 1993 data is again the relatively lower collection distance in the Southern region which could be interpreted as an indication that average collection distances revert when available quality wood resources become scarce. This interpretation would imply that with increasing land pressure, wood resources do not become more plentiful with increasing distance because woodfuel gathering areas start to approach or overlap with collection areas of other villages. As a result, households increasingly start collecting inferior fuelwood closer to their homesteads. However, even though the 1985 and 1993 data point into this direction, due to the lack of more disaggregated data on the district level this conclusion would have to be supported by additional research.

Weighted average hours used for fuelwood collection were estimated without corresponding estimates for collection distances in the 1989 survey. When comparing the data on a regional basis in terms of the time required for collection per km travelled, there is no immediate explanation why this factor was higher in the Northern region (1.14hrs/km) than in the other regions (0.79hrs/km) in 1993. In fact, this result is counter-intuitive when considering differences in regional per capita availability of woodfuel resources. However, especially for the Southern region the lower figure may just be interpreted as evidence for

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[34] In the surveys carried out by the DOF in 1981 and 1985, collection distances and times were evaluated by enumerators familiar with their locations, by asking for the places where woodfuel was collected and the respective sun positions at the start and end of the roundtrip. Although this procedure is still rough, it was considered to be more accurate than personal estimates. Instead the other two surveys referred to in Table 5-8 relied on individual estimates.

the explanation suggested in the previous paragraph.

There are hardly any comparable figures available from other countries in the region and valid comparisons would have to rely on a number of similar economic and resource characteristics of the area and of households. A survey conducted by Mehretu and Mutambirwa (1992) in a communal area of Zimbabwe, which had a population density roughly comparable to the one in the Central region of Malawi between 1977 and 1987 and which was characterized by severe degradation of land resources and low-potential agricultural land, found that rural households used on average 0.46 hours per km travelled to gather fuelwood. This figure is about half the one found in Malawi. The latter figure was based on a mean collection distance of 3.8km for a roundtrip, while the figures for Malawi refer to a weighted average roundtrip distance of 2.5km. Without information about woodfuel availability and quantity collected in a specific area, these data cannot be reasonably compared, but illustrate the possible large variation of time requirements.

Another interesting result from the 1985 survey illustrates the problem of using indicators such as 'difficulty of collection' as a proxy for fuelwood availability in intertemporal comparisons. The 1985 survey (DOF 1985: 26-28) found that despite significantly higher collection distances compared to 1981, on average 16% less of the households found fuelwood collection difficult. Since such a large change was rightfully interpreted to be too large to be accounted for by seasonal factors, the authors of the survey suggested that households may get accustomed to walk longer distances and hence adapt their perceptions about what difficult means. Although this may be a partial explanation, the findings indicate the difficulties associated with the interpretation of this indicator.

5.4.2.7 Changes in the procurement of fuelwood

In order to ascertain how households have adapted to increasing woodfuel scarcity, in addition to the adaptations discussed above, both changes in the commercialization of fuelwood in rural areas and changes in the composition of supply sources and types of fuelwood gathered need to be analyzed.

Concerning the first issue, the available evidence from Malawi suggests that rural households also do not seem to have responded to changes in physical fuelwood scarcities by purchasing more fuelwood.

The 1981 rural energy survey (DOF 1981: 13) found a positive relationship between the collection distance for fuelwood and the percentage of households which collect and buy fuelwood. As shown in Table 5-10, the response has been limited and the relationship is non-linear. Overall, 7.8% of the households collected and bought fuelwood. The corresponding figures for 1985 are also shown in Table 5-10. While the 1981 survey data distinguished between households collecting all their fuelwood and those who collect and bought fuelwood at the national level, the 1985 rural energy survey added a response category which covered households which exclusively bought fuelwood or were given fuelwood by relatives. Moreover, the survey data concerning fuelwood procurement were reported on a district basis. As shown in the lower part of Table 5-10, the percentage of households which collected and bought fuelwood and which exclusively bought or received fuelwood from relatives as gifts in 1985 was 5.7 and 2.0% respectively. The data show that there was no change in the percentage of households which collected all their fuelwood between 1981 and 1985.

However, on a regional basis, the combined percentage of households in the latter two response categories is increasing from North to South. This pattern corresponds to the regional per capita standing stock of biomass which is shown in Table 5-2. In this respect, it is worthwhile to note that the survey data (DOF 1985: 18) show an inverse relationship between the percentage of households collecting all fuelwood and per capita biomass availability, in all but one (Machinga) of the Southern districts which had a per capita biomass availability of less than 50% of the average in 1990/91. This result suggests the existence of a positive relationship between the physical scarcity and commercialization of fuelwood, although the caveat has to be considered that no statistical analysis for this relationship was conducted.

While the 1981 survey did not analyze further the reasons for households buying fuelwood, other than suggesting that it appeared to be a function of fuelwood scarcity, the 1985 survey found that the majority of fuelwood buyers were located in the proximity of plantations. Even then, fuelwood was bought mainly for commercial activities such as brick making and beer brewing which require larger fuelwood quantities, and not for cooking purposes. This finding suggests that fuelwood was bought as an input for income generating activities which allow recovery of cash outlays. This observation is also in line with the view that purchasing of fuelwood for subsistence needs is an expenditure of last resort. Although a positive relationship between physical fuelwood scarcity and the incidence of purchasing of fuelwood cannot be entirely dismissed, the above discussion shows that such a relationship is likely to be rather weak.

The only more recent information about the incidence of households buying fuelwood is available from survey results reported in Culler et al (1990: 28). The survey was conducted in the post-harvest season between July and October 1989, that is during a period when rural households have more spare time for fuelwood gathering and commercial activities.

The survey which allowed multiple responses found that 90% of the households interviewed reported that they gathered fuelwood, 10% used fuelwood from their own woodlots, while only 7.8% also bought fuelwood and 2.2% received fuelwood from relatives. Thus since 1981 the percentage of households buying fuelwood remained virtually unchanged.

Concerning the issue of whether the sources of supply and the type of fuelwood gathered have undergone significant changes, some uncertainties remain. The origin of fuelwood collected was not addressed in the rural energy surveys. Survey results concerning the origin of gathered woodfuels from CODA (1993, Annex 24: 10) show that about 10% of the households collected wood from their own woodlots. This result is comparable to the one found by Culler et al for 1990. Supplies from customary land were the main source of supply in 1993.

The data gathered by CODA also suggest two interesting patterns. First, the percentage of households gathering woodfuels on customary land is positively related to the regional availability of woody biomass. Secondly, a substantial part of the declining share of fuelwood gathered on customary land is being supplied from private woodlots and community woodlots. An increased share of fuelwood supply from woodlots implies a reduction of time used for fuelwood collection. The reduction of the weighted average collection time between 1985 and 1993 for the Central and Southern regions in Table 5-9 was 16% and 35% respectively. Cross-regional data from CODA show that 6.3% more households used woodlots in the Southern as compared to the Central region. This difference does not fully explain the 19% difference of the reduction in the weighted average collection time between the regions, but lends support to the likelihood that average weighted collection times have indeed been reduced.

In summary, it may be concluded that despite declining fuelwood availability, as evidenced by the development of deforestation and increasing woodfuel collection distances, there is neither evidence for an increasing commercialization of fuelwood in rural areas nor for the proposition that significant amounts of fuelwood were bought for household subsistence needs.

TABLE 5-9 Distances and time used for fuelwood collection (per roundtrip)

Year	*Northern*	*Central*	*Southern*	*Malawi*
		Weighted average distance (km)		
1981 (1)	1.64	1.81	2.10	1.85
1985 (2)	2.36	2.52	2.94	2.47
1989 (3)	n.a.	n.a.	n.a.	n.a.
1993 (4)	2.22	2.67	2.39	1.72
1993 (5), (6)	n.a.	n.a.	n.a.	n.a.
		Weighted average time (hours)		
1981 (1)	n.a.	n.a.	n.a.	n.a.
1985 (2)	2.35	2.5	2.92	2.64
1989 (3)	n.a.	n.a.	n.a.	n.a.
1993 (4)	2.54	2.1	1.89	2.03

Region spans the Northern–Malawi columns.

Sources: (1) DOF (1981: 7); (2) DOF (1985: 21-22); (3) CODA (1993:24-10); (4) Culler et al (1990: 29); (5) Nyirongo and Mhango (1993: 15); (6) Average figures based on eight districts

Weighted averages were calculated using mean distances and hours

TABLE 5-10 Procurement of fuelwood in 1981 and 1985

	1981 (1)		*1985 (2)*	
	Percentage of households		*Percentage of households*	
Collection distance (km)	*Collecting all*	*Collecting and buying*	*Collecting all*	*Collecting and buying*
<0.8	96.0%	4.0%	96.4%	3.6%
0.8 - <1.6	94.0%	6.0%	95.4%	4.6%
1.6 - <3.2	90.0%	10.0%	95.3%	4.7%
3.2 - <4.8	90.0%	10.0%	92.1%	7.9%
>4.8	85.0%	15.0%	89.2%	10.8%
Average	**92.2%**	**7.8%**	**94.3%**	**5.7%**

	1985 (3)		
	Percentage of households		
Region	*Collecting all*	*Collecting and buying*	*Buying all and gifts*
Northern	97.9%	1.6%	0.6%
Central	93.0%	6.0%	1.0%
Southern	88.8%	7.5%	3.7%
Malawi	**92.3%**	**5.7%**	**2.0%**

Sources: (1) DOF (1981: 13); (2) DOF (1985: 37); (3) DOF (1985: 18)

5.4.2.8 Fuelwood problems and perceived needs of rural households

As discussed in Chapter 4, supply and demand management options have often failed because they were based on the assumption that rural households perceive the scarcity of woodfuel as a central problem and were therefore dispositioned to mobilize household resources to remedy this problem. The discussion above has shown that there is no evidence that households have indeed shown significant responses to their fuelwood problems in terms of demand-side adaptations, including fuelwood conserving measures, interfuel substitution and procurement of fuelwood. This suggests that households were able to allocate enough labour time to collect fuelwood.

The survey carried out by Culler et al (1990) also provides some valuable insights about the relative importance of problems and needs of rural households. Among the biggest problems households said they were facing were health (88.6%), agriculture (49.7%), food (38.8%, transport (27%) and household problems (26.7%). Probing for the list of goods and services needed showed that specific household goods such as water and fuelwood supplies were only ranked fourth (33.7%) after food, health, and transport services. Specific responses of households concerning fuelwood supply (multiple responses were allowed) revealed that 25.9% had no problems, 43.1% judged that fuelwood collection takes too long or is too far, and 36.7% and 24.0% respectively said that fuelwood is too heavy or not available. Approximately, the percentage of households mentioning the lack of fuelwood and water supply, correspond to the percentage of households who identified specific fuelwood problems. Overall, fuelwood supply problems were not a prime concern of most households.

There are several explanations for this ranking. First, the relative time demands for water and fuelwood collection both of which are predominantly carried out by females (>90%) and children were found in the survey to amount to 8.5 and 5.5 hours per week respectively. Fuelwood demands are higher in the dry and cold season due to higher demands for heating and other fuelwood consuming commercial activities (beer brewing, etc.) than in the wet season which coincides largely with the period of household food deficits and the time of peak agricultural labour demands. Findings from Coote et al (1993) show that women seasonally adjust their fuelwood collection in line with seasonal labour demands for agricultural activities: women in a village were found to carry monthly 10 to 15 headloads in the dry season and 6 to 9 headloads during the wet season. This suggests that labor allocation to fuelwood collection is primarily determined by seasonal labour availability rather than by woodfuel scarcity.

5.5 DEFORESTATION AND REGENERATION OF FORESTS

5.5.1 The woodfuel supply and demand balance

Prior to the discussion of the sources of deforestation in Malawi, it is necessary to provide an estimate of the woodfuel supply and demand situation in the country. The results of previous studies which have estimated wood consumption (including fuelwood and poles) in Malawi for different years in the 1980s are summarized in Kronen (1988: 3). Most estimates for the years 1982 to 1986 were in the range of between 7.7 to 9.2 million m^3 per annum. Several estimates are even higher, ranging from 10.0 to 12.8 million m^3. As discussed in the previous section, the largest source of error in these estimates is the assumption about the annual per capita fuelwood consumption of rural households. A World Bank study (see World Bank 1992b: Annex 3: 3) has used a per capita figure of $0.85m^3$ to derive a total consumption of 7.1 million m^3 for rural households in 1990.

The total fuelwood consumption of rural households which is shown in Table 5-12 amounts to 8.9 million m^3. This figure is based on an annual per capita consumption of 678kg and a density of 0.675 (tonnes/m^3) for indigenous wood. However, despite unresolved uncertainties about the past development of per capita fuelwood consumption in rural households, and limited information about the consumption of village industries, the main point which is illustrated in Table 5-11, is the existence of a considerable fuelwood supply deficit. It should be noted that the wood demand for poles which is shown in the demand category 'other' constitutes mainly the consumption of rural and urban households. Combined with the demand of fuelwood and the wood equivalent of charcoal, households account for almost 86% of the total wood demand.

TABLE 5-11 Woodfuel supply and demand balance in 1990 (cubic metres)

Consumption sector	Northern	Central	Southern	Total	Percent of total
			Wood demand		
		Region			
Households	1 045 556	3 842 646	5 088 450	9 976 651	81.3%
-Rural	1 012 937	3 496 269	4 445 536	8 954 742	72.9%
-Urban	32 619	346 376	642 914	1 021 910	8.3%
--Fuelwood	10 767	275 327	450 223	736 317	6.0%
--Charcoal	21 852	71 049	192 691	285 593	2.3%
Industry	147 116	1 093 242	497 401	1 737 759	14.2%
-Tobacco	45 478	518 541	116 620	680 639	5.5%
--Estates	45 276	318 938	109 366	473 580	3.9%
--Smallholders	202	199 603	7 254	207 059	1.7%
-Tea			192 593	192 593	1.6%
-Village	56 160	56 160	71 568	183 888	1.5%
Other (poles)	59 003	216 847	287 150	563 000	4.6%
Total demand	1 251 674	5 152 735	5 873 001	12 277 410	100%
			Wood supply		
Sustainable supply	2 667 742	1 733 142	1 651 538	6 052 422	100.0%
Unavailable supply	1 403 950	525 850	353 500	2 283 300	37.7%
Net supply	**1 263 792**	**1 207 292**	**1 298 038**	**3 769 122**	**62.3%**
Supply deficit	**12 117**	**-3 945 442**	**-4 574 963**	**-8 508 288**	**69.3%**

Sources and assumptions:

Urban household woodfuel consumption: Ng'ong'ola (1991: 68-69)

Charcoal woodfuel equivalent based on earth kiln yield (weight-based) of 0.12t/t

Rural woodfuel demand: 678kg per capita, from Nyirongo and Mhango (1993: 19)

Rural population estimate: NSO (1987) data were escalated by 3.5% p.a.

Tobacco industry wood consumption: from Table 5-6

Other sectoral woodfuel consumption: see text in Chapter 5

Woodfuel supply estimates: from Table 5-3

Density of indigenous wood: 675 kg/m^3

5.5.2 Harvesting practices, woodland management and deforestation

The discussion in the above sections of this chapter referred to deforestation from a quantitative point of view in the sense that woodfuel demands of consumer groups who employ relatively intensive harvesting practices were compared to the detected losses of indigenous forests in Malawi. The quantitative estimates presented above imply, literally taken, that no or hardly any regeneration has taken place on the harvested woodlands. To the extent that woodland regeneration has taken place during the 20-year period for which deforestation was quantified, the share attributable to the sectors concerned would have to be reduced and had to be accounted for by other demands.

Research of the regeneration dynamics of woodlands in Malawi has been extremely limited. Only one long-term study[35] has been conducted between 1960 and 1981 in a forest reserve (Bunda College) located in the Central region. In 1960, an area of five ha was clearcut, woody biomass was removed and leftovers were burned. Afterwards the area was only managed for fire protection. In 1981, the area was completely regenerated in terms of having a closed canopy and was stocked with almost 2 200 stems. Clear-cutting of one ha yielded $80m^3$ of wood or a MAI of 3.8. This MAI is more than three times higher than the MAI generally assumed for unmanaged miombo woodlands in forest reserves in the country. The regrowth was also associated with no change in the biodiversity of trees. Even though this finding is limited to one site, it suggests that the regrowth potential of managed miombo woodlands is substantial. Consequently, the severe degradation or deforestation of clear-felled miombo woodlands is not an inevitable consequence, unless other factors are taken into consideration.

Factors influencing regrowth in miombo woodlands were analyzed by Hosier (1993a), based on research in Tanzania and evidence from research conducted in other countries with substantial resources of miombo woodlands, notably from Zimbabwe. The explanatory framework developed by Hosier is used for the following discussion. In terms of harvesting intensity, Hosier distinguishes between selective harvesting, clear fell harvesting and agricultural clearance. The potential for regeneration is principally assumed to be related to harvesting intensity, but post-harvesting management measures seemed to codetermine the intensity of regrowth.

As the discussion in previous chapters has shown, the factors causing land degradation after agricultural land clearance, such as poor land husbandry or limited adoption of soil conservation measures, land exhaustion as evidenced by stagnant or declining yields, limited fertilizer application to crops and presumably hardly any application to farm trees or woodlots and the incidence of high soil erosion in Malawi, suggest only limited regrowth on farms. Additionally, the practice under customary law which allows unrestricted grazing of livestock on croplands after the harvest, is an additional factor which has to be taken into account.

The tobacco industry, as the second largest consumer of fuelwood from customary land, practices clear felling. Like the tea industry in Malawi, which was found to have extended the cropping cycle for *Eucalyptus* by one to two years in order to obtain higher density wood, the tobacco industry also has a preference for mature fuelwood stocks. Because of the

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[35] The following results are quoted from the Newsletter of the Forest Research Institute of Malawi (FRIM 1981).

requirements for polewood used for the construction of burley barns, and other on-estate wood pole demands for construction purposes, customary lands are usually not harvested selectively but clear felled.[36] Practices such as coppice management and fertilizer application which are mentioned by Hosier (1993a) as favouring regrowth are not practiced. Instead, the two factors contributing to retarding regrowth, namely grass burning and overgrazing, are important features of land-use in Malawi. Grasslands are extensively burned throughout the country and the pressure on grazing areas has increased due to an increase of the livestock population by more than 150% between 1980 and 1990 (MAS 1993: 37). More than two-thirds of the livestock population is fed in free range (Culler et al 1990: 27).

The harvesting intensity of charcoal operations and the management of charcoal sites, which were studied in detail in Tanzania by Hosier on several sites, is not precisely known for Malawi. Because urban consumers prefer dense charcoal, it may be safely assumed that charcoalers have a preference for mature trees. However, at least for charcoal-making areas in the vicinity of the city of Blantyre, which are likely to have supplied most of the charcoal consumed in the city, there is some evidence which suggests that increased deforestation rather than regrowth has been the final outcome of charcoal-making activities. Observations by Coote et al (1993) and Chipompha et al (1993) in the area, suggest that deforestation has spread in a pattern resembling concentric rings around the city. Forests closest to the city were found to be more depleted. These observations suggests that charcoal producers are likely to have harvested also less preferred species and did not confine their activities exclusively to the harvesting of well-stocked areas.

Hosier (1993a: 500-501) has suggested that the quantities, and hence the type of species which are selected by charcoal producers from a given area, are also determined by the price of woodfuel in the urban market. In other words, higher prices of charcoal are likely to induce the cutting of higher cost wood supplies from the same area. More precisely, because increases in transport costs in real terms may compensate real price increases of charcoal, these relative price movements combined may yield a sufficient value of charcoal which makes it economically attractive to cut higher cost wood. As shown in Chapter 7, charcoal prices in Blantyre have risen considerably in real terms in the 1980s. Additionally, it has to be considered that real incomes in urban employment were declining considerably

[36] The cutting of forests on customary lands for estate is an issue which could not always be discussed very openly with representatives of estates in Malawi, on account of the perceived adverse cost implications of related policy measures which have been under discussion in Malawi. However, confidential interviews with two estate managers of fairly large tobacco producing estates in 1990 confirmed that clear felling of woodlands, most often associated with some form of bribing of traditional authorities to gain permission to cut woodlands, were traditional practices of the industry.

throughout the same period. This has lowered the opportunity costs of labour and hence the production cost of charcoal at a given site. Hence, field observations about deforestation tend to be supported by economic considerations.

It should also be noted that there is also evidence from research conducted by Munela et al (1993) in Tanzania, that charcoal producers cut trees for lower quality charcoal and did not confine their activities exclusively to well-stocked miombo woodlands.

The impact of village industries on deforestation cannot be ascertained because there are no data available. Occasional visits to brick production sites during field visits by the author always showed that a considerable proportion of fuelwood consisted of mature indigenous trees. Taking into account the volumes involved, the harvesting practices of brickmakers and their wood suppliers have to be characterized as relatively selective.

The composition of sources of supply to meet the substantial demand for poles for construction purposes is not clearly known. Field observations in Malawi show occasionally men carrying an indigenous tree or pole. The discussion in Section 5.5.2 shows that there is empirical evidence suggesting that pole sized trees have been extensively cut in indigenous woodlands and have thus contributed to forest depletion.

Collection practices of rural households are generally known to be environmentally more benign. The above discussion about the types of woody biomass collected support this view. Additional survey information from Lilongwe district (LFP 1993)[37] also indicates that cutting of whole trees in customary forests for fuelwood is hardly practiced.

In summary, when the harvesting and post-harvest management practices of major woodfuel users other than rural households for energy uses are taken into account, it appears that most of the harvested forests are unlikely to have regenerated to any significant extent. Most likely a considerable portion of the clear felled land has subsequently been used for agricultural purposes. Fuelwood collection practices of rural households are considered to be less destructive, and their impact on deforestation has been less than attributable to agricultural land clearing and other major sources of consumption. This finding is in stark contrast, for example, to the forecast made in the Malawi National Energy Plan that population growth and associated increases in fuelwood consumption will lead, within the 1990s, to complete deforestation in Malawi. This scenario has not materialized because the impact of woodfuel demands of rural households on deforestation has been misconceived.

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[37] The survey conducted in preparation for the Lilongwe Forestry Project, found that only 1.9% of the rural households were cutting trees in customary forests to obtain fuelwood (LFP 1993: Appendix 1, Table 41).

5.6 ECONOMIC IMPACTS OF DEFORESTATION

In Chapter 2, Section 2.2.1, the role of economic impacts of deforestation for household energy policy formulation has been discussed. Against this background and the preceding analysis in this chapter, such impacts and their equity implications are further analyzed for the situation in Malawi.

5.6.1 Quantifiable costs and benefits of deforestation

Methodologically, the analysis of economic impacts of deforestation can be treated within the traditional framework of cost-benefit analysis. As discussed in Chapter 1, a contentious issue of applying cost-benefit analysis remains the choice of an appropriate discount rate. The identification of costs and benefits usually does not pose a practical problem because the principal categories of benefits and costs which have to be considered are well-known in the literature. However, quantification of costs is a rather more complicated undertaking because often the required data are not available. With regard to deforestation in general, the principal issue is that deforestation cannot *per se* be equated with inefficient allocation of natural resources. For example, the conversion of forests to agricultural land is allocationally efficient when the opportunity costs of agricultural land are higher than when used alternatively as forests.

An evaluation of the economic impacts of deforestation in Malawi was carried out by the World Bank in 1992. On the benefit side, the study accounted for wood harvested in excess of the sustainable yield by using gazetted prices for indigenous wood and the agricultural potential of deforested land. As economic costs, the loss of future forest products due to the cutting of stocks and the costs of soil erosion attributable to deforestation were taken into account (World Bank 1992b: 37), the study estimated that the economic costs of deforestation range between 2.8 and 4.3% of Gross Domestic Product.

In order to relate these results to the findings of this research, several crucial assumptions of the World Bank Study and additional factors have to be taken into account. First, the analysis was based on a forecast of woodfuel supply and demand between 1990 and 2000. The projected woodfuel supply deficit in this research is about 2.5 million m^3 higher than in the study of the World Bank. Due to the uncertainties involved in estimating fuelwood demand of rural households, it is difficult to judge which figure is more appropriate. However, as discussed above, the annual supply of fuelwood was underestimated. This has implications both for the benefit side because the wood harvest in excess of sustainable yield is higher, and for the cost side because of the higher replacement costs. A crucial assumption in this respect was that the World Bank study based the replacement costs of wood on the least cost supply source, namely, production of wood by smallholders.

However, such an assumption is unrealistic unless it can be satisfactorily demonstrated that smallholders are indeed likely to replace the annually lost woody biomass stock. Results from Chapter 6 suggest that this assumption is rather optimistic. Therefore, the underestimation of both the projected woodfuel deficit and of replacement costs, result in an underestimation of the economic costs of deforestation which may be approximately 50% higher than shown above.

5.6.2 Non-quantifiable impacts of deforestation

Additional cost factors which were identified by the World Bank study to generate economic losses, were the loss of biomass products, and externalities such as waterway sedimentation and watershed degradation. However, these issues were not discussed in detail. Particularly the costs of these impacts could not be quantified because of a lack of data.

5.6.2.1 Policy and methodological considerations

Even though the impacts of depletion and deforestation on the availability of forest resources are difficult to quantify in Malawi, the contribution of these resources to production and consumption activities is an important area for woodfuel policy analysis, particularly with regard to the poorer strata of rural communities. The importance of forest resources for the rural household economy and consequently the implications of changes in forest resource availability, has been comprehensively reviewed in a report of the FAO (1989). Even though the degree of utilization of forest resources varies between countries, there is clear evidence that forest resources contribute substantially to the food, fuel, fodder and fibre needs of rural households. They may also be significant in contributing to household income through direct sales of collected forest products and as raw materials for income-generating activities, notably small-scale forest-based enterprises. It is also evident that the poorer strata of the rural households utilize forest resources most. Therefore deforestation and degradation of forests, and hence woodfuel policy and forest management, always have an important equity dimension.

Analyzing the impacts of changes in forest resources on households requires the identification of how the flow of forest resources is linked to on-farm resources for particular uses within the household economy. In this respect, for example, deLucia (1990) has developed an analytical framework which characterizes rural energy systems in terms of flows, competition (substitutability) and complementarity of food, fuel, fodder, fertilizer and fibre resources and their linkage to end-uses. Various elements of these relationships, for example, the impact of diminishing woodfuel supplies on households and ensuing adaptations were already discussed above. Because the objective of this section is to analyze the impacts of forest loss and degradation on rural households, the following discussion focuses on the utilization of forest resources for other uses.

The analysis of impacts of deforestation on rural households is naturally based on the identification of beneficial uses which rural households derive from tree products and other forest resources. Research on the uses of forest resources in Malawi has been carried out by several researchers. However, there is comparably little information available about the utilization of indigenous tree species in particular districts for particular uses and on their relative role for smallholders. Most of the available information originates from an ethnobotanical survey which was conducted in 1989 by Maghembe and Seyani (1991) in ten districts and, to a lesser extent, from an informal survey carried out by Poulsen (1981). Both sources are also important information sources for the analysis of the function of trees on farms and particularly the reasons why specific indigenous trees are retained after land clearing. The latter topic will be discussed in Chapter 6.

5.6.2.2 Uses and relative importance of forest products in rural areas

Fodder uses

Livestock was found by Culler et al (1990: 41) to contribute on average 17.5% to total household income. Moreover, livestock represents an important safety asset which is used to generate cash income to cope with major cash outlays for emergency cash needs for funerals and illness and as a coping strategy of food-deficit households. More than two-thirds of the households use free range to feed their livestock. Although virtually all households were found to have increased the number of livestock (Culler et al 1990: 27), most farmers consider the supply of adequate fodder as a major constraint (Maghembe & Seyani 1991: 17). Most households are constrained to produce their own fodder because of the unavailability of fallow land. During the post-harvest season, farmers rely heavily on biomass residues, mainly maize residues, in the fields. After the dry season, dambos and forests are used as grazing areas.

The utilization of forests as a source of fodder varies throughout the country and is largely determined by availability and suitability of fodder supplies. Discussions with foresters indicate that forests are heavily used in some parts of the country because there are signs of heavy grazing pressure. In general, the supply of fodder from trees in miombo woodlands is considered to be relatively constrained because many species provide biomass which is not palatable (Poulsen 1981: 10). Maghembe and Seyani (1991: 17) found that fodder was used from 62 multipurpose tree species, shrubs and herbs. Leaves and fruits were the most important plant parts used for fodder in most districts, but the supply of leaves is constrained because most plants are deciduous. However, the utilization of species varies considerably by district. Only two species were found to be used in Machinga district, while 29 species were used in Lilongwe district. It is not clear whether these large differences can be attributed to the availability of supplies. Maghembe and Seyani (1991: 17) found that farmers in the Northern districts of Chitipa, Karonga and Rumphi and in the Dedza district considered tree fodder to be a minor source of fodder. The authors advanced the explanation that this may be due to the large distance of woodlands and forests from homesteads. However, as far as the Northern districts are concerned, this interpretation is unlikely to be valid because these districts have the highest per capita volume of woody biomass in Malawi (see Table 5-2). In summary, it appears that forests represent a complementary source of animal feed, the importance of which varies considerably by district.

Food and medicinal uses

Despite the intensive research in Malawi about food security and nutrition, the role of forest foods and medicinal uses of plants and trees has not been addressed in these studies. Wild leaves have been found to be important sources of protein and vitamins which are consumed in some countries by the majority of rural households (FAO 1989: 13-14). The utilization of leaves in Malawi has not been researched in depth. Only Poulsen (1981: 10) mentions that the leaves of a large number of species are prepared as a kind of spinach. The survey carried out by Maghembe and Seyani (1991: 24-26) has provided some insights into the role of wild fruits. They found that farmers considered 44 multipurpose tree species as important sources of fruits. Thereof 33 were indigenous species. Other findings were that many fruit trees are of only localized importance while some were utilized country-wide.[38] Most fruits of the miombo forests are seasonal and mainly available for about three to four months after the rainy season. This season coincides only partly with the food-deficit season. This is likely to be the main reason why the collection of wild fruits does not show up in food security surveys as a coping strategy. Overall, the role of fruits as a food supplement appears to be limited. Households considered fruits as an important food supplement for the entire family in only three districts.

Some wild fruit species are collected and sold in local markets and at roadsides. However, available information from income surveys (see Culler et al 1990) suggest that their contribution to household income must be rather small.

Supplies of bushmeat from forests is rather limited in Malawi because forests populations of

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[38] Fruit trees found to be of national importance included the species *Uapaca kirkiana, Annona senegalensis, Parinari curatellifolia, Azanza garckeana, Carica papaya, Mangifera indica and Flacourtia india* (Maghembe & Seyani 1991: 25).

animals are heavy depleted. Other forest products which are used are mushrooms, nuts, caterpillars and termites. However, there is no reliable information about their degree of utilization.

Thirty-two indigenous species of multipurpose trees and shrubs were found by Maghembe and Seyani (1991: 23) to be used for medicinal purposes. Medicinal uses of plants were found to be widespread and used for a large range of ailments by most households and traditional healers which handle most of the illnesses and diseases in rural areas. The poor health infrastructure in Malawi and limited cash availability are likely to make the use of medical plants one of the economically most important uses of forests. This is illustrated, for example, by the finding of Coote et al (1993) that rural households in a village in Mzimba district relied about 50% for their medicinal needs, on forest plants.

Wood and fibres for construction and other uses

In comparison to exotic species indigenous trees are widely preferred by rural households for building purposes because they have superior strength and better termite resistance. In addition, indigenous trees are widely used for furniture and all sorts of household and farm equipment. For example, Williamson (1975) has compiled information showing that country wide over 100 species are used for such purposes. Maghembe and Seyani (1991: 28) found that in a number of districts more than 20 species were used for these purposes.

As noted above, the consumption of poles for construction purposes is sizable in Malawi. There is clear evidence that forests have been heavily depleted of pole sized trees. For, example, Coote et al (1993) found that in a Village Forest Area (VFA) in Mzimba district most preferred pole species were completely cut out. According to information provided by foresters in Malawi, there is a clear tendency for cutting preferred species and small sized trees in other VFAs as well as in miombo forests, including forest reserves.

Indigenous forests are sources of raw materials for the production of a whole range of products made by small- and medium-scale enterprises in Malawi. A national survey of such enterprises which was conducted by Daniels and Ngwira (1993) found that 1 876 enterprises were using forest-based raw materials. Ninety % of the forest-based enterprises (FBE) are located in rural areas. About two-thirds of FBEs were one-person enterprises and about the same percentage contributed one-half or more to total household income. Thus, their role in creating income is important both in terms of diversifying the rural economy and enhancing the cash income of smallholder households. More than one-third of the FBEs were collecting their inputs and about 15% reported that availability of raw materials is their major problem. Taking into account that the majority of the smallholders have incomes below or close to the poverty line, diversification of household income will continue to be a prerequisite for many to maintain their already desperate income status. Deforestation and forest degradation are likely to have had an impact on the availability of raw materials for FBEs.

Rural households also obtain soap substitutes, gums, dyes and fish poison from trees (Poulson 1981: 10). Indigenous trees are also used for fibre and other minor uses (Maghembe & Seyani 1991: 28).

In summary, the projected quantifiable economic costs and benefits of deforestation are substantial in Malawi. Considering that the supply deficit of wood, which determines both costs and benefits, has been increasing, the economic costs of deforestation in the past have also continuously grown. In general, too little research has been carried out in Malawi to even approximate the economic costs and benefits of tree and woodland uses by rural households. The contribution of forest foods to food security seems to be limited at present, but it is difficult to ascertain whether deforestation had a significant impact on food availability in the past. The role of forests and woodlands as a supply source of fodder for livestock is naturally constrained in miombo forests. Therefore deforestation is likely to have had a limited impact on fodder supplies. The use of forest resources for a wide range of medicinal purposes is widespread in Malawi. The economic value of medicinal supplies may consequently be fairly high. Available evidence does not suggest that supplies have been severely curtailed in the past. The development of forest-based enterprises appears to have been moderately constrained by deforestation but raw material supplies can only be expected to become an increasing problem for FBEs.

Most of the impacts of deforestation, and of constrained access to woodland areas as a result of conversion of customary into leasehold land, are likely to have been borne by the poorer strata of the rural population. This conclusion is drawn from the simple fact that poorer households are more reliant on forestry resources than more affluent households because the latter are, for example, more able to afford the purchase of substitute services which are derived from forest resources. This stands in strong contrast to the emphasis on poverty alleviation aspects which have been formulated in the country's development strategy. In view of a perspective of continuing pressure on woodlands, more quantitative research concerning the impacts of deforestation and degradation of forests on the basic needs of rural households and the economic valuation of forest products, is required for woodfuel policy and forest management purposes.

5.7 SUMMARY AND CONCLUSIONS

The analysis conducted in this chapter in relation to available knowledge from other countries may be summarized as follows.

Deforestation

- This research confirms for Malawi the finding made in many other African countries that the conversion of forests for agricultural use is the single most important factor contributing to deforestation, accounting for about 45% of the loss of forest cover between 1971/72 and 1991. The conversion of forests was, however, not primarily due to the expansion of smallholder agriculture. An agricultural policy which favoured the establishment of estates, combined with broadened access to burley tobacco production and fears of losing out in the rush for taking possession of the ever declining availability of suitable agricultural land, produced a rush in the establishment of estates which utilized approximately one-half of the total forest area lost.
- The impact of woodfuel consumption on deforestation in the hinterland of cities could only be ascertained for the largest urban settlement, the city of Blantyre, due to data limitations for other major urban areas. The analysis suggests that by far the major factor contributing to deforestation in the Blantyre district, and most likely in some adjacent districts, have been urban household demands. Thus for policy purposes it cannot be concluded that the major factor contributing to deforestation is always the agricultural use of forests. This finding also emphasizes the widely held opinion among household energy policy makers, that solutions to household energy problems need to be based on the assessment of regional and local situations.
- The hypothesis that deforestation around cities resembles concentric rings cannot be discarded based on the available evidence for the city of Blantyre. However, in general this hypothesis is likely to depend on the general type and availability of woodfuel resources in areas adjacent to cities, relative to quality and price characteristics of woodfuel demand. In addition, it is doubtful whether the geographical pattern of deforestation necessarily has to be understood as a sequential pattern. Improved access to more distant areas, which are also more likely to be effectively controlled, may entail more favourable transport economics than inaccessible areas which are closer to main consumption centers.
- Insufficient research into the sectoral composition of woodfuel demands was responsible for overestimating the deforestation rate in the country and for assuming that deforestation was mainly caused by the woodfuel demand of households, particularly of rural households. More comprehensive analysis of regional wood energy supply and

demand balances, which was carried out in the National Energy Plan, reinforced these misleading assumptions because the forecasting approach was entrenched in some of the main fallacies of the woodfuel gap school of thought.

- While clearing of land for agricultural purposes has resulted in the retainment of rather low amounts of biomass stock on converted land, woodfuel demands of the tobacco industry, notably the flue cured tobacco industry, has had a strong impact on deforestation in tobacco producing districts. However, except for the implementation of the Tobacco Industry Energy Efficiency Project in the second half of the 1980s, which contributed to the decline of specific fuelwood requirements, the government has hardly taken any other policy initiative to redress this situation. This neglect was not an issue of a lack of available policy options or of a fear of impacts on the country's most important single source of employment and of foreign exchange. Rather, it appears that vested economic interests of the circles holding political power were primarily responsible for continued subsidization of the tobacco industry.
- Thus, in addition to favouring the estate sector relative to the smallholder sub-sector with regard to access to the highly remunerable flue cured and burley tobacco crops, the biased agricultural policies were also extended, though in action, in the fuelwood policy and by virtue of the fact that the adverse impacts of deforestation had to be primarily borne by the majority of the low-income smallholders.
- Quantifiable impacts of deforestation in Malawi are sizable warranting, in principle, the consideration of subsidy elements in policy implementation. The economic impacts of the loss of forest resources which were described above as non-quantifiable, cannot be ascertained without more in-depth research in this area. The supply of fodder, fruits and foods seem to play a limited seasonal role for consumptive purposes, while medicinal supplies appear to have a more important economic function. Emerging constraints in the supply of forest produce as raw material for a range of small-scale income-generating activities, exert most likely the most important adverse impact, because they tend to limit opportunities to diversify and increase income and employment in rural areas.

Changes in energy consumption patterns and adaptations to woodfuel scarcity

- The consumption patterns of rural households in Malawi appear to have been remarkably resilient between the period 1981 to 1993, despite a fairly high deforestation rate in the country. In the context of moderately declining per capita incomes in rural households and improved access to liquid fuels, available evidence suggests that the consumption of kerosene for lighting has increased slightly. The change in consumption levels and the number of households utilizing kerosene seems to be related to the share of kerosene expenditures in total income. While this share was considerably increasing between 1981 and 1985, utilization levels, which were close to the minimum, have declined. Conversely, between 1986 and 1993, when the real price of kerosene relative to the estimated real income declined strongly, kerosene utilization and consumption levels increased, albeit only moderately in the latter. This finding simply suggests that the consumption of kerosene at low levels of use is price elastic.

- Their is still uncertainty in the literature concerning the sequence of types of adaptations of households in response to decreasing physical woodfuel supplies. Distances travelled to collect fuelwood appear to have increased in the Northern and Central regions of Malawi, while their are indications that in the Southern region collection distances have declined. The prime reason why collection distances have increased, is that households have sufficient labour resources available during most of the year so that longer time requirements can be accommodated. A possible explanation for the observed decline in the Southern region is not that the labour constraint becomes binding, but that physical availability of wood is not increasing with longer distances. Hence, households may opt for collection of woodfuel at closer distances.

- The adoption of household energy conservation measures is hypothesized in the literature to materialize first in response to fuelwood scarcities. On this count there is no strong evidence from Malawi that such adaptations have been deliberately employed on a significant scale as far as cooking parameters are concerned. This does not disprove that small-scale energy conservation measures are employed. It is likely that the increased utilization of metal pots with higher cooking efficiencies, which may more appropriately be interpreted as changes which are primarily motivated by cooking rather than by fuel-saving preferences, may have contributed substantially to the decline in the per capita consumption of woodfuels. A second, although quantitatively less important factor, which is likely to have reduced per capita fuelwood consumption is the decline in food availability during the 1980s.

- Several hypotheses have been advanced in the literature concerning the link between fuelwood availability and food security. The rationale of these hypotheses in general is that constrained fuelwood availability triggers adaptations of rural households, for example, in terms of a reduced number of meals, change in the composition of food, food preparation practices, and so on. The evidence from Malawi suggests that the number of meals cooked has apparently not changed. However, since food security is a seasonal phenomenon which occurs at the time of peak labour demand, particularly poorer rural households were found to share food and thus cook together in order to free time for casual labour and to tend their fields. This strategy implies that less time is required to collect fuelwood. However, because this is just the natural outcome of other reasons, the hypothesis that fuelwood shortages result in less meals cooked can be rejected.

- Likewise, their is no evidence that households have changed their food preparation practices in response to fuelwood shortages. The most striking example in Malawi is that the soaking of beans, which represents the most likely candidate for such an adaptation, is not widely practiced because of taste preferences. Where it is practiced, no evidence is available that this practice is motivated by endeavours to save fuelwood.

- It is often suggested in the literature that households facing fuelwood supply constraints resort to the utilization of inferior fuels such as agricultural residues. The evidence from Malawi shows that rural households may have increased the utilization of residues. However, it appears that such changes have been modest. There is particularly no evidence that the percentage of households using agricultural residues as a primary cooking fuel has increased. The possibility of this happening in the future cannot be excluded. The main conclusion, however, is that despite declining supplies of preferred fuelwood species, rural households overall seem not to have chosen this option. As a result, it appears that rural households do not move rapidly down the energy ladder.

- Taking into account the mainstream thinking in the literature concerning the broad sequence of household adaptations to declining woodfuel resources, and given the situation and evidence about the pattern of responses described so far in Malawi, one would expect no significant commodification of woodfuels in rural markets. This expectation can be confirmed for Malawi. The share of households buying fuelwood was found to be rather limited. When fuelwood is being bought it appears to be mainly used as an input for commercial purposes where cash outlays can be recovered. There are only very weak indications at the district level for a positive correlation between biomass availability and the percentage of households buying fuelwood.

Integration of rural energy policy with agricultural and woodfuel policies

- The cause-effect analysis of deforestation in Malawi has shown that agricultural policies, that is the reliance of the development policy on the growth of output in the export-oriented estate sub-sector, and the constrained access of the smallholder sector to the most remunerative tobacco crop have hampered the income development of the smallholders. This is likely to have constrained rural households' increased use of kerosene for lighting and perhaps for cooking purposes.

- Consequences of deforestation which are borne by rural households, especially poorer segments, can largely be influenced only by sector-specific policies and measures. Thus localized pressures on woodfuel resources, for example in the tobacco-producing districts, can only be contained by, for example, more rigorous energy conservation and supply-enhancing measures which are fitted to the requirements and circumstances of the tobacco industry.

Chapter Six

ANALYSIS OF RURAL HOUSEHOLD ENERGY POLICIES

The main objectives of this chapter, are to analyze the design and implementation of the household energy strategy and related policies for rural households which were pursued by the Government of Malawi (GOM) since 1980, and to draw conclusions from this analysis with regard to the findings of policy research conducted in other countries. This analysis is based on the results of previous chapters.

In Section 6.1, institutional aspects of Malawi's rural household energy policy are outlined, followed by a discussion of the question as to why the GOM pursued mainly supply-oriented woodfuel measures, and to a limited extent, rural electrification (RE) projects.

In Section 6.2.1, Malawi's farm forestry policy is discussed. Since 1980 farm forestry policy has been mainly implemented under the umbrella of the National Rural Development Project II Wood Energy Project (First Wood Energy Project: FWEP), the Second Wood Energy Project (SWEP) and the Wood Energy Component (WEC) of the Energy I Project (WEC1), all of which were funded by the World Bank. The main elements of the policies and policy changes which were made in the course of implementing these three projects are then analyzed against the background of relevant research and survey information which became available between 1980 and 1993. Two main questions arise from the analysis of the design and implementation of woodfuel policies. First, what information was available when the policies were designed and secondly, what was the empirical basis of policy assumptions and design considerations? The major conclusions of analyzing these questions are that the woodfuel policy in Malawi was partly based on conjectural assumptions, lacked sufficient in-depth analysis of some key issues and suffered from poor implementation. It was a risky policy approach which eventually largely failed to meet the policy objectives.

Section 6.2.2 starts with a brief outline of general experiences from agroforestry projects which have been undertaken in Africa, including the difficulties involved in measuring the results and success of such projects. This discussion is followed by a description of the economic conditions for introducing agroforestry techniques in the smallholder sector of Malawi, which is based on findings in Chapters 3 to 5. Finally, the experiences of agroforestry research and extension activities of two major agroforestry techniques, that is 'alley cropping with *Leucaena leucocephala*' and 'intercropping of maize with *Acacia albida*', are discussed. These techniques were introduced in Malawi in the mid- to late

1980s. Their relatively short development time does not allow the drawing of final conclusions about the potential for adoption by smallholders. However, available evidence still suggests that the former technique has, as has been experienced in a number of other projects in Africa, less development potential than expected.

Section 6.2.3 discusses several communal forestry pilot programmes to promote communal forestry in Malawi. Because these projects were also in an early phase of implementation, no definitive conclusions can be drawn concerning their potential success. Available evidence suggests that typical factors which impeded the adoption of participatory forestry models, such as the problems of managing such projects and equitably sharing benefits, are widely prevalent in the village communities of Malawi. In addition, it appears that farmers' attitudes towards communal forestry are influenced by the effectiveness and results of other community or group-based projects which have been implemented in the past.

Section 6.2.4 starts with a discussion of the objectives of the GOMs RE policy and highlights the controversy and difficulties associated with the measurement of direct and indirect benefits of RE projects. Subsequently, the latter issue is discussed for projects which have been proposed in Malawi. The main conclusion from this discussion, is that the cautious approach which had been adopted by the GOM was justified, in view of the income situation of the majority of rural households.

The findings and policy conclusions drawn from the analysis in Chapter 6 are summarized in Section 6.3.

6.1 MALAWI'S RURAL HOUSEHOLD ENERGY POLICY

Institutional aspects of policy design and implementation

Major woodfuel programmes, which primarily targeted the smallholder sub-sector, were initiated and implemented through a series of projects which were funded by the World Bank. The first of these projects was the FWEP which started in 1980 and was completed in 1987. This project was followed up by the SWEP in December 1986 and the WEC1 which started in 1989. The latter project essentially continued the implementation of policies defined under the SWEP.[1]

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1 See the World Bank Staff Appraisal Report (World Bank 1986) for the detailed description of the SWEP and the description of the WEC of the WEC1 in Armitage (1988). Relevant details of these projects are desribed throughout this chapter. It should be noted that the SWEP was initially funded by a World Bank loan which became effective in December 1986. On account of the deterioration of Malawi's debt situation, the loan was cancelled and the SWEP activities were financed as the Wood Energy Component of the Energy I Project using a more favourable IDA (International Development Agency) Credit (see World Bank 1989c: 22).

Other non-governmental organizations and development institutions, notably the UNDP, the FAO and the United States Agency for International Development (USAID), launched both small-scale community forestry and agroforestry projects and projects to strengthen the institutional framework of the forestry sector. However, most of these projects started in the late 1980s and involved project activities on a smaller scale compared to the projects funded by loans of the World Bank. Therefore the dialogue about household energy policy and key aspects of policy formulation and implementation, which are typically associated with the assessment and approval process for these projects, were strongly influenced by the World Bank.

When it became evident that energy sector issues had become sufficiently complex to warrant an integrated national energy planning approach, including enhanced coordination of energy sub-sector activities in the public and private sector, the respective mandate was given to the Energy Planning Unit (EPU) of the Department of Economic Planning and Development which was founded in 1986. Since its inception, the EPU was severely constrained in fulfilling its mandate until about 1990 because it was poorly staffed. In view of this constraint, it was difficult for the EPU to cope with its comprehensive planning and policy mandate, and particularly to develop the technical expertise which was required for being accepted by other ministries and government departments which the EPU was supposed to coordinate and advise.

Prior to the establishment of the EPU, the key measures and programmes in the area of rural household energy policy, and to a large extent also in the area of woodfuel-related urban household energy policy, had been designed and implemented by the Ministry of Forestry, the Department of Forestry and its associated Energy Studies Unit. In addition to the manpower constraints of the EPU, vested interests in the Ministry of Forestry made it often difficult for the EPU to actively pursue its policy mandate. For example, the MFNR and DOF were sometimes reluctant to fully disclose information which would have allowed their performance concerning the implementation of the woodfuel policies implemented under the SWEP and WEC1 to be assessed and to broaden the policy dialogue among relevant institutions. On the other hand, indications of the MFNRs deliberate lack of cooperation provoked in some instances relatively aggressive responses by the EPU. Some of these responses may have been objectively warranted, but they also contributed to the development of misinterpretations and fears on the side of the MFNR/DOF concerning the intentions of the EPU with regard to the evaluation of the performance of rural and urban woodfuel projects and its envisaged influence on policy matters.

However, the cooperation between the MFNR/MOF and EPU concerning woodfuel policy and related project implementation matters improved considerably towards the end of 1989, that is at a time when the main rural household energy policies had already been under implementation for almost a decade.

The policy focus

As discussed in Chapter 5, the household energy policy discussion in Malawi during the 1980s was based on the assumption that the fuelwood consumption of rural households was the main source of deforestation in the country and that the annual rate of deforestation was about 3.5% per year. The woodfuel policies which were outlined in DEVPOL (1987: 39-41) were based on the assumption of a 'rapidly growing fuelwood deficit' (DEVPOL 1987: 39). This view was reinforced by the gloomy deforestation scenarios which were produced by the NEP in 1988. Thus, the design of woodfuel policy took place in the context of the perception of an unfolding wood energy crisis. This view was also reflected by forestry policy advisers such as Pardo (1990: 17): `The country is currently on a course towards a collapse of wood energy supply, which could have serious social, economic, environmental and political consequences'.

The results in Chapter 5 have shown that the average long-term deforestation rate during the 1970s and 1980s was lower than officially assumed and, importantly, that most of the deforestation in the country can be attributed to agricultural land clearing and non-rural household woodfuel consumption. Thus with regard to the policy objective of slowing down deforestation in Malawi, there was too little emphasis on policy measures addressing the woodfuel consumption in other sectors.

Scope and orientation of rural household energy policy measures

Relative to the large number of energy demand- and supply-side options which may generally be considered for rural household energy policy, the policy analysis which is discussed in this chapter is confined to the policy options which were pursued by the GOM since 1980 and for which sufficient and reliable information is available.

As discussed in Chapter 5, an attempt was made by the GOM to pursue a demand-side policy option in the form of developing and disseminating an improved mud-stove. However, plans for implementing this programme were abandoned in the early 1980s after the project was found to be non-viable. Renewed interest in improved stoves for rural households emerged again in the early 1990s in connection with the large-scale dissemination of stoves to refugee camps in the context of donor-sponsored projects. However, because the stoves were distributed free of charge to refugee households, an important precondition for analyzing policy issues pertaining to the questions under what conditions rural households are likely to adopt stove designs with particular characteristics, was not fulfilled. In addition, data and other information from surveys which were conducted to evaluate the performance of the programme is limited. As a consequence, the available information can only be used to discuss a limited number of aspects of policy issues in this area.

Other demand-side related options such as, for example, the dissemination of information about energy conservation practices, including fire management or energy-saving food preparation and cooking practices, were not pursued by the GOM. Reasons why the feasibility of pursuing other demand-side options was not studied in Malawi are not very clear. Available policy papers do not include a discussion of demand-side options. The policy recommendations of rural energy surveys, which were discussed in Chapter 5, also focus entirely on aspects of supply-side issues which were related to the on-going and planned woodfuel programmes. That the potential of demand-side oriented policy options was not further explored as a result of these surveys is perhaps not surprising because the survey results indicated that the relatively high per capita consumption of fuelwood in rural areas had apparently been resilient with regard to the observed deterioration in indicators of physical woodfuel scarcity. However, by the same token, the conclusion could have been drawn that there was scope to reduce fuelwood consumption by disseminating information about energy conservation practices, based on observed best practices, involving little or no interference with traditional food preparation and cooking practices.

Rural household energy policy focused entirely on supply-oriented woodfuel measures, notably on farm forestry, agroforestry and community forestry. Programmes involving the technical development and dissemination of renewable energy technologies, which were common in many other developing countries in the 1980s, were not implemented in Malawi because these options were considered as not being economically viable. For example, the widespread attempts in other developing countries to develop and disseminate appropriate biogas technologies for rural household cooking and water pumping were not pursued because the relatively low ownership levels of livestock and prevalent grazing practices rendered this option generally unfeasible. Similarly, other potential supply options for motive power such as windmills, diesel generators or solar pumping were not explored because the low incomes of rural households made their development futile in the context of a smallholder sub-sector which relies almost entirely on rain-fed agriculture.

RE programmes played only a minor role in the rural household energy and development policy agenda of the GOM. As discussed further below, this was due to a combination of government fiscal constraints necessitating the adoption of a least-cost supply strategy and the income and cash constraints of rural households. In addition, the fairly high fuelwood consumption levels which were found in the rural surveys, together with the virtual absence of a rural fuelwood market, indicated that there was little incentive for rural households to change their fuel consumption patterns for cooking by substituting commercial fuels.

6.2 SUPPLY-SIDE ORIENTED POLICIES AND PROGRAMMES

This section distinguishes and analyzes separately projects and policies in the area of farm forestry, agroforestry and community forestry. It has to be considered that these terms are not uniformly defined in the literature. Rather different and partly overlapping definitions of these terms are used. For example, Kerkhof (1990: 3) includes all activities which involve the planting of trees or shrubs on farms or by communities in the term agroforestry.

Cook and Grut (1989: 3) also adopt a broad definition of agroforestry by including all activities which are related to the 'incorporation or retention of trees or shrubs into agricultural or pastoral systems'. This definition includes intercropping of trees with other crops or the growing of trees in woodlots. Similarly, Winterbottom and Hazlewood (1987: 10) assume a broad definition of agroforestry as 'the deliberate association of trees and shrubs with crops, livestock or other factors of agricultural production'. This definition encompasses all land-use systems and is therefore not confined to the farm level. From this point of view, community forestry is included in this definition as agroforestry.

The International Council for Research in Agroforestry (ICRAF) defines agroforestry as follows:[2]

> Agroforestry is a collective name for all land-use systems and practices in which woody perennials are deliberately grown on the same land management unit as crops and/or animals. This can be either in the form of some form of spatial arrangement or in a time sequence. To qualify as agroforestry, a given land-use system or practice must permit significant economic and ecological interactions between the woody and non-woody components.

The definition does not encompass community forestry *per se*. Whether community forestry is considered as agroforestry depends on how a community forestry area is managed and used.

Some authors who explicitly use the term farm forestry, such as Saxena (1992: 420), refer to programmes in which farmers are encouraged to grow trees on boundaries and as woodlots

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2 This quotation is cited from Cook and Grut (1989: 2).

on farms. The same author also distinguishes between farm forestry and traditional agroforestry, whereby the former is characterized *inter alia* more by the planting of trees for sale or, say as a cash crop, than for ecological purposes (Saxena 1992: 420). Another author (Verma 1991: 327-328), who refers to farm forestry, defines the term implicitly, by defining agroforestry as the growing of trees on farm peripheries and mixed with agricultural crops on farms where trees are raised for household subsistence purposes. Thus the implicit definition of farm forestry is similar to the one used by Saxena, except for the different treatment of peripheral tree planting.

Leading agroforestry researchers in Malawi use a definition of agroforestry which essentially coincides with the one used by ICRAF (see, for example, Saka & Bunderson 1991: 15). However, the lack of consensus on a precise definition of agroforestry is not that important in the following discussion.

The term farm forestry is used here, in accordance with Saxena, because the major component of the rural household energy policy which was implemented in Malawi had as its objective the growing of trees in woodlots and on farm boundaries for sale to the market. The discussion of agroforestry issues instead deals with attempts to integrate selected tree species in farm land-use systems, while community forestry refers to programmes and initiatives to grow trees collectively in woodlots. However, it should be noted that the delimitation of these terms does not imply that farm forestry and agroforestry can, or should be, isolated. The ensuing discussion will show that farm forestry issues cannot be isolated from agroforestry issues. Rather an integrated treatment of research issues is paramount to ascertain the potential viability of either option under particular circumstances.

6.2.1 Farm forestry policy

6.2.1.1 Underperformance of the First Wood Energy Project

Farm forestry policy in Malawi in terms of major programmes and policies started with the inception of the FWEP. Major policy changes resulted from the assessment of the performance of this project in 1985/86. These were subsequently implemented under the umbrella of the SWEP and the WEC of the Energy I project. In the following, the policy approaches, their underlying assumptions and changes over time are discussed sequentially. This is required in order to relate the development of these policies to the trends and changes in conditions which were discussed in Chapters 4 and 5 and to the relevant research concerning the retention and planting of trees on smallholder farms in Malawi.

A key component of the FWEP was the creation of a national network of government-operated retail nurseries. During the project, which started in 1980, 88 permanent plus 10 temporary nurseries were established with the objective of producing about 9 million seedlings per year for sale to smallholders. Seedlings were subsidized to reduce tree growing costs of smallholders and to encourage them to grow their own fuelwood and poles (World Bank 1986: 6). The main species supplied from retail nurseries run by the Department of Forestry was Eucalyptus.

A review in 1986 by the World Bank of the projects' performance, in the staff appraisal report for the SWEP, revealed that it was not performing as expected. Sales of seedlings in particular amounted to only 60% of the target (World Bank 1986: 6), while French (1986: 537) estimated an even lower average utilization of nursery capacity of between 15 to 20%. The prime reasons why farmers were reluctant to purchase seedlings was identified by the World Bank (1989c: 21) to be that the subsidization of seedlings was insufficient to encourage smallholders to grow trees:

> The experience under the Project demonstrates that merely providing subsidized seedlings is not enough. The main reasons why tree planting is not popular with small farmers are the low producer prices for wood and availability of free wood in the forest.

The policy changes which were subsequently introduced in the SWEP and the WEC1 projects are further discussed below. Prior to this discussion, it is however necessary to analyze in detail the explicit and implicit assumptions of the approach underlying the WEP1 project as well as its main features, and the policy conclusions which were drawn from the analysis of the projects' performance at the time.

Objectives of farm forestry policy

Sinha et al (1994: 404) have pointed out that a precondition and major conceptual issue for effective interventions in the rural energy sector is a clear operational definition of their objective and scope. They also argue that: `In most rural energy planning exercises the purpose of the intervention is either unstated or is ambiguous and cannot be operationalized'.

With regard to the objectives of farm forestry policy, the policy statements in DEVPOL lack clarity because they refer to the encouragement of tree planting by the smallholder sector without being explicit as to whether smallholders were expected to produce fuelwood solely for household needs, markets or both. That fuelwood production by smallholders was expected to be partly driven by urban demands, (that is a market-led approach) is, however, implicit in DEVPOLs statement about the role of fuelwood market prices

(DEVPOL 1987: 41). Statements of the objectives of the wood energy projects with regard to smallholder tree planting in World Bank reports are somewhat more precise, but not clearly defined in all respects. The appraisal report for the SWEP states that the objective of the FWEP was 'to encourage them to grow their own fuelwood and poles' (World Bank 1986: 6). The stated objective of the SWEP was that part of the output from smallholder woodlots was expected to be used for their own consumption, but the main aim of increased stumpage rates and other tree planting incentives is 'to plant trees for sale in urban markets' (World Bank 1986: 39). The description of the WEC of the Energy I project (Armitage 1988: 6) mentions instead the 'objective of making smallholders self-sufficient in wood energy'.

Thus on the basis of the stated official policy objectives, it can be concluded that for the FWEP, the objective was at least to create incentives for subsistence woodfuel and pole production. For the two ensuing projects, the stated main objectives were ambiguous. However, the overall policy design of these projects clearly suggests that the main objective was tree production for urban markets.

Fuelwood scarcity as an incentive for smallholder tree growing

Survey results from the Malawi Rural Energy Survey (DOF 1981), which were discussed in Chapter 5, were available at the inception of woodfuel policy in Malawi under the SWEP. One important finding was that no significant relationship existed between the distance travelled to gather fuelwood and the intensity of tree planting by smallholders. Accepting that collection distances are a proxy for physical fuelwood scarcity and there were difficulties gathering fuelwood, fuelwood scarcity could not be considered to represent economic scarcity in the sense that fuelwood collection involved any significant opportunity costs of labour. Although collection distances were found in the 1984 rural energy survey to have increased since 1981, the fact that household energy consumption patterns and the percentage of farmers growing trees remained virtually unchanged, and that there were no signs of a commodification of woodfuels in rural areas, indicated that it was unlikely that the situation had deteriorated noticeably. In addition, the fact that the level of household energy consumption appeared to have remained at a fairly high level in 1984, implied that rural households had apparently considerable scope to reduce their fuelwood consumption by employing measures involving no cost and little, if any, changes in convenience such as fuelwood drying and other fuelwood saving measures. It was also known that off-season employment opportunities of labour were extremely limited implying very low to virtually zero opportunity costs of labour throughout most of the year. Thus the assumption that perceived fuelwood scarcities would create incentives for smallholders to grow trees for fuelwood subsistence needs was unfounded by the information available at the time.

6.2.1.2 Trees on farms

A precondition for the design of farm forestry policies is to establish knowledge about the reasons why, where and how farmers retain, plant and manage certain tree species within a specific farming system. The reasons why farmers retain certain tree species during land clearing normally provides useful information for understanding the potential role of specific tree species for farm forestry and agroforestry programmes.

During the inception of the FWEP project, information about the function of indigenous trees in smallholder production systems, and reasons for the retention of trees and management practices, were only available from the informal survey which had been conducted by Poulson (1981). No other survey work was carried out in the early 1980s to investigate reasons for the retention of trees on farms which could have supported the design of woodfuel policy interventions. Most of the agroforestry research programmes on tree species and provenance have also concentrated on exotic species.[3] The comparative lack of agroforestry knowledge for indigenous species began to be stressed, for example, by Sitaubi (1991: 54) and by Banda et al (1991: 133). These authors also emphasized the urgent need for surveys to identify and determine the potential of tree species retained by farmers on crop lands.

More detailed information about the most commonly retained and planted tree species and their uses was produced by the ethno-botanical survey, which was conducted by Maghembe and Seyani in 1991 in ten districts of Malawi, and the farm survey work implemented by Minae (1992a) in Lilongwe ADD in 1990/91. These sources of information are partly complementary in that they differ in their scope of analysis as well as their regional coverage.

6.2.1.2.1 *Factors influencing the retention and planting of trees on smallholder farms*

Tenure and land-use factors

In Chapter 3, several factors were identified which may inhibit the number of trees that are retained on smallholder plots during land clearing. Among these, insecure rights to the utilization of indigenous trees appears to be the main factor which may have induced the cutting of existing stocks of indigenous trees in excess of what farmers would prefer if tree tenure rights were more secure. A related second factor, which is likely to be of rather limited importance, are fears of smallholders as to the possibility that the government may

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[3] See the articles in the *Proceedings of the First National Agroforestry Symposium on Agroforestry Research and Development* (1991) which provide a comprehensive overview of past research programmes.

derive land ownership rights from the presence of indigenous trees on farmland. Whether these factors do indeed exert an impact on the number of indigenous trees which farmers retain after land clearing, could not be quantitatively ascertained. In addition, a third factor which may exert pressures to remove previously retained trees, or which may have led to the substitution of previously retained indigenous trees with planted trees and shrubs, is that declining land-holding sizes in the smallholder sector resulted in the allocation of a higher proportion of land to food production because of the farmers' overriding concern for food security and cash income from marketable agricultural produce. Some evidence is available that the latter factor had an impact on the number of trees which were being retained or planted on farms. Although farmers were aware of the consequences on soil fertility of almost complete removal of trees on their land, most reported that their landholding was too small to sacrifice land for trees (FAO 1982: 2). The same observation was made by Poulson (1981: 7), who also found that most of the farmers throughout the country cleared most of the forest vegetation on their farmland, except for certain carefully selected species.

Production-related factors

The type of species which were found by Poulson to be retained by farmers were mainly legumes[4] and species which are commonly regarded as protected.[5] The most important criteria for retaining selected species were found by Poulson (1981: 11-13) to be avoidance of serious competition with crops, supply of wood for fuel and construction purposes, and utilization of fibres and plant material for medicinal purposes. In some areas, where farmers were apparently aware of the soil fertility restoring characteristics of the species *Acacia albida*, agroforestry was practiced. Throughout the country, mango trees (*Mangifera indica*) were found to be the most prevalent tree species on cropland, occupying an appreciable though not quantified amount of land. Mango trees were also found to serve as an important source of fuelwood, which was obtained through pruning and pollarding, and as a valuable source of fruit supplies after the rainy season.

The survey of Maghembe and Seyani (1991) found that all farmers[6] had trees on their farms. Altogether 71 different multipurpose trees (MPTs) were found to be used in individual interviews and 69 species in group interviews. In this respect it is important to note that the group interviews recognized only 32 species as important and also identified an additional 35 MPTs which were not mentioned by individual farmers. The comparison of reported

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[4] The species of most commonly retained indigenous trees found by Poulson are shown in Table 6-1.

[5] These species are *Afzelia quanzensis, Pterocarpus angolensis* and *Terminalia serica*.

[6] A total of 60 smallholders were interviewed in ten districts. In addition, group discussions were held in five districts involving 105 farmers.

uses of MPTs in individual interviews and group interviews shows that only very few MPTs were mentioned in both types of interviews.

An important finding of the group interviews was that both the number of tree species and the number of uses per species found on uncultivated land surrounding the villages was considerably lower than for species which were found on farms. This finding suggests that farmers had retained or planted species providing more beneficial uses than those species which could be found in surrounding areas. Since farmers retained or planted those species, it may also be concluded that preferred indigenous species were likely to be scarce or anticipated to be subject to depletion. In view of the declining availability of trees with similar characteristics in the vicinity of the farms, the time costs for deriving benefits from off-farm trees must be assumed to be increasing in the context of deforestation woodland denudation. Hence one would expect, under these circumstances, careful management of retained tree resources. Indeed the survey found that retained trees were harvested by farmers with great care.

In accordance with the finding of Poulsen (1981), the survey also found that tree species which are believed by farmers to have adverse impacts on crop yields[7] were either completely removed or pruned. Species known to have soil-improving characteristics, notably *Acacia* species, tended to be retained on farms. It is also interesting to note that farmers believed that *Eucalyptus* and *Gmelina* species produce substances which either poison crops or make the soil infertile. Agroforestry research in Malawi has shown that the abundance of fruits produced by these two species during the sowing season of maize in October and November poses a problem to farmers and that root and litter leachates, and particularly green fruits and leaves, tend to impede significantly the germination of cereal crops (Maghembe & Prins 1991: 227). Research trials which were conducted in 1981 showed that intercropping of *Gmelina arborea* with maize, as compared to planting maize in pure stands, considerably reduced maize yields, while yield increases were found for intercropping this species with beans and groundnuts (Bello 1991: 119). In trials conducted between 1984 and 1987, adverse yield impacts on maize, cassava and beans interplanted with the main *Eucalyptus* species,[8] which were propagated by the DOF under the FWEP project, were found to materialize after two years (Sitaubi 1991: 56). The major observed planting patterns of *Eucalyptus* species, that is planting on farm boundaries or in woodlots, provides additional evidence that they are perceived by farmers as having a negative

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7 Species identified by farmers to reduce yields because of their shading effects are *Eucalyptus, Gmelina arborea, Mangifera indica, Melia azedarach* and *Oxytenanthera abyssinica* (see Maghembe & Seyani 1989: 21).

8 These species are *Eucalyptus camaldulensis* and *Eucalyptus tereticornis.*

impact on crops.

However, Minae (1992a) has found that farmers are to some extent prepared to accept shading effects for some species in return for other benefits. For example, mango trees were found to be retained and pruned in fields. This may also be associated with the circumstance that indigenous tree species, such as *Acacia albida* and *Mangifera indica*, are often not systematically planted but deliberately kept where they germinate naturally (Bulla and Nyirenda 1991: 106). This practice of tending wildlings, particularly of these two species has also been observed by Phiri et al (1990). Women in Malawi are also known to plant mango and other fruit trees in combination with maize and beans. Thus the available evidence suggests that the adverse effect of mango trees on crops is most likely limited to shading effects which can be controlled through pruning. The quantitative data about the composition of species found on croplands, which are discussed below, further support this conclusion.

Although soil-improving trees were retained, most farmers appeared not to employ management practices such as burying leaves or mulching leave litter which enhance the utilization of nutrients contained in leaves.

Farm and household uses

In addition to the more general criteria, a key consideration for the design of farm policy interventions is which beneficial uses motivate farmers to retain or grow specific species and whether there exist specific geographical patterns. Some insights into these issues can be gained from the analysis of the survey data and results of the research conducted by Maghembe and Seyani (1991) and of Minae (1992a).

The analysis of the data provided by the former authors shows that of the 69 MPTs which were reported to be used by farmers, only 31 were used in at least five districts for one-to three end-uses. Of these, 18 were primarily used for a single purpose in all districts. In Table 6-1 the uses of those 24 species are shown for which at least five different end-uses, or at least use in five districts, was reported. Compared to the total this shows that most MPTs are of localized importance. Other important points which can be gauged from Table 6-1 are that there are only two species, that is *Toona ciliata* and *Gmelina arborea*, which are used for fodder in five districts. The same species are the only ones for which three uses were simultaneously reported in at least five districts. For soil improvements only two *Acacia* species were found to be of importance. Similarly, except for mango trees, only five MPTs were used primarily for fruits in at least five districts. In addition, only six species, two of which are exotics,[9] were used in at least five districts for both fuelwood and building purposes. Among the trees with two uses in at least five districts, mango trees are the only ones which are used for fuelwood and fruits.

TABLE 6-1 Frequency and type of use of common tree species on smallholder farms

		Uses						
Species	*Number of uses*	*Fodder*	*Soil improvements*	*Fruits*	*Fuel wood*	*Building materials*	*Medicine*	*Other uses*
Farmer interviews		*Number of districts where use was reported (Total =10)*						
Ficus natalensis	6	3	1	7	3	1	1	
Brachystegia spiciformis	2				5	4		
Parinari curatellifolia	6	1	1	1	2	1	1	
Acacia polyacantha	4		5		4	1	4	
Pericopsis angolensis	6	1	1	1	2	1	1	
Julbernardia globifora	4	3		2	3		2	
Azanza garckeana	2	1		10				
Uapaca kirkiana	2	1		10				
Gmelina arborea	3	5			7	9		
Mangifera indica	4	2		10	3		3	
Group Interviews		*Number of districts where use was reported (Total = 5)*						
Acacia albida	7	2	5	1	1	1	1	1
Bauhinia thonningi	7	1	1	2	1	2	1	1
Toona ciliata	5	5		5	5	1	2	
Ficus sycomorus	5	2		5	1		1	1
Annona senegalensis	5	1		5	1		1	1
Strychnos spinosa	6	1	1	3		1	1	2
Parinari curatellifolia	6	1		2	1	1	1	1
Brachystegia floribunda	5	1	1		2	1		1
Ficus natalensis	5	1	1	2	1	1		
Rothmannia engleri	5	1		1		1	1	1
Albizia versicolar	2				5	5		
Afzelia quanzensis	4	1		2	5	5		
Bauhinia petersiana	4		1	1	5	5		
Eucalyptus saligna	4	1	1		5	5		
Gmelina arborea	3	5			5	5		
Mangifera indica	3		1	5	5			

Source: Compiled from Maghembe & Seyani (1991: Tables 11-15)

Overall the data show that out of 69 species, only eight species were used for two or more uses in all five districts. Seven of these were also reported to be used for fuelwood. However, this coincidence cannot be interpreted in the sense that fuelwood supply is the

[9] These species are *Albizia versicolar, Afzelia quanzensis, Bauhinia petersiana* and *Eucalyptus saligna*.

prime reason for retaining or planting these species because altogether 45 MPTs were found to be used for fuelwood in the survey (Maghembe & Seyani 1991: 27). Even though the sample size of the survey was to small too be statistically representative at the district level, the results which are compiled in Table 6-1 suggest that there are only a fairly limited number of trees which are of regional importance in the sense that they are reported to be used for at least two end-uses in all of the districts which were covered in the group interviews.

Another interesting finding of the survey was that none of the farmers reported to have planted preferred indigenous fuelwood species because they are regarded as slow growers. This suggests that planting of indigenous species is motivated largely motivated by other benefits.

Indigenous tree species which were found to be planted by farmers (Maghembe & Seyani 1991: 26) were *Annona senegalensis, Azanza garckeana, Uapaca kirkiana, Rothmania engleri* and *Uapaca nitida.* Judged by the data shown in Table 6-1, the former three trees seem to be primarily planted on account of their fruit supply, while the fourth appears to be valued for several uses.

From the data shown in Table 6-1, it is apparent that the species *Gmelina arborea* was consistently reported in both types of interviews as a MPT which may be particularly favoured as a source of fodder, fuelwood and building materials. Consistent with the finding by Poulson, the species *Acacia albida* was found in group interviews to be particularly valued for its soil improving characteristics.

Main data which were collected in the survey conducted by Minae (1992a) in Lilongwe ADD,[10] include the quantitative composition of tree species on croplands (see Annex 6-1) and information about the frequency and type of uses of fruit trees found on smallholder croplands (see Annex 6-2). These data, combined with the available evidence about preferred uses of trees from the previous discussion, allow one to draw some further conclusions about the reasons why smallholders retain or plant certain tree species in Malawi. The results are further used below for the interpretation of the results from smallholder tree planting surveys and the design of farm forestry policy.

As shown in Annex 6-1, 50 different tree species were found, the canopy of which covered about 3% of farm croplands. The interesting results were that only five tree species made up

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10 The methodology used in the survey was to select five sites considered to be representative for the land use system from which five transects of 1ha were taken as sample units after every 100m length (see Minae 1992a). Thus on a total of 25ha all tree and shrub species were identified and counted. The source data were prorated to 100ha for easier presentation in Table 6-2.

about 61% of the total number of trees[11] and that 15 tree species had a share of about 78% of the total. Species classified as fruit trees had a share of about 60% of the total. Considering that mango trees are virtually indigenous to Malawi, indigenous fruit trees had a share of about 60% of all trees, while exotic fruit trees were virtually unimportant.

Annex 6-2 shows the percentage of farmers which reported to utilize indigenous and exotic fruit trees for various purposes. The data show that 78.0 and 51.0% of the farmers surveyed used fruits and fuelwood respectively from mango trees. However, the data also show that mango trees are also substantially used for other purposes. Therefore they appear to have much more the characteristics of a multipurpose tree than the results from the group interviews in Table 6-1 suggest. Data for the second most numerous species, that is *Bauhinia thoningii*, show that 73.0% of the farmers used its fruits. However, the utilization rates of this tree for other uses which range from 34.0 to 46.0% are considerably higher than for mango trees. Other major differences between these two most important species are that mango trees are not regarded as having soil improving properties, while for *Bauhinia thoningii* no use of fuelwood was reported. Judged on the basis of the reported rate of utilization for various uses, the provision of fuelwood appears to be the single major factor why mango trees on croplands are almost four times more numerous than the second most important species. Even though it cannot be ruled out that this factor plays a major role, it has to be taken into account that the role of mangoes as a food supplement and as a source of cash income represent also important economic factors.[12]

Other fruit trees which belong to the fifteen most numerous trees found on farms are the species *Azanza garckeana*, *Strychnos spinosa*, *Ficus natalensis* and *Ficus sycomorus* with 4.6, 2.4, 1.9 and 1.8% of the total respectively. For the first two of these species, slightly more than 50% of the farmers used their fruits, while the provision of building material and medicines were also important other uses. Findings from the individual interviews for *Azanza garckeana* from Table 6-1 and from Annex 6-2 are also comparable in terms of the primary use of this species. The same conclusion can be approximately drawn for the species *Strychnos spinosa*. The number of farmers using *Ficus* species is more balanced in the sense that fruits are the primary use, but differences of utilization between the primary use and secondary uses are much smaller as compared to the more important fruit tree species.

It is also important to note that for all fruit tree species, except for mango trees, no use of

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[11] These were *Mangifera indica*, *Bauhinia thoningii*, *Erythrina abyssinica*, *Cassia siamea* and *Azanza garckeana* with shares of 36.5, 9.5, 5.9, 5.0 and 4.6% respectively.

[12] Mangoes and other fruits, mainly from exotic species, are sold at virtually every roadside in Malawi during the harvesting season.

fuelwood was reported. This is perhaps an underestimate, but it indicates that their role as suppliers of fuelwood is likely to be marginal.

A distinctive feature of fruit trees is that their reported utilization for fodder is very low, except for *Bauhininia thoningii, Mangifera indica* and *Ficus* species, in descending order. As discussed in Chapter 5, this feature may be due to the limited palatability of leaves from indigenous species.[13]

Like indigenous fuelwood species, most indigenous fruit trees are not planted for the supply of fuelwood because they are also regarded by farmers as slow growers (Minae 1992a). However, among the indigenous trees which are planted[14], fruit trees were found to belong to those having better income characteristics (Maghembe & Seyani 1991: 24). Mainly exotic fruit tree species are grown.

Very few indigenous MPTs including mango trees were observed by Minae (1992a) to have been lopped. This suggests that indigenous fruit trees on croplands are hardly used as poles. For example, mango trees are usually either pruned or whole branches are lopped off to reduce shading. The data in Annex 6-2 also show that only very few fruit trees were used as building material by more than 10% of the farmers interviewed. The data in Table 6-1 and Annex 6-2 also suggest that practically only *Bauhinia thoningii* is regarded as possessing soil improving properties.

The question arises whether results from the previous discussion, particularly the findings from Lilongwe ADD concerning the quantitative composition of trees on croplands can be generalized for Malawi. In the first instance, it has to be taken into account that different

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[13] According to Munthali (1991: 95-97), who has constructed a seasonal profile of feed supply and demand for the national livestock population in 1987, there is an acute shortage of feed prior to the crop harvest in the months of May and June. During this period leaves may be used, but that would require active collection of leaves because livestock is only allowed to graze in the fields during the dry post-harvest season when most of the feed requirements are met from crop residues. Whether leaves support the feeding of livestock during this period of severe supply shortages is uncertain because their is no information available about such management practices other than for *Leucaena,* the dried leaves of which are widely used in Malawi for the fattening of cattle. During the dry season when the quality of feedstock is declining, the consumption of leaves, which have a higher crude protein content than grasses, browse and crop residues, have a compounding effect on the digestibility of the other sources of feed. This benefit may be a particular reason for the utilization of leaves from leguminous trees. Perhaps the observation, which was mentioned above, that the absence of management practices to utilize leaves as manure is an indication that this may be done deliberately, at least during the dry season, when livestock feeding mainly relies on crop residues.

[14] Indigenous tree species which were found to be planted by farmers (Maghembe & Seyani 1991: 26) were *Annona senegalensis, Azanza garckeana, Uapaca kirkiana, Rothmania engleri* and *Uapaca Nitida.* Judged by the data shown in Table 6-1, the former three trees seem to be primarily planted on account of their fruit supply, while the fourth appears to be valued for several uses.

silvicultural conditions exist in Malawi which exert an influence on the natural composition of tree species in other areas. However, without stretching the interpretation of available data too far, it appears justified to draw several broad conclusions.

Since mango trees are ubiquitous in the farming landscape of all major regions in Malawi, it appears that their relative importance in other regions may not differ significantly from the estimates for Lilongwe ADD. The species from Table 6-1, which were reported to be used in at least five districts, coincide with five of the 15 quantitatively most important species found in Lilongwe ADD. Combined, these five species represent about 47% of all trees found on croplands. This provides some circumstantial evidence that a limited number of tree species may also make up a fairly high percentage of trees on farms in other districts.

Virtually all of the indigenous fruit trees are MPTs, particularly the quantitatively most important species *Bauhinia thoningii* and *Azanza garckeana*, while most of the other species appear to be primarily valued for their fruits as food or income supplement. Of the indigenous fruit trees which are known to be planted, only the species *Azanza garckeana* had a significant share of trees found on croplands. Thus it may be concluded that a major proportion of indigenous fruit trees and about 50% of the trees found in Lilongwe ADD were retained on farms.

6.2.1.2.2 Planting of trees on farms

Based on comprehensive species trials which were conducted in Malawi between 1978 and 1981, several species were selected for promotion in the FWEP (Sitaubi 1991: 55). However, as mentioned before, only seedlings for a limited number of species and mainly for *Eucalyptus* species were supplied by government-operated nurseries. The discussion above has shown that *Eucalyptus* species were found in farm trials as having adverse affects on crop yields which started to materialize only after three years. This makes these species more likely to be planted on farm boundaries or in separate woodlots. Similar experiences of losses in agricultural production after two to three years as a result of planting *Eucalyptus* species on farm boundaries were reported for Haryana (India) in Saxena (1992: 424). Even though many Indian foresters came to the conclusion that root crop competition would not cause loss of agricultural production, a result which was confirmed by a World Bank evaluation, agricultural losses of 8.2% were found by Ahmed (1989) after three years, increasing to about 49% after ten years. In line with the findings of other researchers, Saxena (1992: 424) also found in four villages in northwestern India that crop losses due to boundary planting occurred up to 10 meters from the treeline.

The majority of smallholders were shown in Chapter 5 to employ intercropping practices as a strategy to spread labour requirements and to cushion production risks under conditions of diminishing cropland availability for fallows. Such land-use systems are generally not advantageous for the introduction of trees competing with crops. The existing trend of land fragmentation had an in-built tendency both to diminish further the cropland available for planting trees, particularly in the form of woodlots, and, under conditions of more severe land constraints, to even squeeze trees out of croplands. Thus, there was no reason to assume that these land-use dynamics were not relevant for the design of an intervention strategy in terms of the selection of species and planting configurations. Consequently, the emphasis on *Eucalyptus* species, which are normally grown in blocks, implied a bias towards better-off farmers which are less land constrained. The deliberate targeting of larger farmers in the early stages of implementing a farm forestry or agroforestry programme may be justified by the finding of Verma (1991: 330), who concluded, from the experiences gained from the implementation of such programmes in the State of Gujarat (India), that 'any new technology generally tends to be absorbed by the larger farmers'. However, even if there exists such a pattern of adoption which may be generally explained by the risk attitudes and risk bearing capacity of farmers, this does not imply *per se* that Eucalyptus trees should have been promoted.

A second important element of the FWEP, that is the provision of subsidized seedlings, was based on the simple assumption that farmers needed this incentive to grow trees. This approach was not self-evident in view of the finding by Poulson (1981: 13) who had observed that farmers already raised their own seedlings but employed a distinctly different technique than the one officially promoted. This raises the question why, in addition to the promotion of tested tree technologies and improved seeds, the rationale and adequacy of existing practices was not more vigorously researched and explored as an additional option for the production of seedlings? Distributing subsidized seedlings also had the important drawback of providing a disincentive for farmers to establish their own nurseries.

The Rural Energy Surveys which were conducted in 1981 and 1985[15] shed some light on these and other issues and assumptions which were underlying the FWEP. The first Rural Energy Survey which was conducted (DOF 1981: 15-17) explored several relationships which were helpful for policy formulation. An important finding was that there was no significant relationship between tree planting and indicators of fuelwood scarcity such as 'ease of collection' or 'collection distances'. Moreover, the ranking of intended uses of trees which were planted during the previous year showed that most farmers were planting to obtain building poles (56%), fruit (41%) and fuelwood (36%).[16] The authors of the survey

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[15] Both surveys which were quoted in Chapter 5 included the analysis of farmers' motivations and constraints concerning the planting of trees.

[16] Multiple responses were allowed in the survey.

report concluded from these results that the policy emphasis should be on the promotion of trees providing building poles because there are no ready substitutes for poles, while the option remained for farmers to switch to inferior fuels for household energy use. Moreover, even though no data were provided or other sources quoted in the survey as evidence, it was stated, and perhaps just assumed, that a cash incentive to grow polewood was provided by the expansion of rural markets for poles. That pole sized trees from indigenous forests and village forest areas were being heavily exploited was evidenced by studies conducted in the early 1990s (see Chapter 5). However, the statement that commercial pole markets were expanding was unlikely to have been backed by market data.[17] Apparently the World Bank appraisal report of the FWEP ignored this aspect of the survey because it reflected only urban markets as a source of wood demand for trees produced by smallholders. It is remarkable that the fact that many farmers were planting fruit trees was not further considered in the policy conclusions of the survey.

The 1985 Rural Energy Survey found that 29% of smallholders had planted trees. The survey distinguished between the planting of trees by smallholders on the National Tree Planting Day (NTPD) in December and throughout the rest of the year. It should be noted that the NTPD was introduced as a national holiday in 1976 and may be characterized, in addition to its role as a public awareness campaign, as a mass mobilization effort for private and communal tree planting.

Seedlings were supplied either free of charge or for a nominal price of MK0.01 on the NTPD. During the NTPD 61% of the farmers who planted trees used seedlings from government nurseries and 11% from their own nursery. Most of the trees planted were *Eucalyptus* species (42%) and *Gmelina arborea* (20%), as seedlings were mainly available for these species.[18] Of the 29% of the smallholders who had planted trees, 8.6, 17.2 and 2.9% planted only on the NTPD, during the rest of the year, and during both periods respectively. With regard to the composition of tree species planted during other times of the year, the survey found a large difference to the results for the NTPD. The share of fruit trees was 36.7% of the total, while *Eucalyptus* species and *Gmelina arborea* were planted only by 20.7 and 11.7% of the smallholders. Using the percentage of farmers planting during these two periods, the weighted average percentage of trees planted by species was about

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17 That relative prices of poles are generally higher than for comparable volumes of fuelwood in Malawi can be gauged from the demand characteristics in Malawi and indications for the depletion of pole sized material in forests and village forest areas. However, it is unlikely that representative data for market prices of poles were available in 1984/85 because the author was unable to identify a single source containing such data for this period.

18 Major other species which were reported to have been planted on the NTPD (DOF 1985: 45) were fruit trees (6.9%), Cassia siamea (6.9%) and combinations of major tree species (13.6%).

28.0, 14.5 and 27.5% of the total for *Eucalyptus* species, *Gmelina arborea* and fruit trees respectively.

Because a significant higher percentage of trees is likely to have been planted during the rest of the year compared to the NTPD, the total share of *Eucalyptus* species and of *Gmelina arborea* which was planted during the whole year was even lower than the weighted figures and, correspondingly, the share of fruit trees was higher. Overall the survey results should be treated with caution because the high public and political profile of the NTPD may have led to exaggerated claims by farmers.[19]

Results concerning the anticipated uses of trees planted during NTPD showed that only 2.8% of the households reported that trees were solely used for fuelwood. The most important single use was poles (21.8%), followed by combinations of uses such as for poles and fuelwood (18.1%) and for poles, fuelwood and sales (17.2%). These data suggest that production of poles was the most important consideration for planting. Anticipated uses of trees planted during other times of the year showed that only 1.9% of the respondents were planting for fuelwood as the main purpose. The most important single use was the production of fruit (19.1%) and for 'fruit and sale' (15.1%). These data clearly reflect that fuelwood production was not a prime motive for tree planting. Rather planting for poles, fruit and multiple uses were the most important considerations.

Another interesting finding of the survey relates to the sources of seedlings which were planted during other times of the year. Compared to the NTPD, only 13.4% of the seedlings were bought from government nurseries. This large absolute drop of 48% can only be partly explained by the impact of the free issuance of seedlings during NTPD because this accounts only for half of the total percentage decline. Rather, it appears that farmers' preference for tree species *not supplied* by the Forestry Department was the more important factor. This is particularly reflected in a considerably higher reliance on seedlings from own nurseries (17.5%), but also in the approximately threefold increased reliance on seedlings from self-sown seedlings (30.3%), from friends and relatives (27.8%) as well as the apparent private sale of seedlings. An additional factor supporting this conclusion was the survey's finding that no statistically significant relationship existed between both the source and cost of seedlings planted, and the source of seedlings and the distance to the next government nursery.

The survey also showed that no single constraint to tree planting was dominant for those

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[19] This caution has been voiced by the authors of the 1985 Malawi Rural Energy Survey (DOF 1985: 15) who suspect that some farmers may have only been participating nominally in tree planting activities on the NTPD.

71% of the smallholders who did not plant trees. Lack of silvicultural knowledge impeded only 6.5% of the farmers. Lack of money, land, seedlings and time were quoted by 11.8, 14.6, 17.5 and 16.4% of the farmers respectively as major constraints to tree planting. The low percentage of farmers quoting the lack of money as a major constraint casts some doubt about the principal role of subsidies to promote smallholder tree planting.

At the district level deviations from the national average percentage of farmers quoting the lack of seedlings as a major constraint were minor, except for a few outliers. Government nurseries had operated below capacity levels due to a lack of demand and it is unlikely that the lack of seedlings had been due to seedling supply constraints from government nurseries. Rather, this suggests supply shortages of seedlings of other preferred species. It is worthwhile to note, that the smallholder tree planting survey (DOF 1982) had previously found that the availability of seedlings was not an important constraint for tree planting. Given these results, it appears that the necessity to provide government-subsidized seedlings was over emphasized and reflected more the perceived requirements for implementing the woodlot policy approach rather than the preferences of smallholders.

With regard to the motivations of farmers to plant trees on croplands, the authors of the 1985 Malawi Rural Energy Survey (DOF 1985: 70) concluded that: `All surveys including this one consistently indicate that many people are disinterested in planting trees'. This statement seems to be supported by the fact that only 29% of farmers planted trees in 1985 and that this figure remained constant since 1981. However, it is arguable whether this share of 29% may indeed be interpreted as disinterest of farmers, because only 18% of them explicitly mentioned that they were disinterested in planting trees (DOF 1985: 65), while the remainder mentioned the above mentioned constraints as reasons for not planting trees. Even though the survey`s objective was to gain insights into the performance of the FWEP, it is remarkable that the identified constraints were not further considered in the policy conclusions drawn from the survey.

6.2.1.3 Farm forestry policy changes within the Second Wood Energy Project and the Wood Energy Component of the Energy I Project

As mentioned in the beginning of Section 6.2, the main reasons why tree planting among farmers was regarded as being unpopular was attributed by the World Bank to the unattractive economic returns from trees due to low producer prices and wood supplies from customary land. The finding of the 1985 Rural Energy Survey that a considerable portion of the trees which were planted were self-raised and consisted of species which were not supplied by government nurseries, was considered in the SWEP by integrating multi-purpose trees into the establishment of demonstration woodlots (World Bank 1986:

15). However, the introduction of MPTs by government nurseries was only planned in the context of the WEC of the Energy I project. The notion in the World Bank assessment that farmers were reluctant to purchase seedlings on account of the reasons mentioned above was only a half-truth, simply because farmers were using a large percentage of seedlings which were not supplied by government nurseries.

The three key elements of the changed policy approach which was proposed by the World Bank (1986: 15) focused on the conditions and subsidies which were assumed to be required to make tree planting financially attractive relative to both crops (particularly on marginal agricultural land) and firewood collection.

The net benefits which were accounted for in the World Bank one ha woodlot production model were the revenues of firewood sales at various stumpage rate levels less the cost of crop production foregone on marginal agricultural land, assuming that seedlings were provided at the subsidized cost of MK0.01 per seedling. The level of additional production subsidies required to equate returns per ha from tree planting to returns from agricultural crops was dependent on the assumed stumpage fee (producer price) at the farm gate. The first important element of the changed policy approach involved a cash bonus of MK0.05 payable for each surviving tree after two years. This cash payment equated returns from woodlots and crops at a stumpage fee of MK4.5 per solid m^3. In order to ensure that this producer price could be reached after six years, when the first tree crop was to be harvested, the implementation of two important complementary measures was necessary.

The first measure was to annually increase the 1986 stumpage rate of fuelwood by 15% per year in real terms until 1996. The prime objective of this measure, which was agreed upon by the GOM, was to avoid price shocks in urban retail woodfuel markets by increasing the stumpage fee of fuelwood from government plantations gradually. The second objective was to adjust the stumpage fee to cost recovery levels. Official gazetted prices for fuelwood amounted to MK2.8 per stacked m^3 which were considerably below the stumpage fee required to cover an estimated replacement cost of MK10.7 per stacked m^3 in 1986 prices (World Bank 1986: 59). Slowing down the unabated deforestation of customary forests and achieving the payment of stumpage rates (producer prices) at the farm gate, which would make production of wood attractive as an alternative cash crop, could only be reasonably expected to materialize provided that the supply of lower cost woodfuels from customary land was effectively controlled. As discussed further below, this measure was a necessary but not sufficient condition for the implementation of this policy approach. This, in turn, required enforcement of the payment of stumpage fees for all woodfuels which were produced from forests on customary land. Specific measures that were introduced to achieve this objective were the strengthening of revenue collection from commercial wood users, confiscation of illegally obtained forest produce through a system of Area Control Units in rural areas and the establishment of control posts at major transport roads leading into selected urban centres.

From a conceptual point of view, the general objective of the proposed policy approach was to remove the existing price distortions in the woodfuel market which implied that full economic costs were not reflected in market prices and thus final consumers were not provided with the right price signals to conserve energy. Because this policy package had not been tried before in Africa, the World Bank (1986: 40) emphasized that the objectives of the SWEP could not be achieved if the implementation of one of its three major elements failed.

A major source of risk was seen in the possible development of antagonistic behaviour of the rural population in response to revenue collection and woodfuel confiscation activities. In order to mitigate this risk, forest guards were to provide advice to farmers in forestry matters. Conceptually this expectation was by itself risky insofar as it did not take into account the possibility that the sub-group of smallholders which was likely to participate in the bonus scheme might diverge considerably from the group of smallholders which was relying on the sale of woodfuels and other forest produce. The discussion in Chapter 4 has shown that a considerable percentage of food-deficit households were involved in the collection and sale of fuelwood as a survival strategy. Since there was also evidence that the returns from this activity were likely to be lower compared to other income generating activities, it is reasonable to assume that the poorer strata of the food-deficit households were engaged in this survival strategy. Thus unless there were good reasons to assume that the poorer farmers would be able to get involved in tree planting and the incentive scheme, it was optimistic to expect that the alienation of smallholders from foresters could be contained. An additional aspect of this theme was that the need to generate income immediately may still outweigh the beneficial aspects of receiving free silvicultural advice on growing trees for farmers. As discussed below, there were instead good reasons for assuming that smaller farmers were less likely to participate in tree planting given the design of the policy package.

Implementation of stumpage rate increases

The gazetted stumpage fee represented a share of about 7.0% of the retail fuelwood prices in the major fuelwood markets in Blantyre and Lilongwe in 1986. Therefore fears of major price impacts on fuelwood prices, if implemented gradually, were not warranted. Instead of implementing the stumpage fee schedule as agreed, the government delayed the planned increase in 1987 to April 1988, when a minor increase to MK3.15 per stacked m^3 took place, and then increased the stumpage fee drastically in November 1990 to MK15 per stacked m^3 and in October 1992 to MK30 per stacked m^3. Prior to the increase in 1988, the stumpage fee had declined to about 4.0% of the fuelwood retail price in both cities and continued to decline further until October 1990 to about 2.5 to 3.0%.[20] The drastic increase by the end of 1990 raised its share of the fuelwood price in both cities to an average of 13% between November 1990 and March 1991. Thus compared to 1986, the stumpage fee had been doubled in 1991, but still reached only 60.5% of the scheduled real price increase[21] until 1991. With the doubling of the stumpage price in 1992, the real stumpage rate approximately matched the real price level which had been scheduled for 1992.

The main reason why this erratic pattern of stumpage price increases was adopted is related to the contradictory woodfuel pricing objectives of the GOM. In addition to encouraging the private growing of trees, the government also pursued the objective of limiting the impact of stumpage fee increases on urban fuelwood prices. Because stumpage fees were considered as being the key in controlling fuelwood prices in urban markets, the postponement of major stumpage fee increases were aimed at containing their impact on woodfuel prices. Although production from *Eucalyptus* woodlots, which were established in 1987, would only start to supply the market after a gestation time of about six years, that is in 1993, the main drawback of the delayed stumpage fee increases was that farmers were not provided with the right price signals. Continuous price increases were necessary to signal that the government was committed to implement its envisaged pricing policy. Without the necessary adjustments of fuelwood prices, smallholder woodlot production became non-viable in terms of the smallholder woodlot production model from which the required fuelwood price increases were derived.

Effectiveness and consequences of woodfuel and forest produce confiscation measures

The fuelwood control system was set up in 1990/91 when ten roadblocks were operational. As shown in Table 6-2, the control system had a rather poor performance. In the first year of the scheme, about 3 000 tonnes of fuelwood and 100 tonnes of charcoal were confiscated. In

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[20] The percentages were calculated from monthly retail fuelwood prices data which are collected by the National Statistics Office in the major cities of Blantyre, Lilongwe, Zomba and Mzuzu. Nominal fuelwood prices and stumpage rates were deflated using the consumer price index for low-income households in both cities which is published in the Monthly Statistical Bulletin of the NSO.

[21] By March 1991, the scheduled stumpage fee should have been MK11.08 in real terms according to the following formula (MK2.7 (per stacked m^3)/0.49 (factor to convert price per stacked m^3 to kg) times 1.15^5 (15% real price increase for the period 1986 to 1991). The actual stumpage fee was MK6.7 per tonne of fuelwood, or 60.5% of the scheduled stumpage fee.

rural areas a substantial portion of the fuelwood confiscated consisted of headloads, while the confiscation of other loads, which mainly refer to fuelwood stacked at roadsides for sale, was about twice as high. Confiscation of fuelwood dropped by about 60% in the next year, especially at roadblocks, despite the increase of the number of roadblocks from ten to twelve, while the amount of confiscated charcoal increased only marginally. Figures for 1992/93 show a tripling of confiscated fuelwood which was almost entirely due to the confiscation of headloads in rural areas. This increase is likely to be grossly overestimated or has been wrongly reported because about 86% of the total quantity was confiscated in a single district (Mangochi), where confiscation was reported to have increased from 10 headloads in the previous year to 135 500 headloads. This figure is not believable both relative to changes in other districts and given the fact that the DOF reported the problem of inadequate patrols in rural areas due to funding constraints during 1992/93 (DOF 1993: 4).

TABLE 6-2 Confiscation of woodfuels in Malawi: 1990/91 - 1992/93 (tonnes)

Year	*1990/91*		*1991/92*		*1992/93*	
	Fuelwood	*Charcoal*	*Fuelwood*	*Charcoal*	*Fuelwood*	*Charcoal*
Rural areas	1 771	90	968	122	3 410	61
-Headloads	530		43		3 145	
-Other loads	1 242		925		265	
Roadblocks	1 272	13	317	15	124	8
-Headloads	30		11		0	
-Other loads	1 242		305		10	
Total	**3 043**	**103**	**1 284**	**137**	**3 534**	**68**

Source: 1990/91data from DOF (1991b: 4); 1991/92 data from DOF (1992: 2-3); 1992/93 data from DOF (1993: Tables 1 & 2)

Total charcoal confiscation in 1992/93 was further reduced to 68 tonnes. Except for the uncertainty associated with the data for the confiscation of fuelwood in 1992/93, the data in Table 6-2 show a downward trend in the collection record for all items. Whether this reflected the trend of fuelwood traders and transporters increasingly bypassing the system is however difficult to discern because the data for 1992/93 included only 12 districts as compared to 24 districts for the two previous years.

Notwithstanding these distortions in the data, the confiscation scheme can be regarded as a complete failure in view of the fact that confiscated quantities made up only a tiny fraction of the estimated charcoal and fuelwood consumption in the major urban centres. Therefore claims which were made, by the DOF (1990a: 5) that the control measures were progressing remarkably well are not supported by actual results.

Given the social circumstances of the rural population in Malawi, French (1986) had questioned that any control scheme could work effectively. The apparent ineffectiveness of the policing measures was partly explained by the DOF by the lack of funds to undertake patrols and staff shortages (DOF 1993: 6). Whether the removal of these constraints or even much intensified efforts would have produced considerably better results remains an open question, but is doubtful on empirical grounds. Except for Rwanda, where illegal charcoal production from open access woodlands has been virtually eliminated within a few months in 1986, there is little evidence that such schemes have been successful (Leach & Mearns 1988a: 221-28). The reason why the control of the charcoal market in Rwanda has been successful is due to specific favourable conditions which are not representative for Malawi and for many other countries. The most important factor appears to have been that, after the Bugesera region, which was being mined for charcoal, was closed by the government for charcoal production, charcoal makers could only turn to remaining wood resources which were either privately owned or controlled by communities (Hosier & Milukas 1992: 15). A second important factor was that the closure of the region, which had already been heavily depleted, was actively supported by local communities.

Because of the complexity of the social, economic and logistical factors which are involved in the woodfuel trade, it is difficult to ascertain which factors were mainly responsible for the failure of the woodfuel policing measures. One reason why the scheme has not worked in Malawi was that there was collusion between forest guards, policemen and organized woodfuel, and charcoal traders.[22] Establishing such a control scheme is always associated with the problem that enforcers engage in rent-seeking. Thus it is not surprising that the system had leakages particularly in view of the fact that the enforcement personnel belong to the bottom income category of generally lowly paid civil servants in Malawi. A second social factor which has to be considered is that the policing forces are well aware of the importance of income generation from trading small quantities of woodfuels and other forest produce for poor smallholders who are struggling to survive. This element of social solidarity is prevalent in Malawi society and is likely to have inclined policing personnel to enforce woodfuel restrictions moderately or selectively. A third, though probably less important factor which seemed to have weakened the effectiveness of enforcing the confiscation of charcoal in the field, was threats and physical assaults on forest personnel by charcoal producers, leading to more relaxed controls (Luhanga 1993: 10). A fourth factor, which has to be taken into account, is that controlling the illegal woodfuel trade is a logistically challenging task, because there are everywhere small country roads leading into the major urban cities where transporters and small woodfuel dealers were operating at

[22] Regular fuel trips of the author in Malawi showed, for example, that large quantities of charcoal were transported on open and closed trucks through one of the major forest produce checkpoints, that is Kamuzu bridge, which leads to the largest woodfuel consumption centre in the country (Blantyre), without being checked.

night. These problems in the supply chain of woodfuels might be potentially solved by increased policing efforts. However, it is doubtful whether the associated administrative costs could be borne on a sustainable basis.

Data on the confiscation of other forest produce for 1992/93 (DOF 1993: Table 2) show that thousands of baskets and mats were confiscated in the rural areas. In view of the fact that utilization of raw material to produce these and other products has little impact on forest degradation, but represents a complementary source of income, this aspect of the confiscation policy appears to have been implemented too rigidly. The most important adverse result of the confiscation policy was that policing activities have lead to tremendous antagonism between local people and foresters. According to Luhanga (1993: 9), forest extension activities were impeded in some cases to such an extent that it became impossible to carry out effective extension work. This alienation may have been mainly or entirely due to the confiscation policy. However, it has to be taken into account that other concurrent developments, including the alienation of customary land and thus restricted access to forest resources, cases of corruptive practices by village headmen concerning the granting of fuelwood cutting rights to tobacco estates and the participation of influential businessmen in the organized woodfuel trade (Luhanga 1993: 13-14) may also have contributed to, or even compounded, the negative sentiment that foresters were adopting a biased approach in woodfuel matters.

This outcome suggests that assigning foresters the dual role of being extension workers and policemen is unsustainable. There is now a broad consensus among foresters in Malawi that this dual role has severe repercussions for forestry extension activities and is therefore likely to be abandoned.

Implementation and effectiveness of the bonus scheme

Initially the incentive payment scheme was designed to provide bonus payments to those farmers who had either purchased 300 seedlings or opted for the production of their own seedlings for which the forestry extension service issued seedling production packages free of charge (World Bank 1986: 24). The bonus payment scheme provided for the payment of MK0.05 per tree which had survived two years after registration subject to a minimum of 100 trees. The World Bank assumed in its woodlot model a spacing of two by two meters or a total of 2 500 trees per ha. To encourage particularly small and medium size farmers to plant trees as a cash crop, it was planned that the forestry extension service would focus on these two groups. The planting of 300 seedlings at the recommended spacing rate implied a minimum requirement of 0.12ha. Relative to the average ha size of 1.2ha for farmers in the size group of 1.0 to 1.5ha, this would have required the use of approximately 10% of the total farm area for the establishment of a woodlot, taking into account that virtually no fallow land could be expected to be available for this farm size group.

In connection with the woodlot approach, it was also assumed that farmers would establish woodlots on marginal land on their farms. This assumption was realistic in the sense that this was the only type of land where farmers would potentially establish woodlots because of its lower opportunity costs.[23] However, because reliable land quality data were not available when the policy approach was formulated, it was also not clear whether sufficient marginal land was indeed available on farms to host woodlots.

In view of the land-use data from Table 4-2, the scheme implied that medium size farmers were expected to allocate about 60% of the land, which was not required to produce food crops, to tree cultivation. As shown in Annex 4-5, the returns for cash crops other than composite maize and cassava, which were used by the World Bank as the basis to determine the value of benefits foregone, are higher than for the latter two crops. This suggests that the foregone benefits from cash crops were also likely to be higher than assumed. The latter consideration applies particularly to larger farmers who are able to bear more risk and tend to have the financial resources to become involved in cash crops requiring higher initial outlays. Therefore, it may have been more appropriate to foresee a higher bonus payment as a cushion against this potential effect.

Farmers with smaller average holding sizes have less land available which could be allocated to establish a woodlot of the minimum size required to participate in the bonus scheme. In addition to this physical constraint, the higher risk adversity paired with their concern for food security strongly discourages their involvement in perennial wood crop production. The latter suggests that even a fairly high-income premium for the production of wood may not be sufficient to induce these smallholders to plant trees in woodlots.

The World Bank assessment mentioned that the discount rate of 25% which was used in their calculations may be higher for some farmers. The discussion in Chapter 4 has shown that it is likely that subjective discount rates are correlated with holding size. However, it cannot be excluded that there exists a ratchet effect in the sense that farmers who are able to produce a food surplus have considerably lower subjective discount rates compared to poor households. Although no quantitative information is available about subjective discount rates of small-holders by farm size, available evidence suggests that the uniform discount rate assumption of 25% was likely to have been on the low side for small size farmers. In

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[23] French (1986: 534) showed in a simple calculation, using hybrid maize to measure the opportunity costs of land, that the use of non-marginal land for wood production would imply considerable income losses.

order to capture this uncertainty, it would have been advisable to consider higher bonus payments for more risk-averse farmers.

In summary, for farmers with different landholding sizes uncertainties existed which would have warranted higher incentive payments than those planned for, albeit for different reasons.

An additional assumption of the woodlot model used by the World Bank was that farmers were able to achieve mean annual increments of 12 m^3 per ha. The latter figure was based on the MAI achieved in the government forest plantation in Lilongwe. As the discussion in Chapter 4 has shown, this plantation was performing much better compared to the average MAI of government plantations. This yield figure for smallholder woodlots was rather optimistic taking into account that the DOF had already accumulated considerable experience in growing *Eucalyptus* on plantations, while farmers facing a new tree planting technology could not be realistically expected to achieve a comparable performance easily. Moreover there was some principal uncertainty about the performance of *Eucalyptus* species because they were known to be prone to termite attacks (Poulson 1981: 35; DOF 1985: 68).

No reliable direct information is available about actual MAIs achieved by farmers who had established woodlots. Demonstration woodlots which were established by farmers in the context of the WEC1 were reported to be poorly managed, with weeding in particular not being carried out at all (DOF 1991b: 7). This indication of lack of management is not sufficient to draw conclusions about the performance of woodlots established on farms. However, it has to be considered that the tree survival rate is a key parameter influencing yield. More recent woodfuel policy programmes have assumed more conservative MAI assumptions for pure *Eucalyptus* and *Cassia siamea* smallholder woodlots of 7 and 5m^3 respectively, based on survival rates which were estimated by district foresters and the DOF at 40% (LFP 1993, Annex 1: 23).

Since farmers were only eligible for bonus payments after two years, there was also little flexibility with regard to the possibility of sequencing tree planting. Trees need to be established in Malawi well in advance of the end of the wet season in mid-March. Therefore planting has to take place during the months of November through January when labour peaks occur in the agricultural calendar and when food deficits are already severe. All these factors tend to severely constrain the adoption of the woodlot model by small and medium-sized farmers.

Given the land constraints on small and medium size farms, it could not be excluded that limited land availability would encourage farmers to plant trees at much higher densities, thus compromising yield for short-term financial gains. Within the calculation model of the Bank this possible response would have implied raising the incentive payment because otherwise the equation of returns from woodlots and agricultural production foregone are unlikely to be matched, given the impact of closer spacing on yield.

Overall, many of the key assumptions made in the woodlot model which was used in the assessment of the competitiveness of wood production relative to the production of cash crops on marginal land, appear to have been partly rather optimistic and partly conjectural. As a consequence, it appears, for example, that the initial bonus payment which was derived from the assumptions made in the woodlot model was too low.

The tree planting incentive scheme commenced in November 1987 in nine priority districts. The scheme was judged by Armitage (1988: 8) to be 'enthusiastically accepted' by farmers who registered 3.86 million seedlings for the incentive payment in 1987/88. The number of registered trees which were paid for in 1990 amounted to 1.1 million (DOF 1990a: 6). This suggests a survival rate of trees of 28.5%, not considering that surviving trees below the threshold of 100 trees were not taken into consideration.[24] However, such a low survival rate appears to be unreasonably low.

Annex 6-3 shows the average number of trees and the corresponding average land area which was planted with trees by district in 1988/89 and 1989/90. These figures are based on the number of trees for which the bonus was paid, assuming a tree survival rate of 70%.[25] The total number of farmers which were eligible for bonus payments increased by 27.7% to 9,996 farmers in 1992. Increases were moderate in the Northern region (5.8%), but considerably higher in the Southern (18.1%) and particularly in the Central region (57.2%). Data concerning the size distribution of woodlots and the total farm area covered by woodlots by farm size are not available. The average area planted in the Northern, Central and Southern regions was calculated to amount to 0.19, 0.32 and 0.26ha respectively in 1988/90, increasing in all regions by 5 to 10% during the next season. These data suggest that mainly farmers with larger holding sizes must have participated in the scheme because the possibility that the data may include many small farmers with a surviving number of

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[24] It should be noted that the figure for the number of trees which were paid for in 1990 was interpreted by Mhango (1991: 9) as being related to those trees which were surviving.

[25] Mhango (1991: 7), who had been involved in the implementation of rural and urban woodfuel programmes as a staff member of the Energy Studies Unit, reported survival rates of 76% for trees planted during the National Tree Planting Day in 1987 and survival rates in the same range for those planted during the 1989/90 season on the same occasion. Relative to the estimated survival rates associated with farm forestry by the DOF (40%), Mhango's figures are on the high side. When the lower estimate is used, the initial area allocated to woodlots would be correspondingly higher.

trees close to the minimum requirement, implies unreasonable high figures for the area planted by a small number of tree growers. When tree survival rates are assumed which are closer to the more representative estimate of the DOF of 40%, it becomes even more unlikely that a substantial number of smaller farmers have participated. Even if trees were planted at higher densities, this conclusion is not materially changed.

The survey by Nyirongo and Mhango (1993) of households in the nine priority districts in which the bonus scheme was introduced showed that 30% of all households in the sample had participated in the scheme. This figure, which ranged from 15 to 50% on the district level, appears to be unreasonably high because the total number of farmers in all districts of Malawi which received payments (see Annex 6-3) in 1992 was approximately 0.5% of the total number of smallholder households.[26] Of the 71% of the households who were aware of the scheme, 67% knew about it from forestry extension workers. Among the farmers who did not participate were a substantial share (45%) who were either not interested or did not achieve the minimum of 100 trees. It is also interesting to note that only 1% were discouraged to participate because of fears that the government would take possession of the trees. The most important finding of the survey was, however, that 89% of the farmers who participated in the bonus scheme were not planting trees because of the scheme. From this result no conclusion can be drawn as to whether the amount of the bonus payment which was kept unchanged since its inception was finally too low or too high. The main conclusion is that the cash incentive was largely irrelevant for the decision to plant trees. In addition to being rather ineffective in encouraging farmers to plant trees, the scheme was also burdened with high administrative costs which were estimated to have amounted to MK0.13 for every seedling payment (Dewees 1995: 1098). To this need to be added the high production costs of seedlings raised in government-run nurseries which were estimated to range between MK0.15 to MK0.20.[27]

Fuelwood markets and price incentives

The rationale of the farm forestry approach was that farmers would grow fuelwood for their own needs and for the market. The results from surveys and other information which was drawn into the analysis has shown that the prime motivation of farmers was not to grow trees for their own consumption, but for multiple benefits, and particularly for products such as poles and fruit. As the analysis in Chapter 5 has shown, there was no evidence that a significant rural fuelwood market existed at the time when the new policy package was

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[26] Close to 10 000 farmers of about 1.7 million farm households received payments in 1992.

[27] This estimate was provided by J. Luhanga, Department of Forestry, Lilongwe, in a private discussion in January 1994.

designed and implemented. The limited employment opportunities during the agricultural off-season implied that the opportunity costs of labour during this period was close to zero. In addition, the relatively high consumption level of fuelwood in rural households suggested that physical scarcity of wood could be accommodated by energy saving measures. These conditions suggested that it was unlikely that a major commoditization of fuelwood in rural areas could be expected to happen soon. This situation should be contrasted with the objective of the policy package that smallholders were expected to produce fuelwood for the market.

Notwithstanding the problem that the level of producer prices at the farm gate, which was required to make production of wood financially attractive to farmers, would only materialize if the payment of stumpage fees could be effectively enforced, there was uncertainty whether producer prices could effectively be collected at the farm gate. A major flaw in the policy design was that in 1986/87, there was no comprehensive information available about how urban fuelwood markets and the entire downstream supply chain, including small traders, wholesale traders, transporters and suppliers worked. This implied that little was known about sources of supply and transport means, transport distances and other factors determining the efficiency and competitive structure of the woodfuel market, including barriers to entry in the market segments, profit margins and rents. The implicit assumption of the policy design was that the woodfuel market was fairly competitive. A competitive market structure requires full information for the farmers about the price structure of the market in order to determine their prices at the farm gate. For example, Hosier and Milukas (1992: 17) found in Rwanda, that charcoal producers had no clear idea about the market value of the wood they were using and were therefore forced to act as price-takers. Without reliable information about the competitive structure of the woodfuel market, the possibility could not be excluded that producers would not obtain the assumed stumpage fee because wood buyers/transporters may be able to exercise market power. Similar evidence is reported by Saxena (1992: 424) from India, where weak information of farmers about buyers, prices and government rules were found to be responsible for rents collected by traders buying wood directly from farmers.

Opinions about the competitiveness of woodfuel markets in Africa vary. Hosier and Milukas (1992: 20) who have studied such markets, for example, in Somalia and Rwanda, come to the conclusion that 'wood markets appear to operate competitively throughout most of Africa'. However, Leach and Mearns (1988a: 206-219) have shown that considerable efficiency improvements can be achieved in African woodfuel markets. Examples of the development of market structures in Tanzania, Ouagadougou (Burkina Faso) and in Sudan show that there is still scope for cost-efficiency improvements through enhanced market competition (Tanzania) and that considerable efficiency increases materialized in the fuelwood market of Ouagadougou over a period of nine years, resulting both in lower urban retail and higher producer prices in real terms. The interesting aspect of this finding is that where considerable inefficiencies exist in woodfuel markets, measures to enhance competition may serve the objective of creating incentives for wood production and to control urban woodfuel prices better than costly and largely ineffective measures to police the woodfuel supply chains.

Except for the uncertain impact of the market structure on producer prices, the woodfuel policy in Malawi which was implemented under the SWEP, was not backed by an analysis of the woodfuel market structure for major urban cities. A common issue in the analysis of woodfuel markets is to analyze the cost build-up in the woodfuel supply chain in order to identify whether segments exist in the supply chain where cost-efficiencies can be realized through appropriate measures. The first study in Malawi which addressed aspects of the efficiency of the urban charcoal market, came to the conclusion that the sharp increase in the retail charcoal price in the Blantyre market in 1987 did not reflect a pass-through of higher production costs, that is higher stumpage fees for the feedstock, but 'windfall profits and scarcity premiums captured by wholesalers and retailers' (IPC 1987: 15). However, no data or calculations were shown to support this conclusion. A market price study for fuelwood and poles was undertaken in 1988 in connection with the Blantyre Fuelwood City Project in eighteen markets in the cities of Zomba and Blantyre. The study identified major inefficiencies in the transport and marketing of fuelwood and concluded that both transporters and fuelwood traders were making substantial profits, particularly the dealers (FORINDECO 1989: 16). The study also showed that there was little evidence of vertical integration in the fuelwood market.

The discussion in Chapter 4 has shown that wood produced on government plantations was fairly expensive on account of technical inefficiencies and that tea estates were by far the most efficient producers of fuelwood. The administered stumpage rate, particularly the steep increase to MK30.0 per stacked m^3 in 1992 was oriented towards the recovery of the costs of producing fuelwood on government plantations. Thus the stumpage rate did not reflect the replacement costs of efficient fuelwood producers. Moreover, the problem that a uniform stumpage rate was administered throughout the country entailed that substantial rents might be captured in the supply system. The comparison of actual urban retail market prices of fuelwood and retail prices which were derived from cost estimates of efficient financial supply costs by deLucia & Associates (1992: 3-15), showed that the former were about 45% higher than the latter. In addition to technical inefficiencies in the production of fuelwood, it was concluded that significant rents were captured in the supply chain.

However, although capital constraints were found to be a likely source of limiting entry at the wholesale and retail level, suggesting that traders are likely to capture rents, the available data were insufficient to derive conclusive evidence for this claim. The Urban Household Energy Survey which was conducted in 1990 in the major urban cities of Malawi included a survey of charcoal and firewood traders. The objective of this survey was to establish a picture of the price build-up in the woodfuel markets. However, this objective was not achieved due to time constraints and the lack of vertical integration of transport and marketing activities, particularly for charcoal (see Ng'ong'ola 1991: 115-131), which implied that only limited information could be obtained about the origin of woodfuel supplies.

The origin of supply of fuelwood traded in major urban areas differs significantly. In Blantyre, 65% of the traders purchased their wood from government plantations and reserves, while the corresponding figure in Lilongwe was 45%. Major differences were found between the percentage of woodfuel traders who procured their supplies from various distances. In Blantyre, 60% of the traders got their wood from a distance less than 20km and 85% from a distance less than 40km, while only 5 and 41% of the traders in Lilongwe obtained their wood supply from the same distances. The survey was based on 20 and 22 interviews of traders in Blantyre and Lilongwe respectively. Therefore its results are only of indicative value. If the data for purchases from government sources and the transport distance of fuelwood were representative, the fuelwood market would be even less efficient than suggested by the calculations of deLucia & Associates. This is due to the fact that the stumpage fee in 1990/91 (MK15.0 per stacked m^3) was MK4.0 lower than the assumed production costs of efficient producers by deLucia & Associates and that the assumed transport distance (100km) for woodfuels, which accounted for 25% of the supply costs, was considerably lower for the majority of traders' supplies.

Since the quantification of the most important variables in calculating the average weighted cost of supplies to urban markets is uncertain, no firm conclusions about the distribution of technical and allocative inefficiencies in the fuelwood market structure and price build-up of retail fuelwood price in urban markets can be made. However, the available evidence suggests that efficient retail fuelwood market prices in Blantyre may be even lower than those estimated by deLucia & Associates on account of lower transport distances of fuelwood. Conversely, the inefficiency of the fuelwood market would be even higher.

The main implication of having rather limited information about the efficiency characteristics of the fuelwood markets in Malawi was that the fuelwood policy of the GOM was subject to the risk that inefficiencies in the woodfuel market structure might have impeded the payment of stumpage prices at the farm gate, even if the stumpage fees had been increased as originally planned. One study (World Bank 1992b) has claimed that relatively small stumpage increases have induced fairly large increases in farmer tree planting in Malawi. However, this claim was neither supported by reference to any empirical data in the study nor are other sound data available which could lend support to this view.

Available information from the studies which were carried out in 1987 and 1989 provide indications that there were large inefficiencies in the transport system and that rents were being collected in the fuelwood supply chain. This would have warranted investment in studies to investigate the technical and allocative efficiency of the fuelwood market in more detail and to consider the provision of finance to new market entrants in fuelwood transportation and trading as a stop-gap measure. It is apparent that there has been, in general, a considerable asymmetry in the attention given in Malawi to the analysis of the efficiency of marketing systems of cash crops and wood crops. While the objective of woodfuel supply-side policies was to promote production for urban markets, subject to the assumption that fuelwood and poles were a viable alternative cash crop for farmers, considerable efforts were being made to study and to improve the efficiency of marketing crops, but little attention was given to the analysis of how woodfuel markets function.

That woodfuel marketing issues were indeed important was identified in the survey conducted by Nyirongo and Mhango (1993). They found that 91% of the interviewed households did not require assistance in finding markets for poles and firewood, but only 3% of the farmers sold to cities (mainly to the small town of Mzuzu). This negligible amount of sales was due to a combination of the long distance to urban markets and the lack of adequate transport means. Seventeen per cent of the households who sold wood owned their own vehicle, but apparently transport of wood to urban markets was financially unattractive, as evidenced by the low share of households who sold to cities. Inadequate transport facilities represented a marketing problem for 39% of the farmers. However, there were considerable differences at the district level. In four districts the majority of farmers faced transport problems in selling their wood.

Policy implications

Early studies (Poulson 1981; FAO 1982) provided indications that farmers were already involved in the production of seedlings. Later studies (DOF 1985) confirmed that a substantial amount of seedlings were either self-grown or self-grown and traded, particularly for fruit trees, and that natural regeneration of trees was a common practice (Maghembe & Seyani 1991). That farmers have a large diversity of trees on their farmland among which indigenous and particularly fruit trees and MPTs were dominant was found in the early 1990s (see Maghembe & Seyani 1991; Minae 1992a; Minae 1992b). Broadening the supply of species from government-run nurseries only began in 1987/88 after it was realized that farmers demanded a range of other tree species which did not fit into the woodlot tree planting approach of the Department of Forestry. Had the before-mentioned studies been carried out much earlier, it would have been quite likely that the forestry policy options made available to the farmers would have been more diversified to meet farmers needs and to support existing practices.

High production costs of seedlings in government-run nurseries and high subsidies have produced budgetary problems which are unlikely to be sustainable. While centralized seedling production and subsidization may be necessary to promote the introduction of new species in an early development phase, it is quite likely that this approach is necessary and cost-effective for most other preferred species and an extended time period, taking into account the indications from Poulson (1981) and from DOF (1985) that farmers are willing and capable of producing their own seedlings.

It was pointed out above that the policy objectives of the FWEP, the SWEP and the WEC1 were ambiguous with regard to the question of whether the main focus of the rural household forestry policy was to encourage wood production for home use or for (urban) markets. The rural energy surveys (DOF 1981; DOF 1985) showed that consumption levels of fuelwood remained unchanged despite indications of growing physical scarcity and that only a negligible amount of farmers were motivated to plant trees to meet household fuelwood needs. In addition, economic arguments such as the low opportunity costs of labour throughout most of the year and, in view of the high fuelwood consumption level, the potential to reduce fuelwood demand by low-cost measures, did not support the assumption that farmers would be encouraged to grow trees for household use.

The objective to encourage farmers to produce wood for markets, was subject to large uncertainties from its inception. Very few rural households were purchasing fuelwood and most likely did so to some extent to support cash income generating activities. It was also unclear whether the scarcity of supply of pole sized trees from customary land could be anticipated to encourage the development of a rural market. If farmers were perceived to supply an emerging pole market in rural areas, then it was questionable why seedling supplies should have been subsidized and why an additional financial incentive (tree bonus payment) was needed, because it is known that where markets exist, even poor farmers

farmers have been fairly responsive to supply such markets.[28]

Concerning the encouragement of smallholders to produce wood for the urban market, the approach chosen was risky in several respects. First, the very limited knowledge about the functioning of the urban woodfuel markets inclusive of the supply chains and pricing structures, was subject to the risk that farm gate prices required to make wood production a viable cash crop alternative or an additional income opportunity may be inadequate. This issue was particularly relevant because, even if a competitive woodfuel market structure was assumed to exist, the contradictory government fuelwood pricing policy could have led to a reliance of supplies from government plantations rather than from farm producers. Secondly, several assumptions of the fuelwood production model which underlay the policy were too optimistic, particularly the assumption about obtainable specified yields on farmers woodlots and to some extent the opportunity costs of alternative cash crops.

Competing policy objectives, that is controlling urban fuelwood supply prices through gazetted fuelwood and pole prices from government plantations, and encouraging private investment in tree planting have contributed to a hesitant and ultimately poor implementation of the envisaged pricing policy. Delayed increases of stumpage rates failed to provide the right pricing signals to farmers and to support the cash incentive policy for several years because until 1992, nominal increases were limited and were subsequently largely eroded by inflation. The same applies to the tree planting bonus which was kept nominally constant during the implementation of the scheme.

The effectiveness of intervening in woodfuel markets through controlling and confiscation of woodfuels remains doubtful with regard to the objective of curtailing wood supplies from customary lands. A host of problems are associated with implementing such control schemes including logistic problems (controlling the multitude of supply routes into cities), collusion between woodfuel transporters and surveillors, budget constraints to man check-points, and so on, all of which are not uncommon in many other developing countries. Improved results may be obtained through tighter controls, more manpower, incentive-oriented confiscation structures and other measures. However, it is not unlikely that more controls and their associated expenses will show diminishing contributions to the pursued objective. Notwithstanding the question whether higher expenses can be borne by already tight government finances, it remains also doubtful whether such measures are more cost-

[28] A striking example in this respect is the experience of farm forestry in India. Saxena (1992: 420-22) reports that in many regions and districts even poor farmers were planting trees primarily for sale as poles rather than for use as fuelwood, while the institution promoting farm forestry (National Commission of Agriculture) had anticipated that farmers would plant trees for meeting subsistence needs.

effective compared to investments to improve the competitive structure of woodfuel markets, especially the transportation segment. Regulatory changes which put remaining forest resources on customary land under effective control of the village communities, may be one of the solutions to encourage self-policing of the communities which suffer most form the long-term consequences of a diminishing forest resource base. The experience from Malawi has conclusively demonstrated that assigning a policing role to foresters is jeopardizing forestry extension efforts.

Despite the disappointing results of the incentive scheme, it cannot be concluded that incentives should not be considered in the future. Particularly for resource-poor farmers, incentives to grow trees may be able to play a complementary, albeit temporary role. This role is difficult to judge because many of the data required to analyze their potential importance are not yet available. This lack of quality data is to a large extent due to a major shortcoming of the woodfuel studies and rural energy surveys which have been conducted in Malawi. Whereas studies and statistics concerning the characteristics of smallholders in Malawi are very differentiated so that the data largely meet the analytical requirements for the analysis of agricultural and food security policy issues, such differentiations have not been considered in the design of rural energy surveys. As a consequence, the large-scale rural energy surveys did not produce much information to answer key policy questions such as which type and proportion of farm households have participated under which economic conditions (farming and resource conditions, food insecurity) in which type of forestry activities (farm, agroforestry, communal) and tree management practices, and why? The interpretation of results from the rural energy surveys can be partly enhanced by using results from other surveys. However. such improvements are limited. More effective rural household energy policy analysis requires that surveys and other studies will have to investigate closely the aspects mentioned in the previous questions in close relation to the decision-making characteristics of specific households.

6.2.2 Agroforestry policy

6.2.2.1 Key issues in developing appropriate agroforestry techniques

In view of declining soil fertility in many African farming communities and the long-term constraints to the application of fertilizers for many farmers has led to research on agroforestry systems and technologies which build on traditional as well as new agroforestry systems. Compared to farm forestry programmes, many of which started in the mid-1970s to early 80s, most agroforestry research projects leading were begun in the early to mid-80s. Experiences and research and policy issues from a cross-section of on-going agroforestry projects in Africa have been identified and summarized, for example, in Kerkhof (1990) and Cook and Grut (1989).

A key issue in the design of agroforestry projects is the selection of adequate tree species and a host of other characteristics which make agroforestry systems affordable, easy to adopt and widely replicable. Evidence from case studies reported in the latter two publications suggest that farmers have been very selective in choosing species, that MPTs have been more widely adopted than single use species and improved indigenous species are better suited than exotic species. Because of the complexity of local farming conditions, flexibility of project approaches and agroforestry technologies are required to reduce risks and to avoid incorporating high labour demands and a fairly rigid sequencing of labour requirements which may conflict with the traditional agricultural calendar. On account of risk considerations, farmers prefer gradual changes in the management of their farming system and agroforestry packages yielding early returns. Particularly under conditions where farmers are unable to produce food surpluses, which applies to most farmers in Malawi, farmers adopt low-input and low-risk farming strategies (Winterbottom & Hazlewood 1987: 105).

Certain agroforestry species and techniques have been selected by many projects because they were perceived to meet these characteristics. Notably alley cropping with *Leuceana leucocephala*, intercropping with *Acacia albida*, which is also more generally known as *Faidherbia albida*, and with *Sesbania sesban* fall into this category of species and techniques which were regarded as fairly safe bets or likely success packages. However, the actual performance of these techniques has been less successful than anticipated, often requiring redesign of techniques to suit local farmers and conditions.

Lead times required to develop reliable agroforestry techniques can be substantial. For example, Kerkhof (1990: 8) estimates that these require about eight years to have a 'realistic chance of success'. Evaluating the performance of many agroforestry projects is impeded by the fact that many projects had a shorter lifetime or that publication of the performance of projects has not been forthcoming. Measuring success, or even interim success, is also being made difficult by the variability of farming conditions and the important factor of farmers' management as well as the question of whether reliable results can be best obtained from testing technical packages in station or farmer trials. Due to the multipurpose benefits of many trees which are used in agroforestry projects, and the difficulties involved in identifying and measuring the economic value of direct and indirect benefits to farmers, it is often also difficult to rationalize why certain agroforestry practices have been successfully adopted.

Cook and Grut (1989: 45) have pointed out that the definition of success of agroforestry projects has multiple dimensions, but that 'the best indicator of success in agroforestry projects is the extent to which the recommended practices have been adopted by farmers' (4).

A key objective of many agroforestry techniques which have been promoted, including the most important techniques developed in Malawi, was to increase the yield of agricultural crops. Intercropping trials of agroforestry techniques have often shown promising potential in Africa and elsewhere, but according to Kerkhof (1990: 5) 'none have been able to provide hard proof that this can be achieved under field conditions'.

6.2.2.2 Economic conditions for the introduction of agroforestry techniques in the smallholder sector

The agricultural conditions and trends in agricultural productivity of smallholders in Malawi, which were discussed in Chapter 5, show that agroforestry techniques options have a potential role to play in arresting or reversing adverse developments. Stagnating and declining agricultural productivity of crops jeopardize the food security of the majority of smallholders. The utilization of fertilizers is closely related to household size, income and holding size. The utilization rate of fertilizers by the majority of smallholders is limited. Prospects of smallholders to considerably increase access to fertilizers through participation in farmers clubs or through the informal rural credit system have proven to be inherently constrained. Even increased access to a cash crop such as burley tobacco will only have limited potential to increase incomes of smallholders and affordability of fertilizers. The working capital gap which is embedded in the poverty cycle of many food insecure households is therefore difficult to overcome. To cut through the vicious cycle of having limited access to fertilizer, declining soil fertility and yield reductions, the use of fertilizer may not be the panacea *per se*. This especially affects the poorer segment of smallholders, because response coefficients of their main food crop, the local maize varieties, but particularly of hybrid maize, to fertilizer are very variable and therefore highly risky. Severe labour constraints suggest agroforestry techniques requiring both little additional labour demand during the cropping season and/or flexibility to sequence labour requirements for tree establishment and management. Land constraints suggest minimizing space requirements for agroforestry trees.

Acute seasonal supply shortages of animal feed in the beginning of the dry season, followed by a decline in feed quality until the end of the dry season, constrain livestock production (Munthali 1991: 98). Loss of forest grazing areas and perhaps increased household utilization of agricultural residues, which constitute the major supply source of animal feed during the dry season, put further pressure on the animal feed balance.

6.2.2.3 Experiences and results of agroforestry research and extension

Traditional intercropping practices of crops were discussed already in Chapter 4, while some key aspects of retaining trees on farms were discussed in previous sections of this chapter. Concerning traditional agroforestry practices on smallholder farms, it is known that women plant crops in association with fruit trees. The most common traditionally and widely employed agroforestry practice which has been reported for several ADDs in Northern, Southern and Central regions of Malawi is the intercropping of *Acacia albida* with maize and other crops (Kandaya & Matupi 1991: 129; Bello 1991: 118; Chirwa 1991: 144). This observation is also supported by Table 6-1, which shows that *Acacia albida* was the only tree species which was found to be mainly used for soil improvements in all districts where group interviews were conducted. Another traditional agroforestry practice, which is known to have been applied since the 1970s, is the growing of *Leucaena leucocephala* in hedgerows and woodlots for stall feeding cattle with dry leaf. This practice was reported by Poulson (1981: 11) to be employed on a small commercial scale by smallholders in the Lower Shire Valley. According to Munthali (1991: 98), this practice is widespread in Malawi.

Intercropping of *Acacia albida* with maize and alley cropping[29] of *Leucaena* with maize were the main agroforestry techniques which were widely tested on research stations and partly on smallholder farms in Malawi. The results and experiences produced with the development of these techniques are discussed in the following.

Alley cropping with **Leucaena leucocephala**

Research and promotion of this technique started first in LADD in 1982, while other ADDs begun their research programme between 1985 and 1987. The research programme focused mainly on intercropping *Leucaena* with maize varieties. Why this technique was chosen rather than techniques building on the traditional application of leaves for animal feed is not clear from the literature.

Results of trials on research stations,[30] on observation plots[31] and farmer demonstration plots in all ADDs have been mixed. According to most trials, farmers get some benefits from hedgerow intercropping after about two to three years, while full benefits seem to be

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[29] Alley cropping is the cultivation of annual crops between hedgerows of woody perennials that are pruned periodically to prevent shading of the alley crop and to supply leaf manure/mulch, fodder and fuelwood (see Bunderson et al (1991a: 171)

[30] On-station research has been mainly carried out at Makoka Research Station under the auspices of the Malawi ICRAF Agroforestry Project and at Chitedze Research Station (Ministry of Agriculture).

[31] Trials on observation plots and agroforestry extension work were undertaken by the Land Husbandry Branches of the Ministry of Agriculture in all Agricultural Development Districts.

achievable after five years. Yield responses to the application of dry leaf vary widely both by type of soils and over time. Bunderson et al (1991a: 174) ascertained yield increases for hybrid maize of between 192 to 348% on severely nutrient deficient soils and of 38 to 77% on moderately fertile soils. In some ADDs yield improvements in different trials were variable (KADD, BADD), ranging from positive results to outright failures. Overall the performance of this technique was disappointing leading to cool responses and low adoption of the technique by farmers. One of the main reasons of this poor performance of the technique was that it was promoted to smallholders mainly by using demonstration and observation plots without having carried out sufficient on-station research to develop a proven agroforestry technique. Considerable technical information was reported to be lacking concerning seed treatment and handling (Kandaya & Matupi 1991: 128), optimum spacing between tree row and crops, and application methods of leaf manure (Banda et al 1991: 136). In addition, there was poor coordination between the institutions involved in research and extension. Other constraints which were found to limit the adoption of this technique are high labour requirements for alley cropping, establishment problems of hedgerows due to the unconstrained right of livestock to browse fields after the harvest and a high susceptibility to termite attacks (Minae 1992a; Minae 1992b).

Cost-benefit analysis of intercropping *Leuceana leucocephala* with local and hybrid maize varieties have come to rather different conclusions. For example, Dewees (1995: 1096) comes to the conclusion that 'it is highly unlikely that *Leuceana* intercropping will ever be viable in Malawi except under the best conditions'. This conclusion is associated with the assessment that the technique requires costly and complicated management inputs, a large number of trees per ha and general poor suitability of *Leucaena*. In contrast, Hayes (1991: 9-10) who carried out a financial analysis of the *Leuceana* intercropping trials which were undertaken by the Agroforestry Research Team, comes to the conclusion that this technique 'definitely appears to be a financially viable alternative' (Hayes 1991: 9) because of the following attributes: inexpensive establishment; rapid attainment of full maturity; no wastage of arable land; and substantial soil erosion benefits. It appears that at present no definitive conclusion about the likely adoption rate of this technique by smallholders can be made until more conclusive evidence is available about the critical technical parameters from on-going research.

Intercropping of maize with Acacia albida

Acacia albida is a leguminous indigenous tree in Malawi which is known to be slow growing, reaching maturity after about 25 years. What makes this species particularly interesting for agroforestry is that it sheds its leaves during the rainy season. The species is most common in basins (flood plains) in Malawi.[32]As the tree is known by farmers to have good soil improving benefits and to provide good animal feed from leafs and pods, and because the maturation of the species takes a long time, agroforestry research and promotion has mainly focused on the raising of seedlings on farms and on researching appropriate spatial arrangements and optimal densities (Chirwa 1991: 144). Research activities in most ADDs started only in the late 80s that no rigorous scientific data are yet available. Observed densities of *Acacia albida* trees on farms in Mzuzu ADD were less than 50 trees per ha (Kandaya & Matupi 1991: 129). This number of trees was judged to be low, but the issue of defining optimum densities still needs to be resolved.[33] Even though farmers know the beneficial effects of the species, it appears that they do not attempt to raise the species systematically (Kandaya & Matupi 1991: 129). Recent attempts in Mzuzu ADD to encourage farmers to grow seedlings provided by the government have found enthusiastic response and even have led to the purchase of seedlings.

Measurements of maize yields on plots with mature *Acacia albida*/maize systems were carried out by Bunderson et al (1991b) and by Selenje et al (1991). The former reported mean yield differences of maize under tree canopies compared to maize in the open in the same field. These were measured on different farms in three growing seasons from 1987/88 to 1989/90, of 272%, 43% (local maize) to 77% (hybrid maize) and 208% (local maize). The latter authors found average differences in the seasons 1988/89 (23 fields) and 1989/90 (30 fields) of 220 and 210%.

Financial analysis of *Acacia albida* intercropping with maize carried out by Selenje et al (1991: 233-36) shows gross margins which are a multiple of those without intercropping. The financial analysis of *Acacia albida* intercropping with maize by Hayes (1991: 8-9), using yield data from Bunderson et al (1991b), shows gross margin advantages ranging from 9 to 250%. His analysis also shows that intercropping with *Acacia albida* may produce gross margins which are comparable with fertilized hybrid maize. This result does not account for the benefits from fuelwood and fodder supply and is associated with considerably less risk for farmers.

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[32] On alluvial soils clustered concentrations of Acacia albida have been found, while on upland areas with sandy clay loams Acacia albida is less common and very scattered (see Bunderson et al 1991b: 209).

[33] Selenje and Mwakalagho (1991: 142) recommend a spacing of 10m * 10m, based on the assumption that the canopy area of mature trees varies between 100 to 300m^2. The average canopy area of 33 mature trees measured by Bunderson et al (1991b: 215) instead was about 370m^2 , suggesting a lower spacing. No conclusive evidence is yet available about the relationship between maize yields and the distance from the base of a tree. Measurements undertaken by Bunderson et al (1991b: 209-14) show two different patterns. In the first pattern, maize yields peaked at a distance of about 6m from the tree base, whereas in the second pattern, the peak was at 10-12m from the tree base.

In comparison to intercropping with *Leucaena leucocephala*, intercropping with *Acacia albida* has the disadvantage of generating benefits much more slowly, but establishment and management costs are considerably lower. Despite the remaining uncertainties in the technical and cost parameters for both agroforestry options, particularly for intercropping with *Leucaena*, the available evidence (see also Dewees 1995: 1092) suggests that intercropping with *Acacia albida* is more likely to be the agroforestry option with better economic potential and chances of being more widely adopted by smallholders in Malawi.

6.2.3 Communal forestry

According to Arnold (1987: 126) communal approaches to tree management have a number of advantages compared to farm forestry, including better management of common forests than by individuals; land constraints for individual tree growing; production of products which cannot be obtained from individual trees or groups of trees; and access of all community members to forest products. From an equity point of view, maintaining access to managed forests is especially important insofar as the poorer sections of the rural households tend to rely more on forest products. As the discussion in Chapter 3 has shown, alienation of customary land by the estate sector has led to social frictions.

Little is known about communal forestry practices in Malawi. In 1926 a Village Forestry Area (VFA) scheme was introduced which designated forests on customary land as VFAs. Control and protection of a VFA against illegal cutting was exercised by the village headman, while management was carried out on a communal basis. The creation of VFAs was supported by the rural population so that approximately 2,900 VFAs had been established in the mid-1930s. Thereafter, for unknown reasons, the management of VFAs has fallen apart. Over 2,000 VFAs are estimated to exist in Malawi, but no precise information about their location, size and status is available. Survey work of a VFA in the Mzimba District by Coote et al (1993) indicates that the VFA supplies a number of forest products to the surrounding villages, that pole sized material was heavily exploited and that there was no functioning communal forest management. A more comprehensive survey of VFAs was undertaken in preparation of the Lilongwe Forestry Project (LFP 1993, Annex 1, Appendix 1). Of 437 recorded VFA in Lilongwe district about 100 were estimated to be still existing. No information was provided about the management status of the VFAs, but many were found to be partially exploited which was indicated by the coppicing and pollarding of many trees. A major obstacle to their registration and perhaps improved community management is that the Forest Department, which has responsibilities for forests outside Forest reserves since 1965, controls VFAs commercially. An added disincentive to demarcate, register and manage these areas are fears that formal registration may entail that the land may later be appropriated by the Forestry Department as a Forest

Reserve. Legal changes of several Acts in Malawi, especially in the form of a Draft Forest Bill have been proposed in 1993 to ensure that VFAs, which are registered and managed in compliance with a VFA Management Agreement between village authorities and the Forestry Department, remain under community control.

This approach is an essential prerequisite for increased community interest in managing customary forest land on a sustainable basis. However, it is not known yet whether the typical problems of communal forestry activities, that is the distribution of benefits, can be solved in a satisfactory manner or whether and to what extent, this may be achieved through the creation of smaller user groups. Guidelines to manage at the community level have been made, for example, by Luhanga (1993: 15-17), but their feasibility has not been tested. Similar questions also apply to the feasibility of establishing communal tree planting (woodlots) and group woodlots. Initiatives to promote participatory forestry development have been undertaken by a project (Assistance to the Forestry Sector) funded by the FAO and UNDP in 1988. Several participatory forestry models were adopted by the project, a few of which include participation on a communal or group basis. However, the performance of these pilot activities yet remains to be evaluated.

Experiences of collective management of resources or the use of collective labour are factors which are regarded as contributing to the social coherence which is considered as an important element for communal forestry activities. The practice of communal labour in farming activities which existed in the past has largely disappeared in Malawi. At the village level, village action committees and, in some districts, village forest committees have been established. However, their effectiveness varies widely. Other formal organization forms include farmer clubs, which have a tendency to be self-selective, and political organizations. Thus there are a number of village level organization forms which have been active to promote community development. Except, perhaps, for the issue that in some villages the integrity of the village headmen may have suffered in protecting the interests of the community (see Chapter 3), there are no distinct unfavourable institutional or legal impediments to the formation of activities on a communal or group basis.

Empirical evidence about farmers' attitudes participating in communal or group activities are available from several surveys. For example, results from the survey conducted by the Lilongwe Forestry Project show that 86% of the respondents preferred participation in projects as individuals. This does not rule out that eventually more farmers may be willing to participate in communal or group activities, provided that acceptable mechanisms can be found to disperse their critical attitude about managing and benefit-sharing. A more general factor which may have influenced the prevalence of individualistic attitudes among farmers is that mixed experiences with previously emphasized group activities 'might have resulted in some degree of scepticism concerning the communal approach' (LFP 1993, Working Paper 1: 12).

6.2.4 Rural electrification policy

Policy objectives

RE has not played any significant role in the household energy strategy for rural areas in Malawi. For the development of the power sector, the GOM has pursued a least-cost expansion strategy and thus adhered strictly to an investment policy which was guided by the economic viability of projects, including RE projects. In general the budgetary constraints of the government in the 1980s which were already discussed in Chapter 2 did not allow a venturing into additional policy areas involving substantial financing requirements.

The parastatal Electricity Supply Commission of Malawi also operated under these policy objectives. According to an agreement with the World Bank which stipulated that RE investments had to be financed from grants, ESCOM was not allowed to invest its own funds.

Despite the tight financial constraints of the Malawi government which effectively inhibited the implementation of a RE programme on any significant scale, the available knowledge and remaining uncertainties concerning the factors influencing the economic viability of RE programmes in developing countries when applied to the situation in Malawi, provides good reasons why the government would have been ill-advised to pursue a more rigorous RE programme.

Direct and indirect benefits of rural electrification

There are a host of issues pertaining to the benefits and costs of RE. Some of the main issues which are of relevance to Malawi are summarized, for example, by Foley (1992). Two pivotal and interrelated questions in the debate about RE are: under which conditions does the supply of electricity to rural areas foster rural economic growth and development; and how are the economic and perceived social benefits likely to be distributed between income groups?

With regard to the first question, the main issue has always been whether RE is leading the rural development process and is therefore a necessary condition for rural development or whether electricity supply starts to play a catalytic role only after the development process has reached a certain stage.

Proponents of the first view tend to justify RE programmes which do not meet the financial and economic decision criteria typically applied to RE projects[34] by referring to the existence of indirect long-term social and economic impacts such as poverty alleviation, reduced deforestation, reduced rural-urban migration, or on the grounds of rural-urban equity considerations.[35]

The latter arguments in favour of RE are often technically represented in two variants. In the first variant it is suggested that discount rates or internal rates of return to RE projects be applied, compared to other energy investments. In the second variant it is simply claimed that if other benefits were taken into account the project would be feasible. Eventually both arguments involve subsidization of RE investments which have either to be financed directly by government through budget appropriations or through consumer cross-subsidization. Such claims and counter arguments have often led to heated debates about specific RE projects and ambitious programmes.

There are several facts and research findings which are helpful to rationalize the debate about the relationship between RE and rural development. One of the main problems is that most of the indirect benefits mentioned above are genuinely difficult or impossible to quantify. In addition, deLucia (1994: 9) has pointed out that the existing information base concerning complementarities between different infrastructural investments and indirect benefits of RE is rather limited. However, this does not imply that the issue of the role of indirect benefits or changes induced by RE has to remain undecided until more information becomes available. In this context, deLucia (1994: 33) has argued that 'few if any of these changes, even when observed, can be attributed solely, if at all reason, to RE'. The implication of this view is that attempts to attribute certain impacts to RE projects in isolation from other infrastructural investments and concomitant policy changes appear to be futile.

Measurement problems associated with RE projects are not confined to indirect benefits. Reviews of RE projects[36] discussed in deLucia (1994: 35), which took mainly the standard economic benefits (energy savings and consumer surplus) into account, found that the estimates of economic rates of return were often positively biased on account of measurement errors and, in most cases, lower than estimated. This finding clearly suggests

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[34] RE project evaluations calculate financial and economic internal rates of return using most often cut-off rates of between 8 to 12%.

[35] Other benefits which are typically claimed to exist, but which are difficult or even impossible to quantify, are quality of life considerations (basic needs), employment creation and socio-political effects. See, for example, the discussion in deLucia (1994: 34).

[36] The reviews referred to are those done by Mason (1990) who reviewed 35 World Bank and USAID (United States Agency for Industrial Development) financed projects and by Barnett et al (1990).

that even more elementary problems of applying cost-benefit analysis such as the scrutinization of the benefit evaluation approach and data used in project evaluations have to be addressed.

Foley (1992: 146) has noted that decisions about the viability of RE projects are highly dependent on the specific context and conditions of a specific project area and that the existence of certain basic conditions are required for RE to act as a catalyst for rural development. One of these conditions is that due to the fact that electricity is a derived demand, people must have obtained a certain level of disposable income at which electricity becomes affordable. This argument is particularly relevant for the evaluation of RE projects in Malawi which is discussed in the following.

Rural electrification projects in Malawi

Another consideration which is related to income levels is the role of electricity relative to other basic needs. As discussed in Chapter 5, the improvement of health services and food supply were considered as the most urgent needs by the rural population in Malawi. Energy needs generally assumed a lower ranking and, particularly, the need for access to electricity did not surface in any rural survey. This result is not surprising taking into account the widespread prevalence of food insecurity and very low average incomes which mainly consist of non-cash income and are largely spent on food and rarely on energy other than for small quantities of kerosene and fuelwood for consumption purposes.

A feasibility study (Carl Bro International 1988) for a proposed RE programme for 13 villages with a population of between 1 000 and 3 000 inhabitants in Malawi showed that none of the projects was financially viable. All projects had negative financial rates of return in the range of minus 3.0 to minus 10.0%. The economic evaluation resulted in the identification of four projects which were marginally viable. However, even the viability of these projects was doubtful in view of remaining uncertainties about future power consumption and other key parameters. For all projects under consideration, the income of households was generally found to be too low to afford electricity. Therefore the electricity demand of even the marginally viable projects relied almost entirely on the demand for infrastructure services (water supply, schools and hospitals) and small-scale industrial users (maize mills and workshops).

The costs for electricity connections including internal wiring were MK600 or about twice the average annual income of smallholders in Malawi in 1988. The socio-economic analysis of the feasibility study came to the conclusion that at prevailing income levels probably only 4% of the rural population could afford an electricity connection (Krogh 1988: 23). Even if connections were to be provided free of charge, it is impossible to conceive that the remaining households would be able to afford electrical appliances or even monthly base electricity charges which would amount to more than one-third of the monthly income (Krogh 1988: 22). As a consequence, only a small percentage of rural households who can afford electricity would have benefited from RE. This finding has a bearing on the second major issue which was raised above for RE projects, that is their impact on different income groups. That better-off rural households reap most of the direct benefits from RE is not per se an argument against RE projects. In projects where no subsidies are involved the issue is not relevant. Where subsidies are involved, which is the case in almost any grant-financed RE project, the issue becomes important depending on whether it can be reasonably expected that policy measures which facilitate the access to and utilization of electricity will be effective. As discussed above, the incomes of rural households in Malawi are so low that such measures cannot be expected to benefit but a majority of households.

The indirect benefits of the rural population from the proposed RE projects were also ascertained to be rather limited. For example, to some extent an improvement of existing services in rural hospitals and training institutions might be expected, but most of the population is unlikely to benefit from such improvements because of constrained access to these services due to transportation problems and income-related factors. The author of the evaluation claimed that the provision of electricity may generate increased production from industrial activities with (unspecified) spill-oversee on the local community (Krogh 1988: 25). This contention seems to be purely conjectural, because most industrial activities in villages of the type considered in the study are undertaken in very small workshops which cater for limited local agricultural needs. Only a substantial reduction in production costs due to grid electricity supply could produce measurable production and employment effects. However, such an effect is doubtful because such activities are rather labour-intensive.

In summary, it can be concluded that the level of disposable income of the large majority of rural households in Malawi was far too low to consider RE as an economically viable option for household energy policy in Malawi. Smoothing the access to electricity and to user appliances through innovative financing schemes and subsidies (regardless of their general desirability) is also no policy option in the foreseeable future. This conclusion is simply due to the fact that, given the conceivable future income growth scenarios in rural areas, real income increases will have to be substantial to make the implementation of such options feasible. In a country like Malawi, the issue of RE is of secondary importance from the point of view of rural development. The main concern of combating poverty in the rural areas was, and is, to improve the productivity of smallholder agriculture. As discussed in Chapter 4, the main constraints to enhanced productivity and increased incomes are improved access to information, credit, off-farm income opportunities and the level of education. These constraints define largely the package of required inputs and services which are necessary for the resumption of economic growth in rural areas. Access to electricity in the rural villages has at present limited practical importance because the low level of production technology in the smallholder sector does not require electric power.

6.3 SUMMARY AND CONCLUSIONS

Policy focus of rural household energy policy

- Given the income trend and income situation of smallholders in Malawi in the early 1980s, the composition of rural household energy consumption, a lowly mechanized smallholder agricultural sector, the discouraging experiences made with the demand-side option of disseminating improved stoves and a tight fiscal position of the government, the policy course of pursuing an economically and financially viable RE strategy and the focus on supply-side oriented woodfuel strategy measures, were justified.
- Indications of declining woodfuel supplies from customary land and a fairly resilient and high fuelwood consumption level, warranted a more in-depth investigation into the savings potential of low-cost fuelwood saving measures.

Farm forestry policy

- Policy objectives underlying the supply-side and market-led forestry approach of the woodfuel programmes were conflicting: uncertainty remained as to whether households were primarily expected to plant trees for household consumption or for the market. As later studies have shown, farmers were primarily interested in producing poles and fruit trees as well as MPTs. The prime reasons for tree planting appear to have been an interest in producing marketable outputs and supplies to meet home consumption needs. Misjudgment of the motivations of farmers could have been largely avoided if more detailed studies had been undertaken to investigate the motivation of farmers to plant trees and the rationale of their management practices at the design stage of policies for the woodfuel programmes.
- The fixation on promoting a scaled-down version of traditional commercial forestry models, that is the woodlot approach, was partly justified by findings of the rural energy surveys but was overemphasized. In addition, focusing on the woodlot approach carried an implicit bias towards better-off farmers, because tighter land and labour constraints and associated risk aversity of the majority of the smallholders made it, from the beginning, quite likely that they would be less able to respond to government incentives

for woodlot tree planting than less resource-constrained farmers. Therefore a more diversified extension approach addressing closer the needs of individual farmers would have been justified.

- The need to provide farmers with subsidized seedlings or other incentives to encourage tree planting on farms is doubtful and has proven to be a rather expensive policy option. It is likely that farm households are able to produce seedlings at lower cost than government nurseries. Instead of encouraging and supporting apparently existing seedling production, too much emphasis was placed for too long on the supply of seedlings from expensive government sources.
- The feasibility of implementing a policy package consisting of three conceptually interdependent elements, that is increasing stumpage rates, controlling woodfuel supplies from customary land and the provision of financial incentives for tree planting, was a risky approach in two respects. First, failure to implement successfully any single component would have jeopardized the objectives of the entire policy package. Secondly, even if the package had been successfully implemented, the limited knowledge about the functioning of the technical and economic efficiency of the woodfuel supply chain, especially with regard to its price build-up and possible rents, was exposed to the risk that price incentives would not pass through sufficiently to the farmgate.
- Even though the government had subscribed to the policy which was mainly designed by the World Bank, and was aware of the risk of failure associated with deficiencies in rigorously implementing all elements simultaneously (which was clearly pointed out by the World Bank), they jeopardized the success of the policy by failing to increase stumpage rates in time and perhaps to adjust the incentive payments. Apparently the reason for these failures was that too much concern was put on the perceived impacts of stumpage price increases on urban households although the World Bank had demonstrated that these would not have a considerable impact on prices and disposable income for other expenditures. This points eventually to a lack of consensus within the GOM to stick to the agreed measures. While the first two factors where clearly under government control, the third success factor, that is the control and revenue collection of woodflows from customary land, proved to be much more difficult than anticipated and was in the end an outright failure. A combination of structural factors, which are of logistical and social origins, suggest that it is doubtful that comprehensive policing of woodfuel markets is a feasible approach both in terms of reducing fuelwood supplies from customary land for urban consumption and from the point of view of cost-effectiveness.

- Concerning the policing of woodfuel markets, foresters and forest extension workers should not participate in such activities in order to avoid jeopardizing their primary function which is to support farmers in tree planting activities.
- Including forestry products strictly in revenue collection and confiscation activities is an ambiguous policy from an equity point of view, because it is likely to affect primarily the poorer households which are struggling for survival. It also potentially contributes to adversely influencing the preparedness of rural households to participate in forestry activities and has a negligible impact on the main objective of intending to contain the deforestation and depletion of forests on customary land.
- The negligible impact of the tree bonus scheme to encourage farmers to plant trees may be partly accounted for by implementation failures and constraints. However, the increased planting of trees by farmers who did not participate in the scheme and the unimportance of the tree bonus payment, suggests that such incentives are not successful in general to promote tree planting and that other reasons are inducing farmers to plant trees. However, this finding does not dismiss the possibility that presumably some of the poorer farmers may be encouraged by incentive payments to plant trees. This policy question can only be answered after more household studies have been conducted which differentiate farm households according to their income, land, labour and other characteristics and relate those characteristics to their decisions concerning the planting of specific trees.

Agroforestry research and extension

- Research and dissemination of agroforestry techniques is particularly warranted in the smallholder sector in Malawi, because of declining soil quality, constant or declining crop yields, food insecurity, limited affordability of inorganic fertilizers and a seasonal supply gap and quality deterioration of animal feed. As in many other African countries, the performance of one of the more promising agroforestry techniques, namely intercropping of maize with *Leucaena leucocephala*, has hitherto not met the high expectations of researchers and extensionists. Main factors constraining widespread adoption of this technique are high labour requirements, establishment costs and susceptibility to termite attack. At present this technique has not proven to be a viable option and on-going research will show whether the main constraints to its adoption can be overcome. In addition to technical and tenure constraints, limited success was also due to the poor coordination between researchers and extensionists and, in some instances, the premature promotion of a yet insufficiently tested agroforestry technique.

- Intercropping of maize with *Acacia albida* is a widely adopted traditional agroforestry technique. Due to the long period for this species to reach maturity, research has been focused on on-farm trials. Main research efforts concentrate on optimum planting densities and spacing and management practices because farmers apparently do not actively manage the application of leaves. Compared to alley cropping with *Leucaena leucocephala,* this technique has the disadvantage of a long gestation period, but establishment costs and labour requirements are considerably lower. In addition, this technique has shown more promising potential because it is not subject to termite attacks and is likely to produce, despite remaining technical uncertainties and uncertainties concerning the time path of benefit generation, higher benefits for farmers according to the usual financial evaluation criteria (gross margin, internal rate of return and cost-benefit ratio).

Communal forestry

- It does not appear that major inherent constraints exist in rural communities of Malawi which would impede the adoption of communal forestry activities other than the typical problem found for such projects elsewhere of finding mechanisms to fairly distribute the benefits of such activities. Communal projects undertaken since the late 1980s are still in their development phase which makes it difficult to judge their performance. However, available evidence suggests that the design and response to communal forestry models cannot be isolated from other communal activities because the willingness of farmers to participate seems to be influenced not only by their perception of the merits of the communal forestry options offered, but also by the past performance of other community or group-based activities.

Rural electrification policy

- The main issues and controversies in assessing the economic and financial viability of RE projects are related to the identification and measurement of direct and indirect economic and social benefits, their equitable distribution, and the question of the interdependence between RE and the rural development process in general. Compared to many other countries, where these issues are more complex, the main reasons why RE programmes in Malawi have focused on a few rural centres are that the low average household incomes and limited demand from commercial activities did not justify the consideration of a larger RE programme. In addition, the beneficiaries of such programmes are likely to be a small minority of higher-income households.

Chapter Seven

URBAN HOUSEHOLD ENERGY CONSUMPTION AND INTERFUEL SUBSTITUTION

The dynamics of urban energy consumption in developing countries have attracted considerable research efforts during the past 25 years. This research has focused on the patterns, determinants and constraints of energy consumption growth and the substitution of fuelwood by both lower quality agricultural residues and higher quality energy sources such as charcoal, petroleum fuels and electricity. The analysis of these processes which has been labelled in the literature as the 'energy transition' can be distinguished in terms of the scope of the analysis into two broad and interrelated research areas.

The first area of research examines the systematic relationships between urbanization, economic development and energy consumption patterns of cities, while research in the second area is more narrowly confined to the dynamic factors driving interfuel substitution in the household energy sector.[1] In the former area, the analysis is based on total energy use in urban areas including final energy consumption in all sectors. A key research issue in this regard was to ascertain whether urban energy-use patterns differ systematically across cities of different and comparable sizes and to which factors any such differences may be ascribed (see, for example, Hosier 1993b: 512; Jones: 1991). Variations of this research direction include the question of whether so-called secondary cities[2] have a significantly different pattern of energy use than those found in primary cities (see Milukas 1987; Hosier & Kipondya 1993a). Because these concepts are only of limited relevance for the discussion of urban household energy policy issues and were found by the author not to be applicable to Malawi, related research questions are not further analyzed.

The explanation of the factors driving the patterns of energy consumption and interfuel substitution in urban households are a prerequisite for energy policy and planning, because attempts to influence this process in line with national and sectoral policy objectives have to rely on a sound understanding of the relative importance of the parameters influencing such changes.

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1 An overview of research issues and the empirical evidence concerning urbanization and energy use relationships including household energy use, from studies conducted between the mid-1960s to 1984, is provided by Jones (1989). Leach (1992) reviews research issues from an energy policy and planning point of view and provides an overview about empirical evidence concerning the factors influencing the energy transition in urban households.

2 The concept of a secondary city has been developed by Rondinelli (1983). An in-depth discussion of these concepts is contained in Milukas (1987) and in Milukas (1993: 557).

The main objective of this chapter is therefore to empirically test main hypotheses concerning the relative importance of factors determining the fuel substitution patterns in urban households and the policy conclusions which can be drawn from this analysis for urban household energy policy in Malawi.

In Section 7.1, the main elements of the existing knowledge about the energy transition in urban households are reviewed. This discussion serves the purpose of establishing the background for comparisons with the results of the analysis of the determinants of energy consumption patterns and interfuel substitution in urban households in Malawi. Section 7.2 starts with a brief discussion of the urban household energy database which was available for this research. This is followed by an analysis of income changes in urban areas and of poverty characteristics of the urban population. The analysis then proceeds in Section 7.3 with a cross-sectional analysis of the determinants of energy consumption patterns in the four main cities of Malawi. Analysis in this section relies heavily on data which were collected in 1990 by the MUHES (see Ng'ong'ola 1991).[3] This analysis is supported by the analysis of financial user costs for cooking purposes which is the major energy end-use in urban households. Reasons for the massive backward fuel substitution which took place in Malawi between 1983 and 1990 are analyzed in Section 7.4. Section 7.5 discusses selected household energy policy issues, including the experiences made with supplying subsidized fuelwood from large-scale fuelwood plantations, the introduction of pine charcoal into urban markets, and paraffin and electricity pricing policy issues in connection with equity considerations. Section 7.6 contains a summary of the chapter, which is combined with policy conclusions for household energy policy drawn from the analysis in Chapter 7, and with regard to the earlier discussion of rural-urban linkages.

7.1 DETERMINANTS OF THE URBAN HOUSEHOLD ENERGY TRANSITION

In testing the energy transition concept empirically for Malawi the following methodological aspect has to be borne in mind. Any such test has to be confined to the more stable relationships between changes in end-use energy patterns and the main driving variables which have been inferred from theoretical considerations and country studies. This is due to the fact that there are only a limited number of developing countries for which longitudinal data from adequately designed household energy surveys are available (see Leach 1992: 116). As a result, much of the knowledge about the energy transition had to be derived from either static cross-sectional and cross-country statistical analysis, or by

3 This survey was initiated by the author by launching the project proposal and securing finance from the United Nations Development Programme in Lilongwe, Malawi. The design of the survey was supervised by the author, while its execution and statistical analysis was subcontracted to a local consultant (see Ng'ong'ola 1991).

using limited time series for statistical analysis or comparisons of annual data.

Individual researchers tend to agree on the issue of how well the crucial aspects of the energy transition are understood, often concluding that there is a deeper need for analysis of specific country contexts, before making definite recommendations about, for example, the extent to which substitution of fuels penetration is economically feasible.

Foley (1988: 77), who examined the justification for demand management measures relative to the quality of data required to recommend such specific measures, assumes a particularly pessimistic view in concluding:

> There is a lack of data on consumption levels; and even less is known about how they change over time. There is almost total ignorance about the factors which determine such changes. And the available information on price and income elasticities does not permit the effects of any particular initiative to be established.

More recently, Hosier and Kipondya (1993: 461), who investigated the determinants of the energy transition in three Tanzanian cities, open their introduction to the subject with the remark that 'The most poorly understood question relating to household energy use in developing countries revolves around the urban energy transition'.

For the purposes of this research, the presentation of the broad theory of the factors determining the energy transition relies primarily on the review articles by Jones (1989) and Leach (1988; 1992). Additionally, other pertinent studies were used, notably household energy studies which have been recently conducted in some of Malawi's neighbouring countries, that is Tanzania and Zambia.[4]

Interfuel substitution decisions of urban households are part of the general utility maximizing economic decision behaviour of households, which addresses the question of preference structures or how much households are spending on various groups of commodities, subject to an income constraint. With regard to consumer preferences, the concept of the energy transition holds that households have an ideal fuel preference ladder which is represented by a hierarchy of fuels ranging from the very convenient use of electricity, gas (natural gas or liquified petroleum gas) and kerosene, followed by less convenient fuels such as coal, charcoal and fuelwood and low-grade other biomass fuels such as agricultural residues. This feature is supposed to apply to all major household energy end-uses, that is cooking, heating and lighting, though different fuels are naturally

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[4] These studies are the Zambia Urban Household Energy Strategy (ESMAP 1990a) and the Tanzania Urban Household Energy Survey, the results of which are summarized in Hosier and Kipondya (1993).

used in this transition process for different end-uses. The concept is also intuitively appealing because, as one goes up the fuel ladder, the convenience of using fuels in terms of cleanliness, ease of storage and handling, the matching of heat supply levels to different tasks and use-levels, and the end-use efficiency, increases.

In terms of most of these characteristics, biomass fuels and modern fuels can be distinguished as two more uniform, though not homogenous, groups of fuels. For the analysis of the expenditure behaviour of households, different groups of goods are distinguished whereby these categories can be characterized as inferior and normal goods. According to Engel's law, the expenditure on inferior goods declines with rising income. Hence, by implication, the notion of the energy ladder implies that biomass fuels are assumed to be inferior goods. This also implies that with increasing incomes households will use more modern fuels. However, this does not necessarily imply that only modern fuels are consumed at very high incomes because this would require the empirically not always valid assumption, of perfect substitutability between household fuels. Conversely, sustained decreases in real income, a development which has taken place, for example, in several of the 46 sub-Saharan countries during the 1980s, [5] would be expected to produce a certain degree of backward fuel substitution.

Empirical evidence from many urban household energy studies in developing countries shows that urban households often do not choose the least-cost energy supply option in terms of cost per unit of useful energy delivered. This is consistent with the concept of the energy ladder insofar as consumers' preferences for modern fuels implicitly involve the assumption that households are prepared to pay a premium for higher quality fuels. For example, even if fuelwood for cooking was the least-cost option, the fuel ladder concept would predict that consumers always aspire to use a higher-grade fuel, even if it is more expensive per unit of useful energy. Hence fuel choices also involve a trade-off between convenience and cost considerations.

Though preferences are important, usually they represent a factor of lesser importance in comparison to the factors which have been identified in the literature as being major determinants of the energy transition.

The primary general factors are income (expenditure), household size, access to and availability of fuels, equipment costs and relative fuel prices. However, it should be

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[5] See the GNP per capita data contained in the UNDP/World Bank publication *African Development Indicators* (1992: 32). Precisely, this statement relies on a comparison of annual average GNP per capita data for the periods 1980-85 and 1986-90 (or until the most recent year for which data were available).

emphasized that all economic, demographic and preference factors influencing fuel choice are firstly conditional on access (both absolute and relative in terms of availability and supply and service reliability). The issue of access in terms of the dimensions 'availability' and 'supply reliability' may lead to numerous empirical divergences from the predictions of the fuel ladder concept, with regard to the relative importance of the factors which may influence shifts to different energy sources. Thus the concept of the energy ladder in terms of a fuel preference ladder, which emphasizes a strong link between income and fuel choices, is oversimplified and controversial particularly when access issues are relevant. A criticism of the concept of the energy ladder from this perspective is, for example, summarized in Eberhard and van Horen (1995: 66-70), based on findings of studies which were conducted in South Africa.

Other factors which have been found to play a role in household decisions concerning the choice of fuels and equipment devices are related to social characteristics of the population, food habits and cooking styles, the lack and cost of adequate information about the relative economics of fuel/device choices and, importantly, health and safety considerations as well as gender relations.[6]

For the design of urban household energy policies, a main preparatory task is therefore to analyze the relative importance of changes in these factors on energy consumption patterns. As mentioned above, a major problem in estimating these relationships is deriving reliable statistical evidence concerning the relative importance of these factors.

A fairly linear relationship has been found between household expenditure (as a proxy for income) and household size in a household energy study for Indonesia (ESMAP 1990b: 35). Even though household size is not always positively correlated with income, the important point is that there exist economies of scale, for example, in cooking for a larger number of people. A difficulty in establishing this relationship consists in the problem that households have to be distinguished from consuming units which may be a single person, a nuclear or extended family, or several households combined. The consuming unit has been suggested by Cline-Cole et al (1990) as a more adequate measuring unit for the purpose of

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6 Empirical evidence concerning the relative importance of the latter factors on fuel consumption and fuel/device choices is not further discussed, because there is hardly any useful information available in Malawi concerning these issues, so that no comparison with relevant findings or hypotheses in the literature is possible. However, it is emphasized that the role of (some of) these factors needs to be assessed in detail, for example, in designing woodfuel stoves and other household energy policy interventions. For example, in many situations women are aware of health (respiratory, etc) and safety (children getting burnt, etc) problems that effect their preferences. In addition, it has to be considered that the gender structure and relations within the household influences decisions concerning the utilization of household income for the purchase of appliances as well as for recurrent energy costs (see the discussion of empirical findings concerning the role of this factor in the literature in Eberhard and van Horen (1995: 70-72)).

investigating changes in fuelwood demand. Empirical estimates from four studies in African countries of urban fuelwood-using consuming households presented by ESMAP (1990b), show convex per capita consumption curves wherein the steepest decline of between 42.3 to 54.5% in consumption occurs when unit size increases from 1 to 2 to 3 to 4 persons. Increasing the consuming unit size to 5 to 6 persons was associated with a further per capita consumption decline of between 32.9 to 46.0% in three studies, and a 9.1% decline in the fourth. Further increases in consuming unit sizes resulted in declining per capita consumption growth rates.

This evidence suggests that the distribution of consuming unit sizes has to be taken into account when interpreting survey data. More generally, where income and family or consuming size are correlated and fuel substitutions involving higher fuel efficiencies occur, different outcomes in terms of the level of energy use may occur depending on the strength of the correlation.

As reported in Leach (1992: 116), regression analysis of household energy use which was carried out by the FAO (1987) for 40 countries, using time series data for the period 1981 to 1984, has resulted in statistically significant relationships between socio-economic factors and both the level of total energy consumption and the share of biomass fuels. Concerning total energy consumed, positive relationships were found between average income, population and the share of biomass fuels, while the share of households using biomass is negatively correlated with increasing income and the degree of urbanization. Urbanization was also found to compound income effects albeit at a decreasing rate at higher urbanization levels. Energy prices were found to be an insignificant variable.

A similar cross-country regression analysis covering 57 countries was carried out by Jones (1989). Estimated urbanization elasticities show that urbanization increases the share of total energy consumption per capita (elasticity 0.30) less than the consumption of modern energy (elasticity 0.45).[7]

Income has widely been found to be a major determinant of both the level of total energy consumption per capita, the share of households using modern and biomass fuels and the percentage of each type of fuel used.

With increasing income more modern fuels and their associated utilized higher thermal efficiency end-use appliances and utensils are used. While the level of energy services or useful energy use may rise with income, total (gross) energy use can either decrease or

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7 A series of other regressions was carried out by Jones (1989). However, because of a different specification of the regression models, comparisons with the results of the FAO study are difficult to make.

increase depending on the composition of the fuels used. Data from O`Keefe et al (1984) for urban households in Kenya in 1980 show that the total annual energy consumption of the lowest income group (31.6GJ) amounted to 75.6% of that of the highest income group (41.8GJ); the data also show a slight decline of total energy use with increasing income. Average annual total energy consumption data[8] for three cities in Tanzania and income groups (Hosier & Kipondya 1993: 457), reveal a similar ratio. The total annual energy use of the lowest income group (86.2GJ) amounted to 66.3% of that of the highest income group (129.9GJ). However, when adjusting the latter figures for differences in household size, the gross per capita consumption (22.86GJ) of the lowest income group (household size: 3.77) is only 1.1GJ higher than for the highest income group (household size: 5.95). Results from two urban household surveys held in Hyderabad and Raipur, India, which are discussed in Dunkerley et al (1990) show that the average household consumption of cooking fuels in Raipur were about 50% higher than in Hyderabad (see Dunkerley et al (1990: 92). Even though the composition of consumed household cooking fuels varied considerably between cities (on the basis of gross energy consumption), after adjusting gross energy consumption of fuels by the thermal efficiencies of the cooking equipment used, the level of useful energy (or energy services) used by the average household in Raipur was only 10% higher than in Hyderabad (see Dunkerley et al 1990: 94).

Similar data contained in O`Keefe et al (1984) for urban household energy use in Nairobi, Kenya, show, according to Leach (1988: 58), a 'classic' or prototype pattern. This pattern is characterized by a fairly strong negative relationship between income increases and the share of fuelwood used, a rise and subsequent decline in the share of charcoal and a similar rise and decline of kerosene associated with rising income, and the occurrence of significant shares of liquid petroleum gas (LPG) and electricity in total consumption only at higher income levels. However, despite the existence of such prototype patterns, empirical research has to take cognisance of the fact that there exist considerable variations in this pattern. This is, for example, emphasized by Leach (1992: 119), who suggests that: `Most other Third World cities show a similar progression but, as one may expect, with considerable variations in the fuel shares for each income band and incomes at which the main fuel substitutions occur.'

Empirical evidence from other urban household energy studies, for example, from Indonesia (see ESMAP 1990b: 26-7) shows that with rising income the share of fuelwood consumption steeply declines; kerosene for cooking is not closely related to income but highly income-sensitive for lighting; and LPG is closely following the pattern detected in

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[8] The total energy use data were calculated by applying conversion figures used by Hosier and Kypondya (1993) for Tanzania to energy quantities shown in Table 2 of their article.

Nairobi. Additionally, the cross-sectional evidence for household energy consumption patterns in three Tanzanian cities (see Hosier & Kipondya 1993: 462-463) demonstrates the existence of considerable country-specific deviations from the prototype patterns. The study found that across all income categories, kerosene consumption decreases in the three cities, while, compared to Nairobi, firewood consumption in two cities (Dar Es Salaam and Mbeya) decreased only modestly at higher income levels, and charcoal had an almost constant share across all income bands, except for the highest one where its share declined only modestly. LPG, which was only available in Dar Es Salaam, shows a pattern similar to the one in Nairobi.

Statistical estimates of the relationship between income and woodfuel consumption have, as may be expected, confirmed the nature of fuelwood as an inferior good. However, income elasticities of demand for fuelwood may also vary considerably. Cross-sectional regression analysis which was performed by Burney and Akthar (1990), using the 1984 household income and expenditure data of Pakistan, yielded income and expenditure elasticities of -0.09 and -0.21 respectively. In other words, an increase in income and expenditure of 1.0% was associated with a decline of fuelwood consumption of about 0.1% and 0.2% respectively. Time series analysis of woodfuel consumption data and the real minimum wage (which was chosen as a proxy for income) for the period 1974 to 1987 from Ghana (see Abakah 1990), showed that an increase in the real minimum wage of 4.0% was associated with a decrease of woodfuel consumption of 1.0%. Using data from an urban fuelwood survey in Hyderabad, India, Alam et al (1983) found that an income increase of 10.0% was associated with a decline in fuelwood consumption of 8.0%.[9]

The second key factor which is generally accepted to have a strong influence on variations in fuel consumption patterns are the relative system costs involved in using fuels for specific household energy end-uses. System costs are composed of the costs of fuel devices (stoves, lamps), fuel storage equipment such as LPG containers, connection and internal wiring costs in the case of electricity, and the size of payments associated with the utilization of each fuel. All cost factors may impose barriers to entry into the next step on the fuel ladder. The absolute and relative equipment costs, for example, for charcoal and kerosene stoves, relative to the income level of households, determine their affordability and hence their capability to switch between fuels. In this respect, fuel payments for fuelwood, charcoal and kerosene are usually of lesser importance in urban areas because these fuels can be purchased in local markets in small quantities, whereas electricity and LPG purchases typically require lumpy payments. A specific factor which is constraining

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9 This result was cited in Abakah (1990: 230).

the purchase of modern and typically energetically more efficient fuel devices is that in many Third World cities, but particularly in the lower-income countries, little, if any, consumer credit is available for lower-income groups which would allow them to convert lumpy payments for equipment or electricity and LPG into more affordable lower monthly payments.

Differential access to, and availability of fuels, are considered as important factors influencing household fuel choices and consumption patterns. The rationale is that differential dispersion of fuel supplies for major household end-uses entails higher user costs either in the form of higher local supply prices (because an additional layer of trading becomes involved) or as additional time costs (for fuel procurement) which act as a deterrent or may even be prohibitive. Similarly, generally unreliable or significant seasonal variability in the supply of fuels may also entail additional user costs and inconveniences which are a deterrent by themselves and which may compound effects of differential access on fuel choice. Access to, or availability of fuel supplies, are largely determined by the degree of development of the fuel supply infrastructure. The existence and relative importance of the effects of differential access to modern fuels on household energy consumption patterns, are typically demonstrated by pointing to different patterns of fuel consumption which exist in households with comparable incomes, living in cities and towns of different sizes and different distances to major supply points or centres. This type of comparison is necessary to isolate the income impact on fuel choice which may be highly correlated with city size.

Because of the economics of scale involved in the distribution infrastructure for petroleum fuels, development of their supply infrastructure typically follows demand which is closely related to settlement size. Therefore, city size often serves as a proxy for availability. Strong empirical evidence exists from various energy studies cited in Leach (1988) for ascribing variations in fuel consumption patterns to fuel availability (city size) as well as supply reliability. Particularly interesting is that in several studies a strong substitution of biomass fuels for household cooking was detected between city sizes up to 40 000 to 50 000 and cities with a population of between 50 000 and 300 000. Usually, unreliable supplies of fuels are expected to slow the energy transition.

As already mentioned above, the impact of prices on woodfuel substitution in the 1987 FAO study for 40 developing countries was not found to be significant. Similar evidence exists, for example, from the study of Burney and Akthar (1990) in which private- and cross-price elasticities were found to have very small values, that is fuel prices had very little impact on the fuel consumption of households. The low elasticities were partly due to the fact that actual consumption levels were estimated to be close to subsistence consumption levels.

Where statistical estimates cannot be performed due to the lack of adequate data, the effects of fuel prices on consumption patterns may be evaluated by estimating relative prices of fuel/device choices on the basis of the costs of useful energy delivered. Such studies provide a financial cost ranking of fuels which is used to interpret actual fuel consumption patterns. The underlying assumption of this approach is that households behave rationally as utility maximizers, so that deviations from the rational or least-cost pattern must be due to other factors. For example, the household energy use study for Tanzania mentioned above showed that there were distinct differences in effective energy prices favouring electricity, charcoal using an improved stove, LPG, charcoal using conventional stoves and firewood or kerosene (in that order). However, actual consumption patterns revealed that the relatively limited use of electricity and LPG was largely determined by fuel availability, while the relatively high use of kerosene was determined both by its reliability of supply and particularly by the fact that its real effective energy price has been consistently lower between 1980 and 1990 than that of charcoal. The latter implies that the difference in effective relative prices must have had an effect on fuel choice because kerosene equipment costs were only marginally higher than for conventional charcoal stoves.

While persistent differences in effective energy prices have an impact on the fuel/device choice, particularly where differences are large, relative energy prices do not seem to be the prime determinant of the energy transition. According to Leach (1992: 120):

> there is much evidence that the main role of energy prices is not to drive the energy transition but to promote shifts between fuels amongst households which use several fuels. That is, the major and most permanent step in the transition is, like a ratchet effect, the acquisition of modern fuel equipment. Once owned, other devices lower down the ladder - a charcoal and/or kerosene stove, say- are normally kept as an insurance against supply failure.

Because climbing the energy ladder through equipment purchases is perceived as a stronger factor in, and barrier to, interfuel substitution than fuel prices, the logical consequence drawn from this by Leach (1992: 120) is that 'fuel price differentials are more likely to bring about "backward" substitutions than an upward transition'.

Evidence supporting this asymmetric effect is provided, for example, by Leach (1992: 120), who reports on a massive backward substitution from kerosene to fuelwood in urban households in Sri Lanka over a period of two years when the ratio of prices for kerosene and fuelwood rose from 1.8 to 5.0. However, there is also evidence (ESMAP 1990a: 47-8) that an interfuel substitution process induced by sharp changes in relative fuel prices (here as a result of heavy rains), is not confined to backward or unidirectional changes. In response to a five-fold increase of the charcoal price from 30 to 150 Zambian Kwacha (ZK) per 40kg bag, about one-third of the households using charcoal shifted upwards to kerosene (23%) and electricity (1%), backwards to firewood (6%), and some (3%) to a combination of fuels. Though prices stabilized within a period of 9 months at a high price level of ZK100, and kerosene prices stayed at a competitive level, all households which had moved to kerosene or firewood eventually shifted back to charcoal.

7.2 URBAN HOUSEHOLD ENERGY AND INCOME DATA IN MALAWI

7.2.1 The household energy survey database

The only comprehensive data sources for urban household energy consumption in Malawi are the Malawi Urban Energy Survey (MUES 1984) which was conducted in 1983 and the MUHES (Ng'ong'ola 1991) which was started and finalized in 1990. Both surveys were carried out in the four main cities of Malawi, that is Blantyre (population in 1987: 333 120), Lilongwe (population in 1987: 233 318), Zomba (population in 1987: 43 250) and Mzuzu (population in 1987: 44 217).

These cities made up about 79.0% and 76.7% of the total urban population in Malawi in 1983 and 1987 respectively. However, for analytical purposes, these four cities have to be considered as covering all relevant urban areas because all remaining towns in Malawi have a population size of less than 10 000 and practically resemble low- to medium- density villages. Combined, the four main cities had about 122 000 and 170 000 households in 1983 and 1990 respectively.

7.2.2 Urban household income stratification and poverty

In order to capture relationships between household energy consumption patterns and income, households in both surveys were stratified according to the income classification employed by the National Statistics Office into high-, medium- and low-income households; low-income households were further categorized into five sub-groups according to the type of housing.[10] Table 7-1 shows the classification of households by income for both survey years and the income levels in constant 1980 MK.

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[10] The low-income groups are defined as follows: Low permanent (living in permanent housing, usually made of brick and supplied by the employer); low-traditional (living in traditional baked-brick or unburned-brick housing either rented or built by the household itself); low squatter (in temporary housing, usually mud-walled); low-in-high (servants in quarters belonging to high-income households); low-in-middle (servants in quarters belonging to middle-income families).

TABLE 7-1 Classification of urban households by income categories in the 1983 and 1990 urban household energy surveys

Income Category	*1983* Current MK (1)	*1983* Constant 1980 MK (2)	*1990* Current MK (3)	*1990* Constant 1980 MK (2)
			Income band	
High	> 6 500	> 6 273	> 9 528	> 2 142
Medium	1 600-6 500	1 175-6 273	3 180-9 528	715-2 142
Low	< 1 600	< 1 175	< 3 180	< 715

(1) *Source:* MUES 1984

(2) Current MK were converted to constant 1980 MK by using the Composite Retail Price Index for Malawi (see MSB, various issues)

(3) *Source:* Ng'ong'ola (1991: 8)

In order to interpret the income bands with regard to poverty characteristics, poverty line estimates are required. Though poverty can be measured in two dimensions, that is absolute and relative poverty, poverty line estimates are restricted here to the first concept because the latter concept is considerably more complex and no such research has been carried out in Malawi. Quantitative poverty line estimates can be established by using two concepts, that is by determining the monetary value of expenditures on food to fulfill minimum physiological requirements, or by determining a cut-off point for the share of food expenditures in total income. Both concepts are necessarily normative. The latter concept is particularly fraught with the problem of determining which share of food expenditures can be considered as a suitable yardstick for fixing the poverty line. If the poverty line suggested, for example, in Nelson (1979) is accepted, which is defined by households spending more than one-third of their income on food, then 51 to 75% of the households surveyed in Malawi in 1990 would fall into this category. Taking into account the distribution of the survey sample which included 76% of households classified as low-income, this cut-off point would imply that between two-thirds to 100% of the low-income households would fall below the poverty line.

According to the poverty line estimate of the World Bank (1990b) for Malawi which was based on minimum food requirements of US$40 per annum per adult (equivalent to MK108 per capita or MK454 for the average urban household), approximately 7% of the urban population was estimated to live below the poverty line. In terms of this poverty line estimate, none of the households classified in the low-income category of the 1990 survey would meet this criterion when average income figures are used (see Ng'ong'ola 1991: 27) for comparisons. However, such averages mask the actual distribution of incomes within each low-income group. An income survey conducted in 1988 in the traditional housing areas of Lilongwe and Blantyre by Roe and Chilowa (1989) shows that about 10% of the households had incomes which were below the poverty line defined by the World Bank. Considering the definition of the poverty line and in view of the range of the different poverty estimates shown above, it can only be concluded that a considerable share of the low-income urban households were living close to the poverty line in 1990.

Income groups in the total urban population can only be estimated because recent income or expenditure data were not available. Estimates from the 1983 survey (MUES 1984: 2) show that the average shares of low-, medium- and high-income households in the four cities were 88.1%, 7.8% and 4.1% respectively with no significant inter-city deviations from the average. The share of low-income households was higher than NSO estimates because the survey defined earnings in terms of cash income and thus excluded income in kind and the imputed value of subsidized housing provided by government or other employers. However, accounting for these income items would not reduce the share of low-income households significantly. Income in kind, of government employees which represent by far the largest sub-group of subsidized housing recipients, can only be expected to be rather low and the weight of housing costs in the composite price index amounts only to 13.3%.[11]

A consistency check shows that the estimate in the 1983 survey for the share of low-income households is probably on the high side.[12] How the share of the low-income households has developed until 1990 may be gauged from two sources of data, that is from the number of households which earn the statutory minimum wage and from the development of real incomes in Malawi. The labour market in Malawi is considered to be fairly competitive because wages tend to be market-determined. Due to the low education and formal skill level of labour in the country a considerable number of workers are paid the statutory minimum daily wage minimum wage.[13]

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11 See any Monthly Statistical Bulletin of the NSO on Page 23.

12 The following cross-check of the data was performed. Using the ratio (0.536) between the mean income of the low-income group from the 1990 survey and the upper-income band of that group, the mean income of the low-income group in the 1983 survey was calculated (in constant 1980 prices). Deflating this figure (MK857.6) by the price index to 1977 yields a mean income of MK600.3. According to income estimates for that year provided by Christiansen and Kydd (1987: 37), the cumulative percentage of the population with a mean annual household income of MK600.3 was 96.8%. As virtually all rural households (93.7% in 1977) are included in this percentage (see Christiansen & Kydd 1987: 28-37), the difference (3.1%) as a percentage of the total urban population (6.7%) represents the share of low-income households, that is 46.3%. This is probably a lower bound estimate.

13 The survey carried out by Roe and Chilowa (1989) for low-income households in Lilongwe and Blantyre (sample size: 2 000 households) showed that 84% of the sampled households had one income earner. Of those with formal employment, 8% had a mean monthly income of MK30.0 in the MK20.0-39.99 income bracket, and 21% had a mean income of MK54.0 in the MK40.0-69.99 income bracket. The survey was implemented during a time period when the statutory minimum daily wage was MK1.11. Hence, the monthly minimum wage (assuming 26 working days which are typical in Malawi) was MK28.9. 8% of those formally employed had incomes which were almost identical with the minimum wage. It should be noted that wage levels in the industry

In Figure 7-1 the development of two income indicators for the period 1980-90 are shown - the real urban (monthly) SMW and real average monthly earnings in industry.[14] The figures show that real monthly income measured by the SMW was 16% lower in 1990 compared to 1983. In the interim period declines and upswings occurred, but none of the upswings reached the 1983 level. Overall the real income decline for the lowest income wage earners was moderate. However, the real income for other wage earners declined steadily since 1983 and was 44% lower in 1990 compared to 1983. By 1990 the income differential between these categories of wage earners had narrowed from MK25.0 in 1983 to MK10.0.

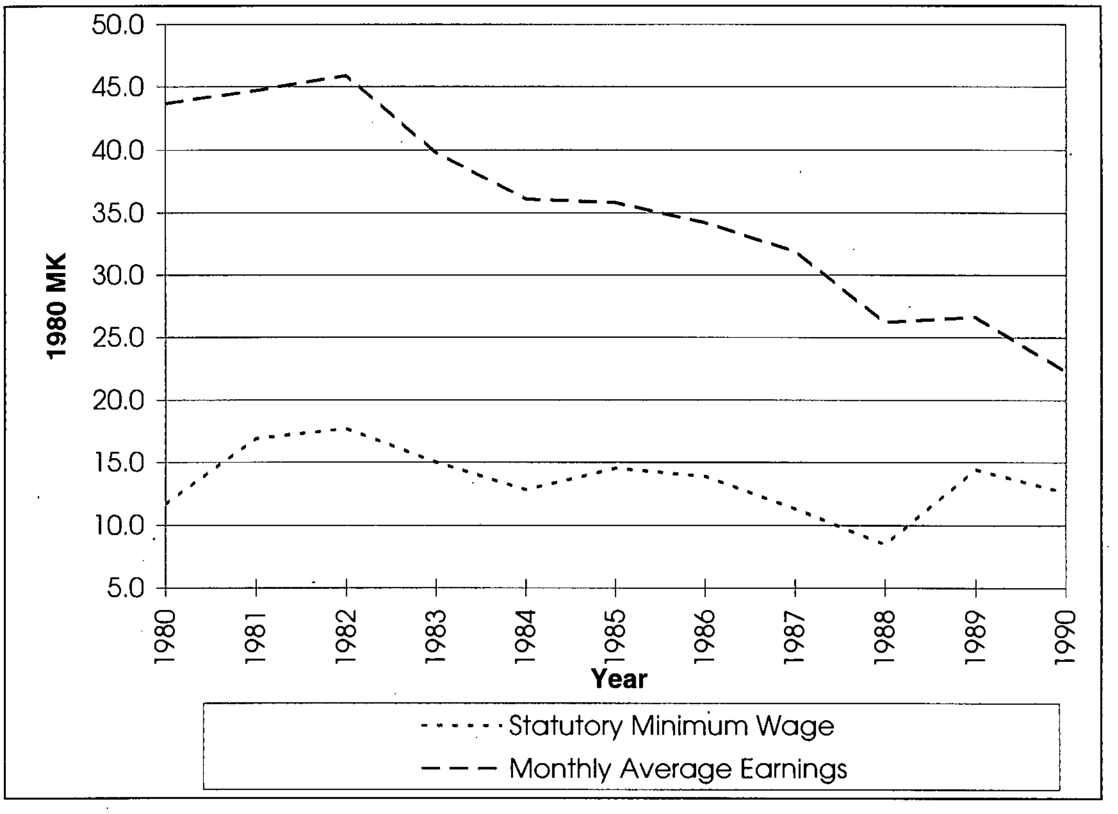

FIGURE 7-1 Minimum wage and monthly average earnings 1980-1990 (in constant 1980 MK)

7.3 ANALYSIS OF HOUSEHOLD ENERGY CONSUMPTION PATTERNS

The discussion in this section is structured as follows. The first section (7.3.1) provides an overview of the aggregate average monthly household energy consumption pattern in the four major cities of Malawi. The first part treats the aggregate level of energy consumption. The empirical findings that per capita income level (GDP per capita) and the net energy consumption of urban households are correlated across countries, and that the level of useful energy consumption of urban households does not differ significantly, are discussed

group agriculture, forestry and fishing, which accounted in March 1989 for 49.2% of all employees in the formal sector, had monthly average earnings (MK30.25) which were close to the minimum wage (see MSB, January 1993: 6).

[14] Data for Figure 7-1 are shown in Annex 7-1.

by comparing the respective data for Malawi and Tanzania. This comparison also serves the purposes of checking whether the urban household energy data in Malawi are in line with what may be broadly expected or whether any major deviations can be found which point to the influence of 'unusual' factors influencing the level and composition of energy consumption. The overall quality of data is also checked.

The results of the analysis in section 7.3.1 show that no major data problems could be ascertained on the basis of cross-country comparisons, except for the fuelwood figures for the city of Mzuzu.

Against the background of the findings in the previous section, section 7.3.2 starts with a comparison of energy consumption patterns by income groups (low-, medium- and high-income) and comments on the patterns in relation to the key determining factors which are known from the literature. This is followed by an analysis of how the factors income, access and availability, fuel prices, cookstove costs, household preferences and income/expenditure-energy/appliance cost relationships may have influenced energy consumption patterns and interfuel substitution. This section is followed by a comment on the urgency of energy-poverty linkages in urban households in Malawi.

7.3.1 Patterns of household energy use by city

Table 7-2 shows summary data for household energy consumption by city in 1990. The most striking feature in the data is that woodfuel is the dominant cooking fuel with utilization rates in excess of 90.0%, except for Blantyre where only three-quarters of all urban households used fuelwood. The lower percentage is explained by a comparatively higher percentage of households using charcoal and higher quantities of charcoal being consumed. The average consumption of fuelwood in Mzuzu is considerably lower compared to all other cities.

Such a large deviation is implausible and must have been introduced during the processing of data. However, this error is confined to fuelwood consumption only because the other data for Mzuzu are plausible. The percentage of households using charcoal ranges from 23.6% in Zomba to 43.2% in Blantyre. Kerosene utilization levels vary significantly by city, ranging from 38.1% in Mzuzu to 72.9% in Blantyre. Utilization rates of electricity range from 51.6% and 54.7% in the smaller cities and are, surprisingly, lower in the larger cities. Kerosene was found in the 1990 survey to be almost exclusively used for lighting[15] and electricity was mainly used for cooking in high-income households. This suggests that for

[15] 97.4% of the households used paraffin for lighting, while 1.1 to 2.9% of the households used paraffin for cooking different kinds of meals (see Ng'ong'ola 1991: Table 12).

cooking purposes either the fuel costs, or fuel and equipment costs combined, must have represented a strong barrier to fuel switching. The lower utilization rates of electricity in the bigger cities may be income-related because both utilization rates and quantities of electricity consumed seem to be correlated with average household incomes.

TABLE 7-2 Monthly household energy use by fuel and city in 1990

Fuel/City	*Blantyre*		*Lilongwe*		*Mzuzu*		*Zomba*	
Units/month	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*
Fuelwood (kg) (1)	75.7	480.8	91.8	476.7	94.3	91.7	95.3	503.3
Charcoal (kg) (2)	43.2	17.5	28.7	10.0	36.2	15.1	23.6	9.9
Kerosene (l) (3)	72.9	1.7	56.1	1.9	38.1	0.9	47.2	1.2
Electricity (kWh) (4)	27.2	48.0	43.7	51.6	61.9	125.6	54.7	57.8
Other (kg) (5)	6.4		7.2		0.9		2.8	
Gross energy (MJ) (6)		8 195.9		7 931.3		2 342.6		8 339.7
Net energy (MJ) (7)		937.3		914.7		498.2		962.8
Household size (8)		5.4		6.2		6.0		6.6
Net energy/capita		174.9		146.6		82.5		147.0
Household net income (MK) (9)		227.1		262.0		384.1		365.7
Household income/capita		42.4		42.0		63.6		55.8

(1) Calculated from Ng'ong'ola (1991: Table 36)
(2) Calculated from Ng'ong'ola (1991: Table 38)
(3) Calculated from Ng'ong'ola (1991: Table 40)
(4) KWhs were calculated by dividing mean monthly expenditure data for electricity from Ng'ong'ola (1991: Table 14) by an estimated weighted average tariff (MK0.16/kWh) using the ESCOM Scale I and Scale II tariffs (April 1990)
(5) 'Other' include sawdust and agricultural residues
(6) Gross energy is calculated using the following conversion factors: fuelwood: 15.5MJ/kg; charcoal: 29.0MJ/kg; paraffin: 36.0MJ/kg; electricity: 3.6MJ/kWh
(7) Assumed conversion efficiencies are 10% for fuelwood, 12% for charcoal, 30% for kerosene and 65% for electricity
(8) *Source*: Ng'ong'ola (1991: Table 5)
(9) *Source*: Ng'ong'ola (1991: Table 13)
Note: Data for users are from Ng'ong'ola (1991: Table 10)

A second striking result is the complete absence of a city size effect. In other words, if city size is interpreted as a proxy for access to and availability of fuels, the conclusion is warranted that there either exist no discernible differences or that such differences do not show up in the data because the consumption levels of modern fuels are so low. Woodfuel markets in cities are generally known to have a better spatial coverage than modern fuels because of the multitude of suppliers which are engaged in the trade and different distribution channels. This is also the case in Malawi.

Woodfuels have a share of about 98% in total gross energy consumption, and gross energy consumption per household is similar in all cities except for Mzuzu, on account of the data error for fuelwood consumption. As the share of biomass fuels in terms of utilization rates and quantity used is relatively uniform, the net energy (useful energy) consumption per household does not differ considerably, except for Blantyre. The higher consumption level in Blantyre may be accounted for by a combination of the comparatively lower mean household size and colder temperatures, that is higher heating requirements during the winter time.

In this respect, it is interesting to note that the level of net energy consumption found in Malawian cities in 1990 was on average about 17% higher compared to the one estimated for various Tanzanian cities (see Hosier & Kipondya 1993: 455). As discussed above, household income is considered to be a major explanatory variable for (cross-country) differences in household energy-use levels. Comparisons based on annual income figures have to be used with caution because energy consumption changes in response to changes in income may be time-lagged, so that income trends have to be considered. Average income levels measured in GNP per capita for Malawi (1985-90) and Tanzania (1985-1989) were US$166 and US$199 respectively (UNDP/World Bank 1992: 32). It is worthwhile to note that the average figure for Malawi contains a decline in 1985/86 and an increase thereafter, while the average figure for Tanzania masks a decline to virtually the same level of income as in Malawi in 1988 and a drastic decline to US$129 in 1989. Broadly the relationship between per capita income and the net energy consumption level of urban households in Malawian and Tanzanian cities, corresponds to findings from other research.

7.3.2 Household energy consumption by income groups

7.3.2.1 Comparison of energy consumption patterns

Table 7-3 shows the household energy consumption by income group for all cities. The patterns of fuel utilization and consumption within income groups and across income groups show several distinct similarities and a few major differences. In Blantyre, where the utilization rate of fuelwood in the high-income group (23.1%) is considerably lower than in the other cities (68.4-90%), the utilization rates of fuelwood increases with declining income. However, this pattern looks different for the other cities. In Lilongwe, fuelwood use also increases with decreasing income but drops off slightly in the lowest, compared to the middle-income category. The patterns in Mzuzu and Zomba show high initial utilization levels for fuelwood (90%) which are almost at the same level for middle-income households and are increasing in low-income households. Overall fuelwood quantities consumed by income groups in all cities show what may be expected: increasing consumption levels are associated with declining income. However, there is an aberration from this pattern for middle-income households in Lilongwe, where fuelwood consumption is higher than in low-income households.

TABLE 7-3 Monthly average household energy use by city and income group, 1990

Fuel/City	*Blantyre*		*Lilongwe*		*Mzuzu*		*Zomba*	
Income group	***High income > MK 795/month (= >US$ 285.4)***							
Units/month (1), (2)	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*
Fuelwood (kg)	23.1	205.0	68.4	270.8	90	15.8	90	283.3
Charcoal (kg)	51.3	22.9	45.6	25.7	40	18.4	25	13.6
Kerosene (l)	5.1	0.1	31.6	1.1	n.a.	n.a.	5	0.5
Electricity (kWh) (3)	94.9	493.1	75.4	253.0	100	485.4	100	395.8
Household size (4)		6.9		7.6		7.0		8.1
n (5)		39		57		20		20
Income group	***Medium income MK 285.3 - 795.0/month (=US$ 95.2 - US$ 285.3)***							
Units/month (1), (2)	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*
Fuelwood (kg)	49.2	371.7	96.1	666.7	90	80.8	85	184.2
Charcoal (kg)	64.3	38.1	42.7	15.7	50	25.6	15	9.7
Kerosene (l)	29.1	1.5	48.5	2.7	5	n.a.	n.a	n.a.
Electricity (kWh) (3)	73	187.0	44.7	74.7	95	190.9	100	211.3
Household size (4)		7.36		7.67		6		6.55
n (5)		126		103		20		20
Income group	***Low income < 285.3/month (=< US$ 95.2)***							
Units/month (1), (2)	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*	*Users (%)*	*Quantity*
Fuelwood (kg)	83.9	517.5	93.7	456.7	96.9	120.0	100	654.2
Charcoal (kg)	38.7	13.1	23.7	6.9	30.8	10.6	25.8	8.8
Kerosene (l)	82.7	1.9	60.5	1.8	60	1.8	74.2	1.8
Electricity (kWh) (3)	14.4	9.7 (0.0)	39.7	69.6 (16.7)	40	59.7 (8.5)	27.3	13.2 (0.0)
Household size (4)		4.9		5.8		5.9		62
n (5)		659		490		65		66

(1) Quantities for fuelwood, charcoal and kerosene are from Ng`ong`ola (1991: Tables 36, 38 and 40)

(2) Percentage of users by fuel type are from Ng`ong`ola (1991: Tables C2-C5)

(3) Calculations were based on monthly fuel expenditure data (Ng`ong`ola 1991: Tables D1-D4) and the ESCOM Scale I (domestic) tariff for the high- and medium-income groups and the Scale II (high density) tariff for the low-income group. For the low-income group, the electricity expenditures of households in permanent buildings was used. Figures in brackets show the average consumption for the low-income group. Zero consumption indicates that the monthly expenditure on electricity was below the fixed monthly charge of MK2.05 in 1990

(4) Data for household sizes are from Ng'ong'ola (1991: Table 5)

(5) Data for sample sizes by city are from Ng'ong'ola (1991: Table 7)

Charcoal utilization shows the expected pattern of increasing utilization rates for middle-income households and lower utilization rates in low-income households. Again, there is an aberration of this pattern in the medium-income households of Lilongwe and Zomba where utilization rates and quantities consumed are lower than in the high-income group. However, charcoal consumption still continues to increase in the high-income group. Across income groups, kerosene utilization rates for lighting show a classic pattern in that utilization levels increase in distinct steps with declining income. For high- and middle-income groups, kerosene utilization rates in Lilongwe are higher than in Blantyre. This may be explained by the distinctly lower electricity utilization and consumption rates in Lilongwe which seem to be counterbalanced for lighting purposes by considerably higher consumption rates for kerosene.[16]

Electricity utilization rates decrease significantly with decreasing income, though utilization rates in the middle-income group in Mzuzu and Zomba are almost at the same level as for high-income households. However, in terms of quantities consumed, the data show a classic pattern because, despite higher utilization levels for medium-income households, their consumption levels are comparable to the one in Blantyre.

Data in Table 7-3 show that fuelwood comprises the largest share of energy consumption in all cities and across all income groups. Fuelwood behaves as a normal good at the low-income level and then becomes an inferior good at higher-income levels. Charcoal and electricity consumption instead show characteristics of a normal economic good across all income categories, while the opposite behaviour applies in general to kerosene.

7.3.2.2 Analysis of determinants of energy consumption patterns

Variations of energy consumption levels across cities and income groups may be explained by differential access to and availability of fuels, income, relative energy prices and useful energy costs, and the barriers imposed by the cost of fuel devices on switching to higher-grade fuels and electricity. In the following it is analyzed how these factors have influenced the energy consumption patterns which are shown in Table 7-3.

7.3.2.2.1 Household energy end-uses, appliance ownership and income

The MUHES distinguished between seven major end-uses, that is water heating, heating, lighting and cooking of slow foods, quick foods and main meals, and other uses. The survey revealed the following end-use patterns. Firewood is the dominant fuel for water heating and cooking. Relative to charcoal, twice as many users use firewood compared to charcoal. Conversely, charcoal is the preferred fuel for heating for almost twice as many households.

Nine different types of stoves are used for cooking purposes in urban households in Malawi. Among these, the traditional three-stone stove and the traditional metal stove which is fired with both fuelwood and charcoal, represent the most commonly used stoves

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[16] It should be noted that LPG does not play a role in Malawi because only minor quantities are imported rather infrequently into Malawi. LPG is only being sold in Blantyre to a few high-income households.

in urban households.[17] The utilization of the traditional three-stone stove is highly related to income in all cities, ranging for high-, middle- and low-income households from 10.3 to 65.0%, 55.0 to 89.0% and 72.0 to 91.0% respectively. In the same income groups, traditional metal stoves are used at levels ranging from 25.0 to 40.4%, 30.0 to 45.1% and 21.2 to 45.1% respectively. Approximately three times as many households use the three-stone stove compared to the traditional metal stove. With regard to relative usage rates of both types of stoves, there exists a distinct inverse relationship across income groups: the higher the percentage of households using the three-stone stove the lower is the usage of the traditional metal stove. The ratio of utilization of these two stoves by income groups range from 1.5 to 2.5 for high-income households, 1.6 to 2.3 for medium-income households and 3.3 to 4.3 in low-income households. However, there are three deviations from the characteristics of stove utilization discussed above.

First, in middle-income households in Lilongwe, the percentage of middle-income households using the three-stone stove (89.2%) is about 30% higher compared to the average user rates of the other cities. At the same time, the percentage of households using the metal stove (45.1%) is about 13% higher than the average user rates in the other cities. This can be partly explained by the low percentage of electric stoves which are used in middle-income households in Lilongwe (7.3%), in comparison to Mzuzu (30.0%) and to Zomba (40%). Secondly, in Blantyre, where the dissemination of a more efficient charcoal ceramic stove was first promoted in Malawi, and reached a utilization rate of 41.0% in high-income households, compared to a utilization rate in the range of 0.0-8.8% in other cities, utilization rates of the traditional three-stone stove in high-income households (10.3%) are considerably lower than in the other cities (50.0-64.9%). The utilization rate of the metal stove in high-income households (23.1%) is also lower than in the other cities where user rates range from 25.4 to 40.4%. These data suggest that high-income households must have primarily substituted the traditional three-stone stove with the ceramic charcoal stove. This change also implies a partial switch from fuelwood to charcoal. Thirdly, in low-income households in Blantyre, the utilization of the three-stone stove is about 17% lower than the average of the other cities, where utilization rates range from 87.7 to 90.9%, while the utilization of the metal stove is about 24% higher compared to the average of the three other cities, where utilization rates range from 21.2 to 26.6%. These data suggest that the dual-fuel metal stove is the main substitute for the three-stone stove.

The conclusion that can be drawn from these findings is that a fairly steep gradient may exist in urban households with regard to the possession of the major two types of stoves: the

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[17] The following discussion is based on the data concerning the utilization of stoves in cities from Ng'ong'ola (1991: Tables H5 - H8).

higher the utilization rate of fuelwood, the lower is the utilization rate of the traditional metal stove.

Improved ceramic charcoal stoves have been used by 5% and 8.8% of the high-income households in Mzuzu and Lilongwe, while 8.0 to 15.0% of the middle-income households and 1.5-3.0% of low-income households in cities other than Mzuzu (where no utilization was reported) were also using this stove. The ceramic firewood stove which was introduced as a fuel-saving device, targeted primarily at low-income households, has not made any tangible inroads into urban households because less than 0.6% of low-income and 0.4% of all households were reported to use this stove.

Utilization rates of paraffin stoves in low-income households range from 1.5 to 5.0% and are used by 1.2 to 3.0% of all households for water heating and cooking. Except for Lilongwe, where 10.5% of the high-income households use paraffin stoves and where the utilization of electric stoves (47.4%) is about 30.0% lower compared to the other cities, no paraffin stoves are used. This lower utilization rate is consistent with the significantly lower electricity consumption of its high-income households (see the discussion below). In middle-income households, the utilization rates of electric stoves are significantly lower, ranging from 4.9% in Lilongwe to 10.3% in Blantyre, and to 30% and 40% in Mzuzu and Zomba respectively. Again, the low utilization rates in Lilongwe partly explain the much lower electricity consumption of these households compared to the other cities. In middle-income households in Mzuzu and Zomba no paraffin stoves are used. In Blantyre only 2.4% of the middle-income households used paraffin stoves, whereas in Lilongwe 7.8% of the middle-income households used paraffin stoves. In low-income households, the utilization of paraffin stoves and of electric stoves (or hot plates) ranges from 1.5 to 5.0% and 0.0 to 3.3% respectively.

Overall, the above characteristics of user rates for stoves by income groups indicate that the utilization of stoves seems to be strongly correlated with income. The survey data also suggest, that the lower the income of households, the lower is the utilization of the traditional metal stove. The fact that the purchase cost of the traditional metal stove is low (see Annex 7-2) and that a considerable number of households who were using both the three-stone stove and the metal stove judged the latter to be more fuel-efficient (see Ng'ong'ola 1991: 79), suggests that even low cash outlays for this stove may impede its purchase. This also implies that the lower income households have less flexibility to adapt to changes in relative fuel prices. Therefore significant price changes of fuels are more likely to be observed in the fuel substitution pattern and changes in the utilization of stoves in the medium- and higher-income groups.

7.3.2.2.2 *Differential access to fuels and fuel availability*

There is no evidence of major woodfuel supply interruptions in urban woodfuel markets. Apparently, this factor has not played a significant role in determining the fuel consumption patterns indicated by the survey in 1990. In the cities of Malawi, the availability of paraffin in urban areas does not appear to be constrained either. According to information provided by the oil companies operating in Malawi, [18] most of the kerosene sold to private consumers is sold at filling stations, while smaller amounts are sold to the commercial sector. The relative importance of these supply sources is confirmed by the findings of the MUHES. On average, with minor variations across cities, 91.4% of households were found to purchase paraffin from filling stations. Only 18.2% bought from grocery shops, 7.9% from local markets and 4.6% from other sources, mainly small door-to-door vendors (see Ng'ong'ola 1991: Table 20). The composition of sources of supply indicates that the existing distribution infrastructure is unlikely to entail major differential access problems within particular areas of the cities, because this would be reflected in much higher figures for purchases from other sources. In addition, filling stations appear to be fairly well-distributed within the cities and along major roads.

Multiple stove utilization is usually also attributed to differential (seasonal) availability of fuel supplies which is an expression of a household fuel supply security strategy. Therefore, the general low level of multiple stove use, particularly in Malawi's lower-income households, may be interpreted as an additional indicator for the absence of past seasonal supply interruptions or differential availability.

As access problems can be largely ruled out as a major factor constraining the use of woodfuels and paraffin, relative fuel prices, user energy costs and cooking equipment costs must be considered as the major factors determining the low overall utilization of paraffin for cooking, both in low- and in middle-income households and the overall consumption pattern. Similarly, connection costs and costs for internal wiring represent a barrier to the increased use of electricity.

7.3.2.2.3 *The influence of fuel prices and energy appliance costs on energy consumption patterns*

In order to investigate the relative importance of fuel prices and energy appliance costs[19] on

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[18] Interviews were conducted in 1990 with representatives of the oil companies operating in Malawi, especially with those of Shell, which runs the most extensive network of depots and filling stations in the country.

[19] It has to be noted that, even though fuel prices and equipment costs are analytically treated as separate factors, in combination, they constitute a third decision factor, that is the role which comparative useful energy costs or pure cost considerations play in the choice of fuels and interfuel substitution.

fuel consumption decisions of households, the methodology of calculating comparative user energy costs can be employed. The rationale of this approach is to compare the combination of fuel/equipment options available to consumers to meet the energy demand for a particular end-use (cooking, lighting, refrigeration, and so on) in terms of the discounted costs (life cycle costs) per unit of useful energy. The objective of performing such calculations is to generate a ranking of fuel/equipment options. Because the ranking of options is based entirely on costs, it does not take the influence of other decision factors, which were discussed in Section 7.1, into account. Even though the relative costs of options may be considered as a major decision factor, deviations of actual energy consumption patterns from the purely cost-oriented ranking, indicate that other decision factors and constraints must have influenced the fuel/equipment decisions of households. Thus, when major deviations are observed, the influence of other decision factors needs to be analyzed.

A major issue in conducting this analysis is the availability of sufficiently reliable data in estimating the useful energy costs for end-use options because they serve as the benchmark for comparisons. As the discussion below will show there are several uncertainties involved in estimating technical parameters which are required for cost calculations, especially for the thermal efficiency of cooking options. For this reason, the assumptions made for user cost calculations are discussed in detail. Most of the survey data which are used in the following analysis are those compiled by the MUHES in 1990. The report of the survey (see Ng'ong'ola 1991) contains a wealth of data but did not conduct any in-depth policy analysis. Because of the necessity of comparing the energy consumption patterns in the four major cities in Malawi, and their fine differences, it was considered necessary for an adequate understanding of the following discussion to present a considerable amount of detailed survey data.

Since cooking is the major energy end-use in urban households and a comprehensive analysis of lighting options for urban households has already been conducted by deLucia & Associates (1992), the scope of the following analysis was confined to a comparison of cooking options.

The comparison of user energy costs for different fuel/stove options in terms of effective fuel prices and of useful energy costs, which is shown in Annex 7-2, was based on assumptions for the market price of fuels, fuel heating values, conversion efficiencies, cost and economic lifetime of equipment, and the choice of a financial discount rate. As can be seen from Annex 7-2, the variables having the strongest impact on the calculations of user costs are fuel prices and device efficiencies. Fuel prices, device efficiencies and other input data used for the calculations were estimated as follows.

Assumptions for user cost calculations

The prices for fuelwood and charcoal were based on their average cost for the period January to December 1990. These data are compiled monthly in woodfuel markets in all four cities by the NSO.[20] Market prices compiled by the NSO refer to split pieces for fuelwood and small bags of charcoal which are typically traded in urban markets.

The price for paraffin was based on the weighted average paraffin price in 1990 (MK1.12/l).[21] This price assumption is considerable lower compared to the average price for Blantyre (MK1.49/l) and Lilongwe (MK2.23/l) per litre which was ascertained by Ng`ong`ola (1990: 42) by dividing reported expenditure for kerosene by reported consumption. Even though smaller traders are known to charge a mark-up, their limited role in total household kerosene supply does not support the assumption of a significant price premium.

Costs of electricity for urban households vary by consumer tariff. Households pay the domestic tariff (Scale I) or the high density domestic tariff (Scale II).[22] Due to the construction of the tariffs, costs per kWh vary considerably with the level of use under the Scale I tariff. For households with a consumption of approximately 500kWh per month, that is for high-income households (see Table 7-3), the average costs per kWh are about MK0.16, increasing to MK0.21 per kWh at a consumption level of 200kWh per month. The latter consumption level is approximately typical for the average middle-income household. The Scale II tariff is constructed in such a way that unit costs are not very sensitive to the level of consumption. The average costs per kWh at monthly consumption levels of 50, 100 and 200kWh are MK0.141, MK0.123 and MK0, 121 respectively. Consumption below 50kWh per

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[20] Fuelwood and charcoal is being supplied from various sources (urban markets, roadside/village markets, door-to-door sellers, government reserves, and privately-collected wood). In larger cities, urban markets, door-to-door sellers and supplies from government plantations are the main sources of fuelwood. In smaller cities, supplies from government reserves and door-to-door sellers are the most important sources of supply. Their own collection of fuelwood was found in the MUHES to be a regular source of supply for only 5.7% of the urban households. Fuelwood is being sold in the form of split pieces, headloads, bundles or logs. Market prices vary in relation to the degree of preparation of woodfuels when sold. Split pieces command the highest prices on account of the labour costs for splitting the wood. About half of the households in the 1990 survey bought wood in split pieces, followed by headloads and bundles (18.0%), with a price premium of about 27% for the former. Charcoal is bought by about 60% of households in bags from door-to-door sellers and from urban markets (see Ng'ong'ola 1991: 34-38).

[21] The price of paraffin during the first three months of 1990 was MK1.06/l. The price was raised to MK1.10/l in April, followed by an increase to MK1.22/l in October which lasted until the end of the year. When the survey was conducted, the price of paraffin was MK1.22/l.

[22] The Scale I tariff applies to residences in low density areas which are a proxy for residences occupied by medium- and especially high-income earners. The tariff is composed of a fixed charge of MK10.25 per month, a charge for the first 225kWh at MK0.16/kWh and a charge of MK0.12/kWh for units in excess of 225kWh. The Scale II tariff is applicable to low- and medium-cost residences. The tariff has a low fixed charge of MK2.05/month, a charge of MK0.1/kWh for the first 150 units and a charge of MK0.15/kWh for units in excess of 150kWh.

month hardly implies any electric cooking, while use levels of about 100kWh may be considered as the minimum consumption for households which regularly cook with electricity. Low-income households usually reside in housing areas where the Scale II tariff is being charged, while middle-income households reside both in low density and high density housing areas. Therefore either the Scale I or the Scale II tariff is being charged. Thus for low-income households considering the option to switch to electricity, an average cost of MK0.12 per kWh was applicable, while middle-income households had to pay an average cost per kWh of either MK0.12 or MK0.21 if their average consumption units were 200kWh. These two unit cost levels were used in the calculations.

Heating values of fuels which are shown in Table 7-2 were taken from the Malawi Energy Information System (see Romahn 1991b).

The estimation and accuracy of thermal efficiencies of stoves has been a controversial issue in the literature. For example, Gill (1987) has demonstrated that most of the data reported in the literature until 1987 concerning the efficiencies of various types of stoves were cross-referenced, while only a limited number of efficiency figures were based on actual performance tests. Different eating habits, types of pots used and cooking practices influence the measurement and comparability of measured stove efficiencies. Measurement problems are also compounded by the problem that stoves used in real-life cooking situations hardly ever perform as well as under laboratory testing conditions. As a result, efficiencies for the three-stone stove in Malawi were based on widely quoted figures in the literature, [23] ranging from 8.0 to 12.0%. In view of the findings from the MUHES concerning the relative fuel efficiency of the traditional metal stove compared to the three-stone stove, an efficiency of 12% was assumed for the former.

Two types of tests have been conducted in Malawi to ascertain stove efficiencies for the firewood ceramic stove (mbaula).[24] A survey conducted in Mozambican refugee camps in Malawi addressed the issue of fuel efficiency only qualitatively, as have many other surveys

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[23] See, for example, Gill (1987: 142-4) for a comprehensive comparison of stove efficiencies quoted in the literature and Leach and Gowen (1987: 69) who have compiled average cooking efficiencies for stoves and fuels.

[24] The design of this stove, the main features of which are a metal casing and a ceramic liner, was partly adopted from an all-metal Kenyan firewood stove ('jiko') in 1987. Stove production and dissemination has been promoted by the Energy Studies Unit of the Ministry of Forestry and Natural Resources in Malawi. As shown in the MUHES, the adoption rate in urban centres has been low which was partly due to the fact that the urban stove dissemination programme was still in its development stage at the time when the survey was conducted. Major dissemination activities, including direct sales and sales through supermarkets, were primarily undertaken in Blantyre and Lilongwe. Several thousand stoves were also supplied to refugee camps in Malawi. Through resales, an unknown number of these stoves were purchased by households in Blantyre and Lilongwe.

of improved cookstove programmes, and found that stove users had considerably reduced the frequency of firewood collection trips (see Mhango 1990: 6). Boiling and cooking tests of the stove were also conducted by Demante (1990) who found an efficiency improvement of 44% relative to the three-stone stove. However, the test was conducted only once so that this result cannot be considered representative. The ceramic firewood stove was field tested and had shown savings of 50% of firewood under laboratory conditions, compared to the traditional metal stove, and a thermal efficiency of 30% (DOF 1990b: 2).

Because remaining uncertainties as to actual device efficiencies cannot be resolved as long as cooking tests or the application of advanced statistical techniques[25] have produced more reliable data for Malawi, surrogate thermal efficiency data were used. Efficiency assumptions for the improved firewood stoves, improved charcoal stove (the ceramic charcoal stove in Malawi), [26] kerosene stoves and electric stoves were based or related to stove efficiency data contained in Leach and Gowen (1987: 64). The ceramic fuelwood and charcoal stoves disseminated in Malawi were thus assumed to have an efficiency of 25%, that is 5% less than measured under laboratory conditions.

Equipment costs and lifetime estimates for improved stoves were taken from the DOF (1990b: 3), Mhango (1990) and Demante (1990), while equipment costs for kerosene and electric cookers and electricity connection costs were taken from deLucia & Associates (1992: Table 7-2). A discount rate of 25% was used. This assumption takes into account an average inflation rate of consumer prices of 13, 3% and high credit costs.[27] The assumption and results of these calculations are shown in Annex 7-2. The costs and ranking of cooking options in terms of (discounted) useful energy costs are summarized in Table 7-4.

Comparison of user energy cost calculations and fuel consumption patterns

As can be seen in Annex 7-2, the ranking of charcoal and firewood stove options is strongly influenced by relative fuel prices. In Mzuzu and Zomba, where fuelwood and charcoal prices are considerably lower compared to the larger cities, using fuelwood in an improved

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25 The problem of estimating end-use efficiencies of appliances in connection with changes in fuel use which may accompany a fuel switch, was overcome in ESMAP (1990b), where the researchers developed a specific statistical procedure to estimate fuel substitution ratios which are independent of exogenously assumed conversion efficiencies of end-use devices.

26 The ceramic charcoal stove in Malawi was also designed on the basis of the Kenyan 'jiko' stove.

27 The average inflation rate was based on the low- and medium-income retail price indices in Blantyre and Lilongwe which ranged from 10.0 to 16.2% in 1990 (see MSB, February 1992: Tables 22 and 23). It should be noted that consumer credit is hardly available in Malawi and that interest rates in informal credit markets are also high. Even though it has to be considered that individual households may even apply subjective discount rates in excess of 25%, it has to be taken into account that the results shown in Annex 7-2 are not very sensitive to variations of the discount rate.

stove was by far the lowest cost option. However, no household was found to have bought this stove in Zomba and only 5% of all high-income households in Mzuzu used the stove. In Mzuzu, where the improved charcoal stove would approximately halve the cost of cooking with a traditional metal stove, only 1.5% of the low-income households used this stove compared to 5% of the high-income households. Using an improved charcoal stove is even more expensive than cooking with fuelwood on a three-stone stove at low efficiency, but would also cut the costs of using charcoal in a traditional metal stove by 50%. However, none of the low-income households used this stove, which suggests that stoves were not affordable enough. In comparison, 15% of the middle-income and 5% of the high-income households used the stove in Mzuzu. Paraffin stoves were not attractive options for households in both cities. This explains its low use by low-income households in Zomba (1.5%) and in Mzuzu (4.6%). Middle-income households in both cities did not use paraffin stoves at all. In comparison to the larger cities, where paraffin stoves are used by more middle-income households (see below), this may be explained by the considerably higher use of electric stoves in the smaller cities which was ranging between 20.0 to 30.0%.

The least-cost cooking option in Lilongwe was also the ceramic firewood stove, followed by the electric stove for low- and middle-income households benefiting from the Scale II tariff and, with only marginally higher costs, for the improved charcoal stove. The dissemination and marketing programme for improved woodfuel stoves was under implementation in Lilongwe and Blantyre in 1990, although it may be argued that not all households were aware of the availability of these stoves. That 1.8% of the high-income households used the improved firewood stove compared to 0.6% of the low-income households, does not necessarily suggest that stove costs were an impediment to its purchase. However, the survey figures show that 2.1% of the low-income households used the improved charcoal stove, which was only marginally more expensive than the improved fuelwood stove (see Annex 7-2), compared to 7.8% of the middle-income and 8.8% of the high-income households. This suggests that the stove was not affordable for most low-income households. Electric cooking (for Scale II tariff consumers) was the second ranked option. However, the consumption levels of low-income electricity users (see Table 7-2) indicate that only few households used electricity for cooking at all or only sporadically for the preparation of selected food or water heating. On average, 3.3% of the low-income households were reported to have used an electric stove. In the highest income group of the low-income households, that is households in permanent buildings, 6.6% used an electric stove. All other low-income sub-groups did not use an electric stove, with the exception of those which were employed and living on the premises of middle and high-income households where electricity and cooking equipment is sometimes provided free of charge.

TABLE 7-4 Useful energy cost comparison of urban household cooking options, 1990

	Blantyre		*Lilongwe*		*Mzuzu*		*Zomba*	
Stove (efficiency)	*(MK/GJ)*	*Rank*	*(MK/GJ)*	*Rank*	*(MK/GJ)*	*Rank*	*(MK/GJ)*	*Rank*
Firewood 3-stone (8%)	208.1	10	180.6	10	70.1	5	90.0	7
Firewood 3-stone (10%)	166.5	9	144.5	8	56.1	4	72.0	4
Firewood 3-stone (12%)	138.7	7	120.4	5	46.7	2	60.0	2
Firewood metal stove (12%)	140.4	8	122.1	6	48.4	3	61.7	3
Firewood ceramic stove (25%)	69.1	2	60.4	1	25.0	1	31.4	1
Charcoal metal stove (12%)	106.0	4	180.2	9	160.6	10	157.8	10
Charcoal ceramic stove (25%)	53.0	1	88.6	3	79.2	6	77.8	5
Kerosene stove (30%)	118.6	5	118.6	4	118.6	8	118.6	8
Electric stove (65%), (1)	83.8	3	83.8	2	83.8	7	83.8	6
Electric stove (65%), (2)	122.3	6	122.3	7	122.3	9	122.3	9

Source: Annex 7-2; (1) Refers to unit costs of MK0.12/kWh. (2) Refers to unit cost of MK0.21/kWh.

Unless a high efficiency of 12% for the three-stone stove is assumed as being a representative efficiency figure, cooking with paraffin and with fuelwood in an improved metal stove are the next cheapest options. Only 2.9% of the low-income households in Lilongwe used a paraffin stove, while 26.6% used the traditional metal stove. Even middle-income households were using paraffin stoves only at a rather limited level (7.8%), while 45.1% of them used the traditional metal stove. This suggests that stove costs were likely to have been a constraining factor for low- and even medium-income households to switch to paraffin as a regular cooking fuel. The comparison of cooking costs also suggests that an efficiency of 12% for the three-stone stove is unrealistic, because households would have little incentive to purchase a traditional metal stove.

In Blantyre, the ranking of useful energy costs of cooking options is different compared to Lilongwe on account of considerably lower costs for charcoal and slightly higher costs for fuelwood. The lowest cost option, that is the improved charcoal stove, was reported to be used by 41.0%, 8.7% and 3.0% of the high-, middle- and low-income households respectively, while the second ranked option, that is the improved firewood stove, was not used by high and middle-income households and only to a limited extent (0.3%) by low-income households. Thus the percentage of low- and middle-income households purchasing improved stoves in Blantyre was just marginally below that in Lilongwe.

Taking into account that in Blantyre fuelwood was about 20% more expensive and that charcoal prices were about 40% cheaper than in Lilongwe, it appears that households in Lilongwe using charcoal, and households in Blantyre using fuelwood, were not encouraged to reduce their respective fuel cost by employing more efficient stoves. This result has also to be interpreted in the context of the perception of the majority of households in Blantyre and Lilongwe (about 57%) that fuelwood prices have risen rapidly in recent years.[28] In an environment where households expect rising fuelwood prices, it may also be expected that a certain percentage of households who can afford to purchase a higher efficiency fuelwood stove will do so. However, most low-income households were apparently not able to purchase a ceramic fuelwood stove, which could have reduced their cost of cooking by a factor of 2 to 3. The traditional metal stove was used by a much larger percentage (45.1%) of households compared to Lilongwe. This difference cannot be explained by the difference in fuelwood costs in both cities, but perhaps partly by the cost advantage of using charcoal in Blantyre which is used by a considerably higher percentage of low-income households at twice the consumption level compared to Lilongwe (see Table 7-3).

The impact of fuel prices on fuel and fuel/cooking equipment choices

In terms of affordability, households in the two larger cities ranked fuelwood (64.0%) as the cheapest fuel, followed by paraffin (45.1-52.4%) and charcoal (17.9%). With regard to the question of how perceptions of price increases and of relative fuel costs may have influenced fuel/device choices, the survey data show some results which differ from actual developments. As mentioned above, the majority of households (54.9%) in all cities had perceived rapid increases in fuelwood prices in recent years. An even higher percentage (63.1%) had perceived a rapid increase of charcoal prices, while only 21.5% of the households thought that this was true for paraffin. In nominal terms, prices for all fuels had been increasing throughout the past five to six years. In real terms, however, only charcoal and fuelwood prices had increased in some cities during this period, while the price of paraffin was declining. Figure 7-2 shows the development of real paraffin prices since 1980. Since mid-1985 the price of paraffin was continuously declining and reached a price level in 1990 which was almost 50% below the 1985 price level. The figure also shows that the real paraffin price converged with the development of real average monthly earnings and continued to fall in line with this real income indicator until 1990.

The development of real charcoal and fuelwood prices in Lilongwe and Blantyre are shown in Figure 7-3[29] and Figure 7-4 respectively. In Lilongwe, fuelwood and charcoal prices show

[28] See Ng'ong'ola (1991: Table 28).

[29] Between 1980 and 1986, only data for the month of December were available. Thereafter monthly data until March 1991 were collected by the NSO. Data for Figure 7-4 are based on monthly data which were available for the period January 1980 to March 1991.

a declining trend until the end of 1984. Thereafter fuelwood prices were subject to large interannual variations and show a rising trend. In early 1988, fuelwood prices almost dropped back to the end of 1984 price levels and then increased by about 70% to 80% until the end of 1988, and started to decline by about 35% between the end of 1989 and 1990. Charcoal prices in Lilongwe also show a rising trend since 1984. Prices increased by about 20% until the end of 1986 and then increased by another 15 to 20% until the end of 1990.

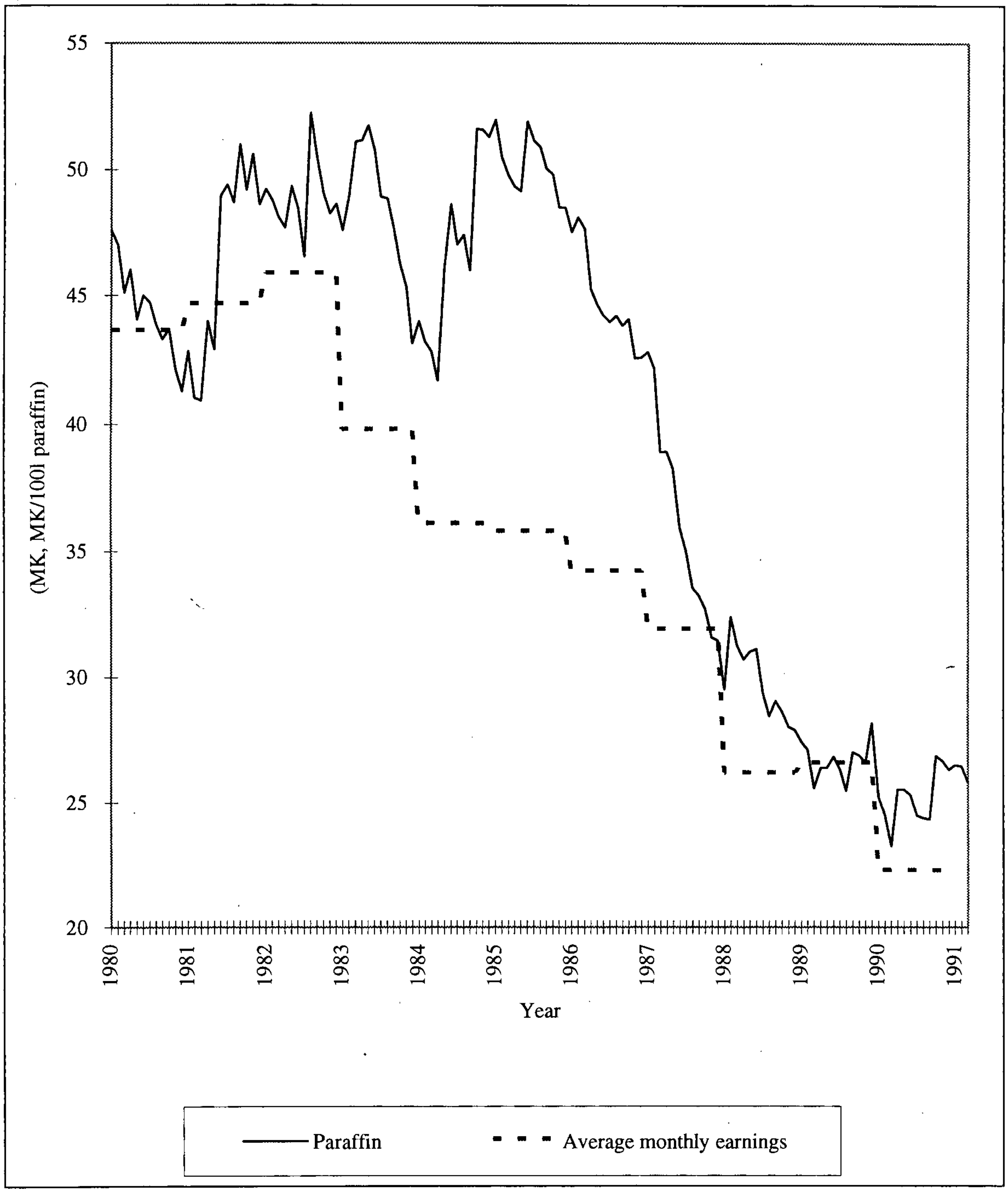

FIGURE 7-2 Development of real paraffin prices and average monthly earnings 1980-1991 (in constant 1980 MK)

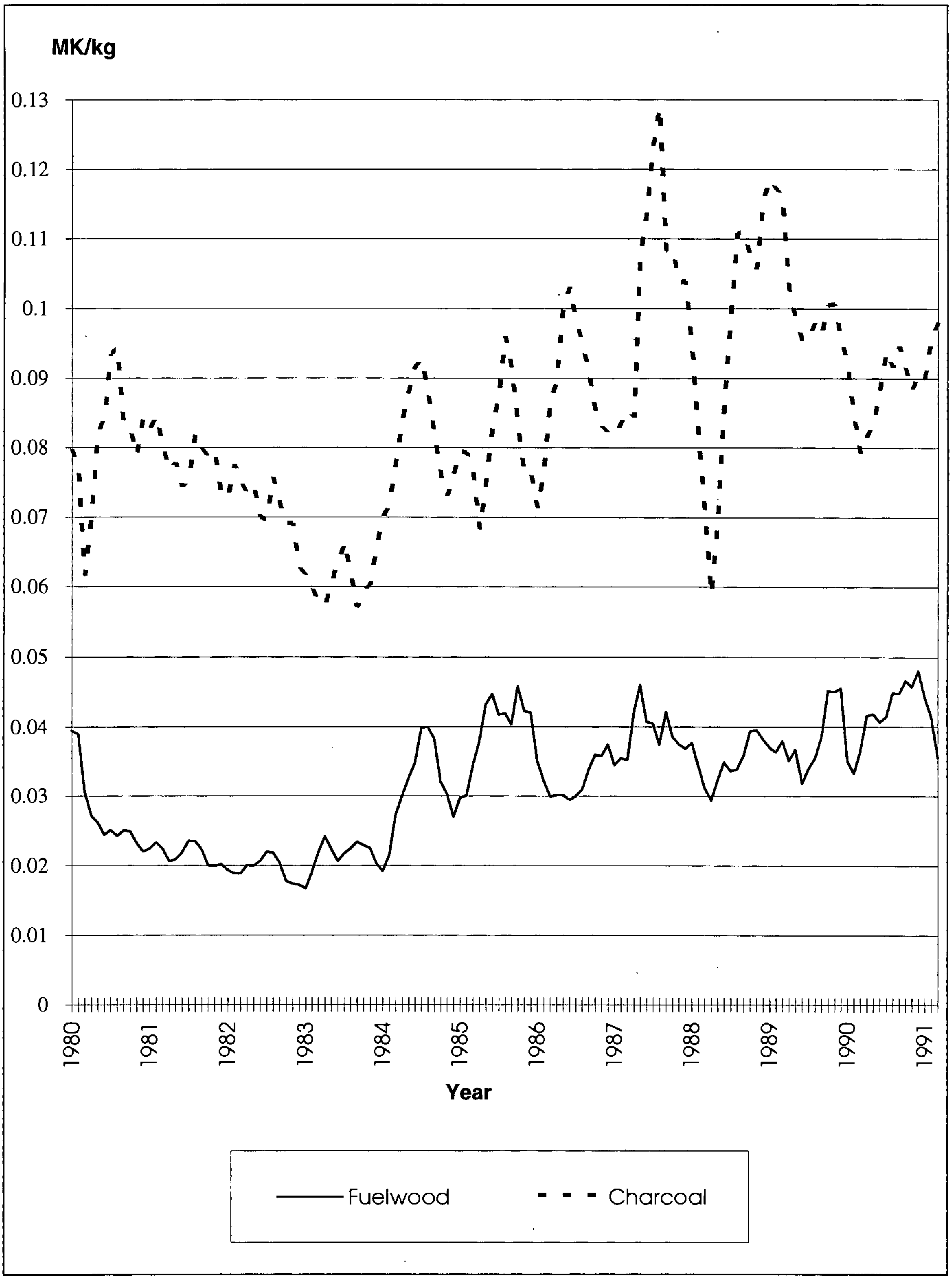

FIGURE 7-3 Blantyre fuelwood and charcoal prices 1980-1991 (in constant 1980MK; four-month moving average)

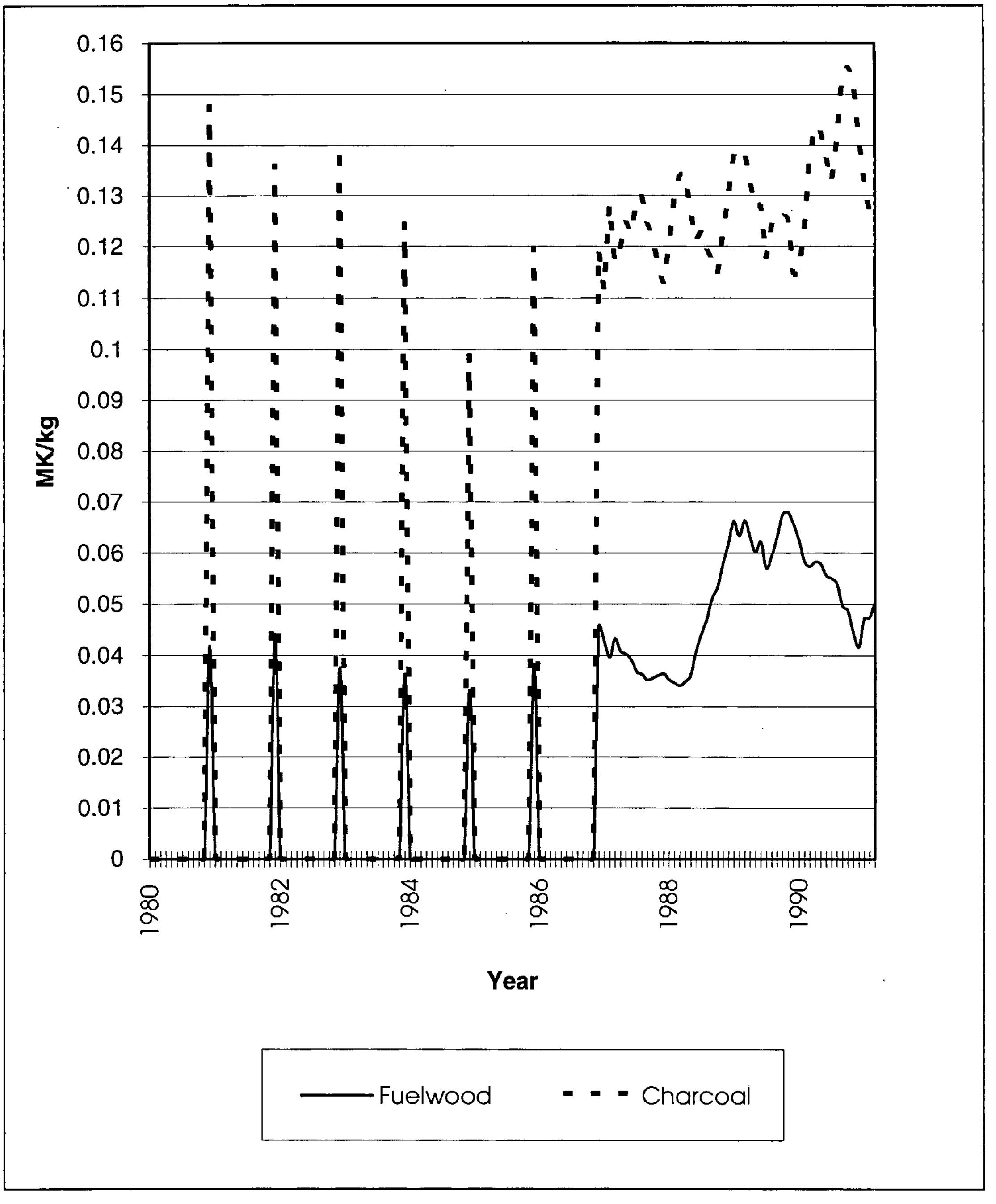

FIGURE 7-4 Lilongwe fuelwood and charcoal prices 1980-1991 (in constant 1980MK; four-month moving average)

In Blantyre, the real charcoal price declined strongly until mid-1984. The subsequent price development was also characterized by large interannual volatility. Prices increased by about 50% until 1987. Thereafter price volatility accelerated and prices fluctuated around MK0.1 per kg. Real fuelwood prices declined slightly until the end of 1984. After a strong upward shift in 1985, prices fluctuated around MK0.4 per kg.[30] Although a slightly rising

[30] It should be noted that the development of real woodfuel prices in Lilongwe and Blantyre between the end of 1988 and the end of 1990, suggest that the increase of stumpage fees by the Government of Malawi and especially the policing of woodfuels, do not appear to have had a significant impact on woodfuel prices in Blantyre. Charcoal prices were declining and fuelwood prices showed fluctuations during this period around the price level of MK0.04 per kg which are comparable to fluctuations in previous years. For Lilongwe the evidence is inconclusive because fuelwood prices rose above previous price peaks but charcoal prices declined during the same time.

price trend can be observed for woodfuels in Figure 7-3 and more clearly from Figure 7-4, the households' perception of strongly rising fuelwood prices was only justified for woodfuels in Lilongwe.[31] However, when fuel price developments are related to the development of real income indicators, especially to the development of the average monthly earnings, it becomes clear that urban households were apparently not referring alone to fuel price trends but to the relationship between woodfuel and paraffin prices and fairly strongly declining incomes.

The distinctly lower percentage of households who had perceived a strong increase in paraffin prices relative to woodfuels can be explained both by the price path of paraffin and the development of the relationship between this price path and real average earnings since 1988. Real income declines ranging from 16 to 44% between 1985 and 1990, were associated with woodfuel price levels which were between 35 to 50% higher in Lilongwe in 1990 compared to 1985, and woodfuel prices which were up to 10% higher in Blantyre in 1990 compared to 1985.

Changes of user energy costs for woodfuels and paraffin

Given the continuous real decline of the price of paraffin relative to woodfuel prices in the larger cities since 1985, the question arises why so few low-income and even middle-income households were cooking with paraffin in 1990. This question can be addressed by comparing the useful energy costs of the main cooking options which were available to households in previous years. For this comparison, it should be noted that the improved fuelwood and charcoal stoves cannot be considered because both were not available yet in the market in 1988 and only to a limited extent in 1989. Using the same assumptions for the comparison of cooking options in 1990, and the average annual fuelwood and paraffin prices in Lilongwe and Blantyre in 1988 and 1989, yields the following results. In 1988, the useful energy costs of cooking with paraffin (MK103.8/GJ) were comparable to cooking with the three-stone stove assuming a 10% conversion efficiency (MK106.5/GJ) and about 10% more expensive, compared to using fuelwood with the traditional metal stove and about 10% cheaper, compared to the use of charcoal using the same stove. Price changes for fuelwood and charcoal changed this ranking in 1989, when the paraffin cooking option was about one-third cheaper than the three-stone stove option, 15% less expensive than using fuelwood in a traditional metal stove and 10% cheaper than using charcoal in the same stove. In Lilongwe, the useful energy costs of the paraffin option (MK103.8/GJ) was

[31] This can be easily observed from Figure 7-3, so that no regression analysis is required to support this statement. For Blantyre, a linear regression of the 1986-1991 time series of fuelwood and charcoal prices yielded slightly increasing regression lines. Regression analysis of woodfuel prices in Zomba show a declining regression line for fuelwood and a constant charcoal price development, while prices for charcoal in Mzuzu remained virtually constant since 1986.

comparable to using fuelwood in a traditional metal stove (MK98.5/GJ) in 1988, but about 11% cheaper compared to the three-stone stove option (MK116.1/GJ) and about 21.6% cheaper compared to using charcoal in the traditional metal stove (MK131.0/GJ). In 1989, the paraffin stove option (MK103.8) was considerably cheaper than all other options. Cost advantages ranged from 25.9% compared to using fuelwood with a traditional metal stove, to 32.5% for the three-stone option assuming a conversion efficiency of 10%.

The cost comparison shows that especially for households in Lilongwe, the paraffin stove began to have a clear cost advantage, starting in 1988. However, as discussed before, the utilization of paraffin stoves by low- and middle-income households in both cities differed only by a few percentage points. The higher utilization of paraffin stoves in middle-income households in Lilongwe (7.8%) compared to those in Blantyre (2.4%) may be interpreted as an indication that households have responded to the improving comparative cost advantage of using a paraffin stove. However, that paraffin stoves are utilized at a fairly low level despite its relative cost advantage, must be clearly attributed to the high cost of kerosene stoves.

The ranking of cooking options according to financial costs may also be used to partially explain why much more charcoal was consumed by all households in Blantyre compared to Lilongwe. There are two basic factors which explain the higher charcoal consumption in Blantyre. First, Blantyre is located in a hilly area, where average annual temperatures are lower compared to Lilongwe. This may account for comparatively higher charcoal consumption for heating purposes. Secondly, the average net monthly income of high- and medium-income households were found in the 1990 survey to be 20.7 and 29.8% respectively higher than for the same income groups in Lilongwe. This difference may account for both the higher utilization and consumption of charcoal and electricity in both income categories in Blantyre compared to Lilongwe. Thus higher incomes seem to have made charcoal and electricity stoves more affordable. Conversely, the average monthly net income of low-income households in Blantyre (MK107.0) was found to be 21.8% lower than for the same income group in Lilongwe. This lower-income level may account for the higher consumption of woodfuel in low-income households in Blantyre (see Table 7-3).

The combination of two factors suggest that stove costs have impaired the switch of low-income households to more efficient stoves and to more convenient fuels. First, in Blantyre, the more efficient woodfuel stove options had a relative cost advantage vis-a-vis the three-stone stove, in comparison to Lilongwe. Secondly, lower incomes in Blantyre imply that higher efficiency woodstoves are less affordable (see also the discussion below).

Overall, the analysis of consumption patterns of fuels in relation to the approximate range of comparative financial costs of alternative cooking options, suggest that the cost of stoves had a major impact on the fuel/cooking stove decisions of urban households. Especially low-income households and even middle-income households have been constrained by the cost of stoves to substantially reduce their energy costs for cooking and to switch to more convenient fuels.

7.3.2.2.4 *Income, household expenditures and affordability of cooking equipment*

The importance of equipment costs as a barrier to fuel switching can also be gauged from the composition of expenditure on food, energy and other items. Data collected by the 1990 MUHES show that 45.1% of the households spent between on average 25 to 50% of their net income on food. The survey sample contained 76% of households classified as low-income. Given the relatively low-income levels of urban households in comparison to poverty line estimates, this result appears as being fairly low. A cross-check on these data is possible by comparing them with the findings from the income survey conducted by Roe and Chilowa (1989) in Blantyre and Lilongwe for low-income households. This comparison is facilitated by two factors. First, the income survey found that the mean income of low-income households was MK108.7 in Lilongwe and MK109.8 in Blantyre; these data are broadly comparable to the average incomes of the same groups in the household energy survey of MK107.0 in Lilongwe and MK136.9 in Blantyre. Secondly, nominal incomes in 1989 and 1990 did not change but inflation soared, implying that average real income in 1989 was higher than in 1990. The income survey found that the share of food expenditures of total disposable income in Lilongwe and Blantyre was 54.3% and 55.6% respectively. In view of the higher real income in 1989, it has to be concluded that the result concerning the share of food expenditures in total net disposable income from the MUHES in 1990 is very likely to be too low.

The average share of household expenditure on energy ascertained by the 1990 MUHES for high-, medium- and low-income households was 8.1%, 12.8% and 17.0% respectively. While there is little variation around these averages across cities in the high- and medium-income groups, expenditures of the low-income households vary considerably due to the large price differences for fuelwood between cities. Low-income households in Blantyre, Lilongwe, Mzuzu and Zomba were found to have spent 20.9%, 24.6%, 11.9% and 11.9% respectively of their net income on energy. If the expenditure data of the income survey by Roe and Chilowa (1989) were representative, households in Blantyre and Lilongwe would spent about 76.0% and 79.0% respectively of their disposable income on food and energy. Even though this estimate may be slightly on the high side, it still suggests that there is limited scope to afford expenditures on durable consumer goods such as stoves. For example, the costs of the ceramic charcoal stove or a kerosene wick stove would have amounted to 14.0%

and 32.8% respectively of the average net monthly income of low-income households in 1990. In percentage terms, a charcoal stove seems affordable, but it has to be considered that many low-income households do not possess any savings and that current expenditures on other basic needs such as health, housing, clothing and schooling have also to be covered.[32]

7.3.2.2.5 *Fuel preferences of households*

Households were asked in the 1990 survey about their reasons for using each particular fuel. In terms of the fuel choice criterion 'convenience', households in all cities judged charcoal as the most convenient fuel (39.1-47.4%), followed by paraffin (21.1-27.3%) and fuelwood (12.5-15.7%). The low ranking of fuelwood clearly suggests that households had a preference to switch to more convenient fuels. The ranking of paraffin does not fit into what would be expected from the concept of the energy ladder. However, given the fact that on average only 3% of all households used paraffin for cooking in 1990, a possible explanation is that households perceived the convenience of using paraffin primarily for lighting purposes. From this perspective, a low ranking of paraffin can be simply explained by the unpleasant smell of paraffin when using wick lamps. As in Lilongwe, electric and paraffin stoves, which are ranked three and four, were hardly used by low- and even middle-income households. About 5% of the low-income households and 2.4% of the middle-income households reported to use a paraffin stove, whereas electric stoves were used by 1.7% and 10.3% of the low- and middle-income households respectively.

7.3.2.2.6 *Energy-poverty linkages*

A comparison of household fuel expenditures as a percentage of average income from the household surveys in 1983 and 1990, shows that the expenditure share for energy has slightly increased for the middle-income and low-income groups from 11.8% to 12.8% and from 13.1% to 17% respectively. Due to the fact that the 1990 survey classified the cut-off point for the low-income group below the one used in the 1983 survey in real terms (see hereto Table 7-1), the increase in the average expenditure share for energy in the 1990 survey would have been lower if low-income households were classified in accordance with the development of real purchasing power. An increasing share of energy expenditures in income associated with real declining incomes could have provided evidence that low-income households are consuming energy close to, or at, subsistence levels. Although the high energy expenditure shares in Lilongwe and Blantyre point in this direction, this conclusion cannot be drawn because comparable data from the 1983 survey were no longer

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32 An impressive study by Roe (1992) in Lilongwe provides valuable insights into the income generation and survival strategies of the urban poor. The study particularly illustrates the intimate relationship between problems of poverty, changes in environmental conditions and financial resource constraints of households.

available. However, the high shares of energy expenditures in the larger cities indicates that their low-income households are particularly vulnerable to increases in the real costs of biomass fuels, unless the declining trend in real incomes is reversed. In 1989, low-income households complained about being unable to afford fuelwood and women seen to have started using low-grade combustible matter (see Roe & Chilowa 1989: 43).

Energy-poverty linkages are thereby not only established by constraining household budget constraints or backward substitution to inferior fuels. Household income may also be directly affected because low-income households, and particularly women, are engaged in woodfuel using income-generation activities such as beer brewing and the sale of home-prepared foods. This demonstrates the important role of household energy policy in securing affordable energy supplies to the urban poor in major cities of Malawi[33]and of improving their access to more expensive and efficient cooking stoves.

7.4 BACKWARD FUEL SUBSTITUTION BETWEEN 1983 AND 1990

As mentioned above, the data base available to analyze longitudinal interfuel substitution patterns in Malawi consists of the two MUHESs which were conducted in 1983 and 1990. The surveys are comparable with regard to the sampling method, but it has to be taken into account, as shown in Table 7-1, that the income bands used to classify households were not consistent in terms of constant purchasing power. Given the strong decline in average real urban incomes between 1983 and 1990, combined with increasing real prices for woodfuels in the larger cities since 1984/85, the existing empirical evidence concerning the energy transition would predict that overall a backward substitution should have taken place.[34]

The comparison of the consumption of woodfuels by city in Table 7-5 shows that an extensive backward substitution from charcoal to fuelwood has taken place since 1983[35]. Unfortunately, consumption data by income groups for 1983 are no longer available in Malawi, so that the average fuel consumption changes by city could not be analyzed by

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[33] The recent economic development in 1992 and 1993 was characterized by declining growth rates and further declines in real income as measured by the increase of the low-income price index in the bigger cities of 53% during this period. This development is likely to have exacerbated the importance of the role of energy costs. If the recent trend of slightly increasing woodfuel prices has continued since 1990, the notion of energy poverty in the sense that expensive energy contributes to poverty, may have assumed a very real dimension in the major cities of Malawi.

[34] It should be noted that the expectation of a backward substitution effect in the context of declining real incomes over an extended period of time, can be counterbalanced by massive subsidies for modern fuels. As reported in Hosier and Kipondya (1993: 465) this was the case in the urban areas of Tanzania, where the energy transition which took place in the context of increasing poverty was due to high public subsidies for electricity and kerosene.

[35] The decline of the fuelwood consumption in Mzuzu in Table 7-5 is due to the data error which was discussed in section 7.2.

income groups. Overall, the increase of fuelwood consumption relative to changes in charcoal consumption appears to be too high. Because fuelwood consumption levels in 1990 are broadly in line with those of other urban households in comparable countries, for example, in Tanzania, it appears that the 1983 consumption data have been perhaps underestimated.

TABLE 7-5 Comparison of average annual woodfuel consumption in urban households

	Fuelwood (1) (tonnes)		*Charcoal (2) (tonnes)*	
City	*1983*	*1990*	*1983*	*1990*
Blantyre	1.15	5.77	0.65	0.21
Lilongwe	1.99	5.72	0.35	0.12
Mzuzu	2.08	1.10	0.41	0.18
Zomba	1.55	6.04	0.36	0.12

(1) *Source:* Ng'ong'ola (1991: Table 37)
(2) *Source:* Ng'ong'ola (1991: Table 39)

The previous analysis suggests that the major factor driving this backward substitution was the decline in real disposable incomes. This result is broadly in line with other authors who have found high-income elasticities of demand for fuelwood. However, interpreting the entire size of the substitution effect as being income-driven would result in income elasticities of demand which are unrealistically high, compared to available evidence from other country studies. This problem could not be resolved in this research because the detailed data from the 1983 energy survey were no longer available and there are reservations concerning the validity of the reported fuelwood consumption levels in 1983.

Isolating statistically the influence of income changes and price changes of fuels on fuel consumption levels and interfuel substitution over time, is only possible if sufficient longitudinal data of appropriate quality are available. Such data typically do not exist in most developing countries, including Malawi. As discussed above, Leach (1992: 120) had found that available empirical evidence suggests that energy prices influence consumption shifts between house-holds using different fuels and that the likelihood is higher that fuel price differentials induce backward rather than upward fuel substitutions.

Data concerning adaptations of urban households to perceived fuel price increases in recent years, were gathered by the 1990 MUHES.[36] The responses of households to a perceived price increase of fuelwood showed that 15.3% have not altered their consumption behaviour, 22.6% economized their woodfuel consumption and 35.1% increased their budget to maintain consumption levels. Only a small percentage reported to have used more electricity (3.5%), charcoal (6.0%), kerosene (1.4%), or agricultural residues (1.7%) and

[36] The following discussion is based on the data shown in Ng'ong'ola (1991: Tables 30, 32 and 35).

wood shavings (2.5%). These responses show that increasing fuelwood prices have resulted in both upward and backward interfuel substitutions. Unfortunately, the survey data do not disaggregate these responses by income groups so that their specific responses could not be ascertained.

The responses of households concerning their reaction to an increase in charcoal prices shows that 14.8% of the households did not change their consumption behaviour and 25.1% used less charcoal. The percentage of households showing these reactions to increased charcoal prices is comparable to the percentage of households responding in the same way to increased woodfuel prices. However, the percentage of households who increased their budget for charcoal (16.1%) in response to higher charcoal prices was distinctly lower than the percentage of households which showed the same reaction in view of perceived price increases for fuelwood (35.1%). Considerably more households reported a switch to fuelwood (24.1%) than the percentage of households who switched from fuelwood to charcoal (6%) in response to perceived higher prices of fuelwood.

The overall response to a perceived price increase in kerosene also did not seem to have triggered any significant fuel substitution, if any at all. Of the households surveyed, 29.9% responded that they did not change their consumption behaviour, 32.5% used less kerosene and 29.2% increased their budget, while the remaining 8.4% reported to have responded in another unspecified way. These responses are consistent with the above findings. Since kerosene is overwhelmingly used as a lighting fuel and the average quantities consumed are close to minimum lighting requirements, there was limited scope for fuel savings from the point of view of basic lighting needs. Even though cooking with kerosene emerged as an attractive cooking option in Lilongwe, the survey data indicate that no increase of consumption and thus of increasing paraffin use for cooking, had materialized.

From Figure 7-4 it can be gauged that the relative price of fuelwood and charcoal was increasing in Blantyre in 1989 and was about constant in 1990, while Figure 7-3 shows that the relative price of fuelwood and charcoal in Lilongwe was increasing in 1989 and decreasing in 1990. Considering longer-term price trends, both figures show a slightly rising fuelwood-charcoal price relationship between 1984/85 and the end of 1990. Thus the evidence from Malawi suggests that, contrary to the weak evidence from elsewhere, medium-term woodfuel price differentials disfavouring fuelwood cannot be interpreted as having been a major factor causing the backward fuel substitution which has occurred in Malawi. Real income changes appear to have exerted a much stronger influence. However, in the short-run, that is over a period of about one year, it appears that urban households have responded as may be expected: given an approximately unchanged woodfuel price differential in Blantyre and relatively more expensive charcoal in Lilongwe in 1990; in aggregate more households have switched to fuelwood than to charcoal. If household responses to changing relative woodfuel prices are regarded as being short-term, in the sense that they adapt their consumption of fuelwood and charcoal in response to a change in relative prices within a few months, the adaptation to fuel price differentials in 1990 tend to coincide with the available empirical evidence.

7.5 URBAN HOUSEHOLD ENERGY POLICY ISSUES

7.5.1 Supply of subsidized fuelwood to the urban poor

The main policy of the GOM to influence urban fuelwood prices was to enforce the ban on illegally cut woodfuels from customary land through roadblocks and other confiscation measures, and the supply of fuelwood from government-operated fuelwood plantations at gazetted stumpage fees. Fuelwood plantations using exotic species, especially *Eucalyptus*, were first established under the FWEP which was largely financed by the World Bank. As discussed in Chapter 4, government-operated fuelwood plantations turned out to be a high cost supply source because of managerial and other technical inefficiencies. Gazetted stumpage rates were set to cover production costs, implying that the government was subsidizing fuelwood from government plantations which reached the urban market. According to a survey of firewood traders in the major cities, 65% and 45% of the traders in Blantyre and Lilongwe respectively (see Ng'ong'ola 1991: Table E1) were buying firewood from government plantations and reserves. Which percentage of the total fuelwood volume sold in cities is obtained from government plantations is not known because the survey could not obtain estimates about volumes by supply source. Since the mid-1980s the World Bank was increasingly reluctant to continue financing government fuelwood plantations in Malawi. One of the proposed projects which was abandoned by the World Bank was the Blantyre City Fuelwood Project (BCFP). The project was finally started in 1986 as a pilot urban wood energy project under the programme of the Southern African Development Community (SADC), financed by the Government of Norway and the GOM. The overall objective of the BCFP was 'to contribute to fuel requirements of low-income groups living in the Malawian towns of Blantyre and Zomba' (BCFP 1993: 2). In terms of production, an output of 120 000 solid m^3 of fuelwood per year were expected to be supplied from a plantation of 10 000ha.

The review of the project's performance in 1993, after about 4 800ha had been planted, showed that the project turned out to be commercially nonviable. Economic internal rates of return (EIRR) over its life cycle ranged from -7.3% to a maximum of 0.1%, where the latter figure corresponds to the best scenario (BCFP 1993: 15). In order to meet a target EIRR of

5%, which still may be considered as rather low for this type of project, the production costs per m^3 measured as replacement costs on the stump, would amount to MK45.0 per stacked m^3 or MK15.0 more than the gazetted stumpage fee in 1993. Thus production costs finally were three times higher in comparison to the economic production costs which were estimated by deLucia & Associates (1992: 3-14).[37]

Several factors contributed to the failure of the project. First, there were considerable management problems, including permanent changes of the top management and reliance on *ad hoc* decisions because of a lack of management plans. Secondly, while a MAI of 12.0 m^3 per ha was initially expected, the plantations, 90% of which were planted with *Eucalyptus* species, only yielded about 8.0m^3. Whether similar technical inefficiencies as those identified for many other government-operated plantations, contributed to the low yield, is not known. However, a main factor causing the very high production costs of fuelwood from BCFP plantations was that the initially envisaged allocation of plantation areas was changed by the GOM. Plantation establishment costs which were initially estimated to amount to MK2, 000 (in 1993 prices) per ha increased to MK4, 900 because the allocated land was much more scattered and located on steep and partly badly degraded hill slopes with very shallow soils. Thus the project economics were jeopardized already in the planning stage of the project. In addition, it was found that certain areas could not be harvested because this would most likely have led to severe soil erosion (BCFP 1993: 9). Thirdly, the project suffered from poor planning concerning the realities of the retail fuelwood market. The objective of the project was to supply fuelwood to urban low-income households, but it was not clear how this targeting approach could be successfully implemented.

In order to reach the urban poor, salesyards were established in Blantyre and in Zomba and the price of fuelwood prices was cross-subsidized by revenues from the sale of poles. However, no mechanism such as constraining sales to small volumes or charging higher prices for larger volumes, could be identified or was workable to ensure that fuelwood was actually bought by the target group. Eventually, it was found that a large part of the customers were fuelwood traders (BCFP 1993: 36). Additionally, compared to normal sales operations by fuelwood traders selling in markets with low transaction costs, establishing and operating permanent salesyards was rather expensive, particularly because actual losses were experienced of up to 65% of the fuelwood delivered to salesyards, due to theft. As a result, the discontinuation of this type of involvement in the retail trade was recommended. Other economic factors contributing to low sales from the salesyards were

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[37] Production costs estimated by deLucia & Associates amounted to MK17.0 per m^3 (stacked) less MK2.0 for wood extraction. The latter costs were not included in the BCFP cost data.

that, despite subsidized prices, the project had to compete against low price supplies from government forest reserves where headloads of fuelwood can be collected at prices of between MK0.15 to MK0.50 per headload.

In summary, it cannot be concluded that peri-urban fuelwood plantations are *per se* a non-viable or non-competitive supply option of fuelwood. The failure of the project in terms of the production economics was mainly due to the poor execution of the project, particularly the planting of plantations in areas which were perhaps more suitable for a soil conservation project. Operating urban retail operations which carry considerably larger overheads than competing low-cost sales activities is, for obvious reasons, difficult to sustain. Reaching low-income households with subsidized fuelwood supplies through targeted measures is made difficult by the practical problems associated with the control of leakages.

7.5.2 Introduction of pine charcoal into urban markets

Since 1988/89 the government started to foster the introduction of pine charcoal as an alternative to charcoal supplies from customary land into the urban markets. The development of the marketing chain has been subject to major problems, as few traders were willing to get engaged in the trade with pine charcoal because of the commercial risks involved of competing with hardwood charcoal produced from forests on customary land. Attempts were also made to market pine charcoal in supermarkets together with the improved ceramic charcoal stove. By 1990, in all cities about 28% of the high-income households, 24.0% of the middle-income households and 13.0% of the low-income households were reported to use pine charcoal (see Ng'ong'ola 1991: Table 6-1). No information is available about the quantitative share of pine charcoal consumption in urban cities. Pine charcoal supplies from government forest reserves were still constrained by the establishment of sufficient production capacity and the availability of transport capacity which is evidenced by the high percentage of urban households (50.8%) who reported that unavailability of pine charcoal was the main reason for not using it. Of the households using pine charcoal, only 16.7% or about 2% of all urban households were using it in a ceramic charcoal stove, while more than two-thirds consumed it in the traditional metal stove.

At present, insufficient information is available in Malawi to ascertain whether pine charcoal can become a commercially viable fuel in the major cities of Malawi. Availability of hardwood charcoal supplies from customary land and the image that pine charcoal burns faster than charcoal from hardwood, are factors inhibiting a more widespread use.

7.5.3 Pricing policy and other measures

As in most other developing countries, the main pricing issues refer to the question of whether prices for paraffin and tariffs for electricity as well as connection and wiring costs should be subsidized, to enhance the access and affordability of the urban poor to these energy carriers to meet basic consumption needs. If subsidies are introduced, the question is how electricity tariffs should be structured and paraffin prices set to meet equity objectives and to avoid major price leakages. In this respect, deLucia & Associates (1992: 7-12) have pointed out that the equity objective has two important dimensions. First, is the concern about low-income households who have access, in the sense that the supply infrastructure is developed, but can only consume at very low levels without subsidized energy prices. Secondly, is the concern for those who do not have access, which is normally a larger group. Where the supply infrastructure is less developed, for example, for rural supplies of paraffin in Malawi, so that access may not exist for a large group of rural households, subsidization of energy prices by the government implies that those who do not have access are effectively subsidizing those consumers who do. Because supply infrastructures of petroleum products are typically better developed in the cities, the subsidy issue turns out to be a rural versus urban question.

Data for paraffin consumption in Malawi (see Table 7-3) show that the majority of the low-income households, which make up about 76% of the total number of urban households, as well as a considerable number of medium-income households consume paraffin for lighting. Given the quantities consumed by different income groups, it is clear that subsidies are reaching most of the urban poor. Actual paraffin prices for rural households are perhaps higher than for their urban counterparts because of mark-ups charged by traders but they still benefit from the subsidy. An unresolved question concerning the effectiveness of the subsidy is the extent to which other users are benefiting from it because it can not be ruled out that major quantities of kerosene are used for blending with diesel or gasoline. If substantial quantities of paraffin are diverged, a possible alternative to directly subsidizing the paraffin pump price may be to utilize the subsidy to improve the access of rural users.

As available kerosene consumption data do not allow one to ascertain whether major quantities are diverged, it cannot be ascertained at present whether a restructuring of the subsidy to avoid subsidization of commercial and industrial users, is needed. The useful energy costs of cooking with paraffin have been favourable compared to the traditional woodfuel during the past few years, but cooking with paraffin was limited because of the unaffordability of paraffin stoves. Thus, facilitating the purchasing of paraffin stoves by making credit facilities available or by using part of the kerosene subsidy to lower the costs of paraffin stoves, are measures which could also be considered.

Given the expectation that real income increases in urban areas will be rather limited in the forseeable future, most of the low- and middle-income urban households are likely to continue relying mainly on woodfuels for their cooking energy needs. Therefore, increasing access to improved fuelwood and charcoal stoves by similar measures as those suggested for paraffin stoves appear to be the most suitable options to contain, or even substantially reduce, the cooking costs of low-income urban households. Most low-income households use paraffin only for lighting and were found to have difficulties affording even the relatively cheaper improved woodfuel stoves. Thus measures to promote the access to, and use of electricity for cooking purposes, have at present low priority because it is difficult to perceive that most low- and medium-income households will be able to afford the costs, even when they are heavily subsidized.

7.6 SUMMARY AND CONCLUSIONS

In summary, the empirical evidence from Malawi suggests the following results and policy conclusions concerning the main hypotheses of the energy transition and the linkages between rural and urban household energy issues.

Household energy consumption

- In line with findings from other empirical studies, there is only a limited variation in the consumption of useful energy in the average households of major cities in Malawi.
- A comparison of urban household energy consumption data from Tanzania and Malawi suggests that there is a positive correlation between the level of useful energy consumption and income.

Energy transition

- There is strong evidence that income has been the major factor driving the energy transition in Malawi from 1983 to 1990 because of the substantial backward substitution from charcoal to fuelwood which has occurred during this period. This supports the finding in the literature that income is the major variable affecting interfuel substitution. It has been difficult to compare the situation in Malawi with other countries, as there is considerably more empirical evidence concerning the relationship between rising income and interfuel substitution, than for a regime of declining incomes.
- The direct impact of changes in relative fuel prices on interfuel substitution is difficult to ascertain because woodfuel prices have been volatile and fuel price-effects are swamped by the impact of fairly strongly and continuously declining real incomes. However, the

notion that 'fuel price differentials are more likely to bring about backward substitutions than an upward transition' (Leach 1992: 120), is only confirmed with regard to short-term changes in fuel price differentials. The evidence from Malawi suggests that this relationship is not applicable over the long-term because the backward fuel substitution during the period 1983 and 1990 took place in the context of a slight rise since 1984/85 in the relative price of fuelwood compared to charcoal. This finding also supports the conclusion that changes in real incomes have been the major factor driving interfuel substitution.

- Household responses to perceived increases in fuelwood prices suggest that substitution effects are not unidirectional and limited, implying a low price elasticity of demand. Reactions of households to perceived price increases of charcoal suggest that charcoal price elasticities are likely to be significantly higher than for fuelwood. Even though no firm quantitative estimate of the poverty status of urban households in the low-income group could be derived, a substantial portion of the low-income households can be regarded as poor. This income status can explain the lower price elasticity of demand for fuelwood compared to charcoal. When households consume woodfuels close to subsistence energy needs, they are more likely to maintain their existing consumption level. This argument is supported by the fact that the share of food in total household expenditure increases with lower income, which implies that in absolute terms, food purchases and demand for cooking energy remain fairly constant. In urban areas where fuelwood is the least-cost cooking fuel, price elasticities for charcoal may be expected to be higher because there remains scope to trade off cost savings against better fuel attributes. Additionally, the use of charcoal for heating offers a greater scope for fuel savings because heating demand can more easily be reduced than fuel demand for cooking.

- Multiple stove ownership is commonly regarded as an indication that households safeguard themselves against fuel supply interruptions, or that they use different stoves for different end-uses, or for the preparation of specific foods. Even though seasonal variations in woodfuel prices exist in the two largest cities in Malawi, there is no evidence of a history, or even single occurrence, of woodfuel supply interruptions. This rules out the possibility that urban households keep several stoves for energy supply security reasons. As the traditional metal stove can be used with both charcoal and fuelwood, urban households possessing this stove have some in-built protection against possible supply interruptions in fuelwood. However, the main finding concerning the roles of the most widely used traditional stoves is that their ownership and use is determined by income. With increasing income fewer three-stone stoves are used and a fairly strong inverse relationship exists between the ownership and utilization of traditional stoves: the higher the ownership and use of the three-stone stoves, the lower the ownership of the traditional metal stove.

- The cost of cookstoves was found to be a major barrier for low- and even middle-income households to utilizing more efficient fuel/appliance combinations which could lower the useful energy costs for cooking by a factor of 2 to 3. This finding confirms the general conclusion from the literature that equipment costs may represent a major barrier to fuel switching. Perhaps a special feature in a low-income country like Malawi, where most of the urban households belong to the low-income category and where it is quite likely that the majority of such households are living close to the poverty line, is that even a relatively small cash outlay for a higher efficiency fuelwood or charcoal stove seems to represent a significant, if not insurmountable, barrier to interfuel substitution or cooking cost savings.
- As a result of the equipment cost barrier, low- and middle-income households are constrained to switching to the least-cost supply option for cooking end-uses. This is a demonstration of a constraint to conduct economic efficient behaviour.

Energy pricing policy and equity objectives

Income and woodfuel price developments in the major cities of Malawi justified the concern of the GOM about the impact of fuel prices on the urban poor, who constitute a majority of the population. However, the attempt to control the impact of higher urban fuelwood prices through the supply from government fuelwood plantations and their stumpage prices, was ill-conceived because of the repercussions on the level of fuelwood prices which are required to induce investment in fuelwood production by rural households. The attempt to supply low-cost, subsidized fuelwood from the plantations established under the BCFP to low-income households in Blantyre and Zomba, failed in two major respects. First, the production costs of fuelwood turned out to be very high and thus non-competitive, even compared to the gazetted fuelwood price. That the project turned out to be commercially non-viable (even considering that a rather low internal rate of return for such a project may be justifiable), was due to poor planning (the GOM apparently did not investigate whether sufficient land of suitable quality was available and was forced to supply large tracts of unsuitable land) and management. Secondly, and equally important, was that during the planning stage there was insufficient investigation into whether the targeting approach (sales to low-income urban households) was feasible, that is whether a distribution and sales mechanism could be developed which can reach this group without major leakages to other consumers. As a result of this planning deficiency, it was found seven years after the start of the project, that the approach to establish urban salesyards was too expensive and that major leakages in the form of sales to fuelwood traders and perhaps to other non-targeted consumers had occurred.

The experience with the BCFP has several policy implications:

- First, it is difficult, if not impossible, to compete with the existing sales system of fuelwood which is characterized by low commercial overhead costs in retail sales (sales from trucks or bicycles instead of permanent salesyards). Competing with this system is particularly difficult when the production costs of fuelwood are not low enough to absorb higher retail sales costs. In this respect it has to be considered that it is unlikely that the existing urban fuelwood retail sales system in Blantyre and Lilongwe is going to shift increasingly to permanent salesyards: the price volatility of fuelwood constitutes a financial risk for traders; the carrying cost of storing larger fuelwood quantities are high; and the volatility of prices does not seem to provide an incentive for exploiting even seasonal fuelwood price differentials.
- Secondly, finding a mechanism to sell fuelwood to low-income households by means of sales-oriented measures (selling small volumes, charging higher prices for larger volumes and locating salesyards in typical housing areas of the target group), without suffering major leakages to other groups, is difficult to achieve. Other measures may be conceived such as an administrative system of fuelwood stamps (comparable to food or kerosene stamps). However, it is doubtful whether the preparation and administration of such a system is feasible both from a cost and personnel point of view, taking into account that the existing administration in Malawi is already burdened with staff shortages.
- The subsidization of kerosene prices reaches the urban poor and, most likely, to a lesser extent rural households. Because of potential high leakages and the issue of access of rural households to kerosene, further studies have to determine whether using part of the subsidy to improve the rural distribution infrastructure will prove more efficient in reaching equity objectives.
- Even though measures can be considered to lower the acquisition costs of kerosene stoves or to lower the cost barrier by introducing a suitable financing mechanism, the relative fuel prices and comparative useful energy costs of cookstoves as well as the development of urban incomes, suggest that the largest contribution in terms of lowering cooking costs can be made by focusing on the mass production and dissemination of improved woodfuel stoves.

Urban-rural equity considerations

From an equity point of view, it has to be considered that urban household woodfuel consumption has significantly contributed to deforestation on customary land in the Blantyre district, and perhaps in neighbouring districts. The negative impacts of forest destruction, although they could not be quantified, are likely to be mainly borne by the majority of the poor rural households which are already comparatively poorer than their urban counterparts. As the urban population represents a small share of the total population and substantial amounts of woodfuel are consumed also by middle- and high-income households, it may be concluded that there is not only an implicit subsidization of the urban poor by the rural poor but also a subsidization of the higher urban income groups. Thus, from an equity point of view, it is justified that a key emphasis of household energy policy in Malawi should be on implementing those studies and measures which contribute to the improvement of the efficiency of fuelwood markets and which directly or indirectly affect the well-being of the poor rural households. Such measures include both energy-related measures (see Chapter 4) and measures which are outside the realm of traditional energy policy, including improvement of tree tenure rights and enhanced local control over customary land forest resources, as well as control and support to those rural wood consumers who also contribute to the exploitation of local forest resources.

Chapter Eight
CONCLUSIONS

The main objective of this chapter consists of summarizing and drawing conclusions from the research presented in this thesis. As outlined in Chapter 1, the primary aim of this research is to explore and evaluate key hypotheses and specific methodologies for an integrated planning approach for the household energy sector in developing countries. The second related objective of this research consists of an analysis of household energy policy options for rural and urban households, by analyzing the performance of projects and policies which were implemented in Malawi since about 1980. As detailed methodological and policy conclusions have already been made at the end of Chapters 2 through 7, the following conclusions focus on the major findings with respect to the broader and fundamental themes of this research.

8.1 FINDINGS AND CONCLUSIONS

Deforestation and the scope of woodfuel policies

The causes and social implications of deforestation have been the main concern of household energy policy and planning in developing countries where woodfuels have a high share in total household energy consumption. Even though the discussion of causes of deforestation is contentious in the literature, there is some agreement that land extensification or the conversion of woodlands to agriculturally used land, has been a major contributing factor over a longer time period. The latter factor was also found to be responsible for about 45% of the total deforestation which has occurred from 1967 to 1990 in Malawi. Overgrazing, which is commonly regarded in the literature as contributing to deforestation, does not seem to have played a discernible role in Malawi. However, an important empirical finding from Malawi is that deforestation due to land clearing is not necessarily a process which is equally distributed or has always to be considered as the prime factor causing deforestation. It was found that land clearing in BADD had virtually no impact on deforestation from 1967 to 1990, but deforestation was mainly caused (in some districts of BADD) by urban household woodfuel consumption. Therefore energy policy planners also need to analyze carefully land-use changes for smaller geographical entities in order to derive conclusions about the factors causing deforestation.

The main factors driving land extensification in Malawi have been population growth and agricultural policy. Population growth rates in excess of 3.0% have been experienced in Malawi since 1966. Because selective population policy measures were only introduced by the mid-1980s, land extensification caused by the land needs of smallholders has developed faster than under a scenario of a more vigorous population policy. The process of land extensification in Malawi was also fostered by strategic agricultural policy decisions such as promoting the establishment of estates and prohibiting access of smallholders to producing more remunerative tobacco (burley) crops. The development of an export-oriented estate sub-sector was economically sensible, given the competitive disadvantages of the country (land-locked, long distances to major ports and a low level of education and technical skills). Although the expansion of the estate sub-sector absorbed a considerable amount of the rural labour force and thus slowed down rural-urban migration, the expansion of estates and other agricultural policies had adverse consequences for the decline of woodlands, the access of rural households to forest resources and perceptions regarding the utilization and management of woodlands.

In principle, the expansion of agriculture and of estates in developing countries may be regarded as being part of the normal economic development process. Therefore the associated loss of forests may to some extent also be considered as a typical or inevitable process of economic land-use changes where available land and forests are put to higher value uses. However, deforestation in Malawi has exacerbated on account of four factors. First, while financially feasible options to reduce the fuelwood consumption of tobacco estates were researched in the mid-eighties, little was done until the early 1990s to encourage estates to engage in more vigorous energy-saving or afforestation measures. Delayed implementation concerning the latter option is related to the second factor, that is the lack of enforcement of existing laws and estate lease covenants concerning fuelwood plantations, and the utilization of forest reserves and of customary woodlands by the tobacco-producing estates. Also the consideration of other options were neglected, for example, the introduction of producer taxes for tobacco-producing estates, the size of which may be linked either to meeting specific conservation norms or fuelwood self-sufficiency levels; and changes in the land tenure of most tobacco estates (extending the land lease period of tobacco farms which are currently too short to encourage better land-use management on estates, including reforestation). Thirdly, in view of declining availability of good arable land, the rush in establishing thousands of new estates meant that large tracts of customary land, including woodlands, appear to have been alienated from the local communities, restricting further their access to woodland resources. Fourthly, policies to reduce the impact of rural industries on deforestation were entirely neglected.

Relative to the impacts of transforming woodlands to agriculturally used land and the fuelwood consumption of the tobacco industry on deforestation, the fuelwood consumption of rural households most likely had a comparatively small quantitative impact on deforestation. Thus before woodfuel policies are developed which have the objective of containing deforestation, an analysis of which processes and consumers contribute to deforestation is paramount. The analysis of the development of deforestation in Malawi has shown that country-specific factors determine the relative importance which certain processes and consumption sectors play with regard to deforestation and regional differences in deforestation rates. The latter finding reinforces the point which is often made in the literature that the analysis of woodfuel supply-demand balances needs to be made on a suitably disaggregated level.

An important policy implication for national energy planners is that policies which aim at slowing down deforestation or at securing woodfuel supplies for the rural population on a sustainable basis have to be more broad-based on the one hand, and more targeted, on the other. A concentration on increasing smallholder production of fuelwood, which is premised partly on the wrong assumption that rural household fuelwood consumption is the main cause of deforestation, will make only a limited impact. Therefore, interventions have to focus on those consumer groups who have the largest impact on deforestation which in Malawi comprise the tobacco industry, urban households and rural industries.

A major concern of energy and development planners is the magnitude of externalities induced by deforestation and the economic implications of the loss of forests and woodlands on rural households. Externalities in Malawi are already sizable and there is evidence that rural households, and presumably the poorer segments of the smallholders, collect a wide range of products from woodlands. The supply of some of those products (medicines) may be unique for woodlands so that they cannot be substituted by growing trees on farms. Too little is known about these issues and very limited quantitative information is available about the value of benefits which households derive from forest products. In Malawi, small-scale forest-based industries which provide one of the few off-farm income-generating opportunities for rural households, are also adversely affected by deforestation and forest depletion.

Therefore it has to be realized by energy planners that agricultural policies which contribute to the acceleration of forest losses and land alienation, as well as the implicit subsidization of larger estates, and urban and rural industry woodfuel users, imply an irreversible exploitation of natural resources or a distribution of wealth which significantly affects the substantial number of subsistence farmers.

In this context it has to be emphasized that impacts of deforestation on smallholders consist not only of losses of benefits which households derive from woodlands. Farm households are also affected, because they have to find ways of substituting products which are obtained virtually free from woodlands, by using their limited available cash or by using other resources available to them. Producing lost woodland inputs for consumption and production has the important implication that additional land resources have to be used. Under conditions where suitable agricultural land is already so scarce that it has to be largely used without fallowing and is also subject to further fragmentation, the majority of the land-constrained smallholders are put under additional stress to cope with such a situation.

Because of the described linkages between population policies, agricultural policies, land-use changes and deforestation, the effects of which trickle down and tend to accumulate at the front door of the smallholders, it has to be acknowledged by planners and policy makers that rural household energy policy and broader-based fuelwood policies can only solve part of the (energy) problems and equity issues which are involved in the process of deforestation. Put another way, the rural energy issues are intimately linked with a range of other development challenges - and for rural energy policies to be effective they have to be linked to, and supported by, a range of other social and economic policies.

Conceptualizing and operationalizing farm household decision-making

The disappointing experiences encountered with household energy policy interventions in rural areas, notably in the area of woodfuel policy, have shown that the perceptions of energy planners concerning how rural households respond and adapt to the dwindling availability of fuelwood, had serious flaws. In particular, the view that rural households perceive physical fuelwood scarcity as a major household energy problem, was overemphasized. Past policy failures have given rise to the search for a new conceptual framework for rural household energy policy. Criticisms of the existing approach have emphasized the need for developing a new framework for understanding the decision behaviour of farm households, which integrates an analysis of the markets farm households are interacting with, and which takes broader land-use changes into account. In other words, past methodologies to tackle woodfuel problems were characterized by a serious lack of understanding concerning the economic rationale of farm household decisions in general and, more specifically, how existing biomass management practices and proposed policy actions and their associated instruments (subsidies, financial incentives, extension efforts, and so on) fit into farm household resource allocation decisions. From a household energy policy or woodfuel policy perspective, the main questions which have to be answered are what type of farm household will respond under which economic circumstances, in which way, and why, to declining availability of woodfuel resources?

In the area of agricultural policy analysis, farm household models have been developed with the explicit aim of explaining and predicting the rationale of farm household decision behaviour concerning the allocation of farm household resources to certain activities. Virtually all woodfuel and other policy interventions which have been conceived to alleviate the problem of woodfuel shortages of rural households involve a household decision to mobilize or reallocate cash, land and labour resources. Thus households evaluate the trade-offs between perceived benefits of proposed interventions and the utilization of their resources in other productive or consumption activities. Many woodfuel interventions, notably farm forestry and agroforestry options, may be simply regarded as an additional household production option.

Against this background it is surprising that few energy policy analysts have explored in depth the potential contribution of existing farm household models to gain insights into the decision-making behaviour of farm households with regard to household energy policy options. Perhaps a partial explanation is that, foresters who have had a leading role in designing woodfuel policies, have been too entrenched in their conventional approaches of forest management and have been convinced that their industrial (plantation) approach would fit, by and large, into the existing agricultural systems of smallholders.

In this research, selected farm household theories and related concepts were reviewed with regard to their ability to explain aspects of farm household decision behaviour which are relevant to household energy policy. One of the findings which corresponds to the view in the literature is that none of the existing models or concepts is able to capture the specific characteristics of farm household decision behaviour in Malawi. However, certain features of these models and concepts are useful to conceptualize and explain farm household decision behaviour, which has a strong bearing on household energy-related and farm forestry or agroforestry decisions. The theoretical approaches have to be generally regarded as tools for empirical analysis. Predictions of these concepts need to be empirically explored and operationalized which requires empirical analysis of household objectives and constraints related to the allocation of available resources to farm and non-farm activities, including access to land, access to off-farm resources, and of labour and credit markets. Risk considerations play an important role here as well.

The main policy implication from this analysis is that the design of energy policy interventions for rural households has to be firmly rooted in a comprehensive understanding and explanation of the rationale of resource allocation decision behavior of farm households. Most elements of this type of analysis lie with the analytical scope of agricultural policy analysis. In addition, the rural women in Malawi do not perceive the dwindling availability of fuelwood, which is manifested, for example, in increased time requirements for fuelwood collection, as the main household problem. Rather, problems related to agricultural production and health were found to be of much higher importance. These implications and findings emphasize the points that perceiving household fuelwood problems in terms of an isolated household energy problem is inadequate and that agricultural policy analysts have a much larger role to play in designing woodfuel policies.

Against this background, rivalries between forestry and agricultural planning and extension departments which are often found in developing countries in relation to responsibilities for woodfuel matters, reflect the close relationship between agricultural and farm forestry policy approaches. Complementary areas of expertise have to be integrated for formulating sensible household energy policies.

Rural household energy consumption and responses to fuelwood scarcity

The above analytical framework can be used to explain empirical observations of what rural households do when faced with growing fuelwood scarcity. If they change their fuelwood consumption patterns or plant trees, or do not, why and under what circumstances are these choices made?

One of the general criticisms of the fuelwood gap model was that the assumption of a linear relationship between population growth and woodfuel consumption of rural households is incorrect because fuelwood pressures will lead to shifts in fuelwood demand. An important associated question is over which time period, and to what extent, will fuelwood consumption patterns change? Data on deforestation (at the district level), and for longitudinal changes in regional fuelwood collection times, show that the availability of fuelwood in rural areas has been substantially reduced. The rapid increase of new estates which occupy former woodlands have additionally exacerbated the access of rural households to woodlands in a number of districts, which is testified by the problems of encroachment of estates (for fuelwood collection and other land uses). Concurrent long-term changes in fuelwood consumption of rural households could not be reliably estimated from available data sources. However, the analysis of household energy consumption patterns and of household responses to actual physical woodfuel scarcity, provides strong evidence that fuelwood consumption levels have not significantly declined from 1980 to 1993.

The main reason for the resilience of household fuelwood consumption levels and energy consumption patterns in Malawi appears to be that the low opportunity costs of women`s labour and severely constrained off-farm employment opportunities imply that there is little incentive to engage in woodfuel saving practices or the use of inferior fuels. The methodological implication of this conclusion is that, in addition to the more conventional study of time budgets and constraints, an assessment of the existing situation and likely development of income-earning opportunities and (seasonal) opportunity costs of household labour is required for ascertaining whether it is likely that changes in the procurement of fuels or other responses will occur.

The assumption made by some researchers that fuel economization is the first response to fuelwood stresses cannot be definitely ruled out for Malawi, although there is no evidence that many rural households have made substantial fuelwood saving efforts. There is also no evidence for the contention that rural households have adapted to fuelwood scarcity by using increasingly agricultural residues as fuel. Agricultural residues are used, but their consumption appears to be determined by (seasonal) availability rather than fuelwood pressures. The policy implication is that as long as fuelwood gathering can be accommodated in the labour budget of women, rural households are unlikely to switch rapidly to agricultural residues. The resilience of energy consumption patterns also indicates that there exist strong preferences for better quality fuels.

No evidence has been found in Malawi supporting the hypotheses that fuelwood scarcity impacts on food security (by constraining the number of daily meals cooked) or induces energy-saving changes in the preparation and choice of food. Rather there is evidence that the reverse causal relationship exists in Malawi: poorer, food-insecure households share food and cook together in order to free time for off-farm employment needed to provide food for the household. Thus fuelwood saving is a result of adaptations to food insecurity rather than a factor influencing food insecurity. This finding confirms other research in the area which has come to the conclusion that no hard empirical evidence is available supporting the hypothesized link between increasing fuelwood pressures and food security.

Available evidence from Malawi suggests that there is only a very weak relationship between per capita biomass availability and the percentage of households buying fuelwood. Moreover, buying of fuelwood appears to be mainly used for commercial purposes (beer brewing) which recover cash outlays. This behaviour can be partly explained by the extreme scarcity of per capita cash incomes of smallholders from the perspective of which purchasing fuelwood is likely to be a measure of last resort.

As substantial regional deforestation and large differences of per capita biomass availability co-exist in Malawi, the main implication for household energy planners is that the absence of developed fuelwood markets in rural areas may not be taken for granted as indicating that physical fuelwood scarcity is limited or negligible. Rather, energy planners have to be aware of the possibility that acute fuelwood supply problems may materialize much faster than anticipated.

Rural household energy policy

The high deforestation rate, which was assumed to exist by woodfuel and household energy planners, gave rise to the notion of an emerging woodfuel crisis in the rural areas of Malawi. The deforestation process was therefore assumed to generate widespread household woodfuel supply problems unless remedial actions were initiated. Because the fuelwood consumption of rural households was considered to be the main factor causing deforestation, rural household energy policy was given top priority. Since its inception in 1980/81, rural household energy policy focused almost entirely on supply-side oriented woodfuel policy options. This orientation was justified on account of the socio-economic situation of rural households and their energy needs which did not warrant attention on non-biomass related energy supply options. Priority was given to farm forestry policy, while agroforestry and communal forestry policy and projects were put on the woodfuel policy agenda later, but received less attention and funding.

The definition of the main objectives of farm forestry policy was ambiguous in the sense that official policy statements were unclear concerning the question of whether tree growing on farms should primarily serve household fuelwood needs or production for markets.

A main policy conclusion which can be drawn from the farm forestry policy and projects experience in Malawi is that farm forestry policies cannot be successful unless their design is firmly based on in-depth knowledge concerning the following: how trees or tree production and management systems fit into the diverse farming systems of smallholders; how deforestation and changes in the access to woodlands affect smallholders; and the nature of household decision-making characteristics which determine risk perceptions and benefits associated with farm forestry policy packages, that is, objectives and constraints of different segments of the smallholder community.

The disappointing performance of farm forestry policy in Malawi can be attributed to a considerable extent to shortcomings and gaps in the analysis of these issues in the policy design phase and in policy reviews. The related and second major policy conclusion from this research is that in view of the typical information gaps which characterize household energy planning situations, farm forestry policy approaches have to be designed which emphasize modularity and flexibility. This conclusion is derived from the experiences observed with the design of the policies under the umbrella of the SWEP and the WEC1. The policy package largely failed because it relied on a risky approach whereby its potential success was dependent on implementing, successfully and simultaneously, various policy measures which were subject to uncertainties and political controversy.

Concerning the first policy conclusion, a major shortcoming was that too little research was conducted in the preparation of policies to understand the role of trees in the interdependent production and consumption system of smallholders. In addition, the relevance of already existing information and information which was produced in the context of the performance evaluation of these policies, was partly ignored or misjudged.

The FWEP began with the dissemination of a farm forestry approach, that is essentially the promotion of establishing woodlots on farms in conjunction with the production of a narrow range of tree species which fitted this extension message. This approach was implemented despite the fact that the ongoing process of land fragmentation and very limited availability of fallow land on the farms of the target group, that is the poorer and land-constrained farmers, were critical factors questioning its suitability. In the end, most smallholders were found to plant and manage trees mainly on farm boundaries and around homesteads. Species selection by FWEP was linked to the requirements of the woodlot approach and was based on the assumption that households were motivated and able to plant the type of seedlings/trees offered, and that fuelwood pressures would encourage smallholders to grow trees for household consumption or urban markets. It was also assumed that seedlings production in centralized government nurseries was the most cost-effective approach. These assumptions turned out to be largely misleading and conjectural.

Studies conducted at the end of the 1980s (Maghembe & Seyani 1991) and early 1990s (Minae 1992a; 1992b) showed that smallholders retain and plant a wide range of tree species on their farms and that multipurpose trees were most commonly found, providing inputs for farm production and consumption needs. Results from these studies and the Malawi Rural Energy Survey (1985) indicated that the main incentives of farmers to grow trees were multiple benefits from trees and tree products, including particularly, the potential for generating income from the sale of poles and fruits. Findings from Poulson (1981) indicated that farmers traditionally grew trees from wildlings and had developed unique techniques for raising seedlings. However, no attempt has been made to explore further and to strengthen these practices. To the contrary, these practices were indirectly discouraged by supplying heavily subsidized seedlings.

The high consumption level of woodfuels, the absence of established fuelwood markets in rural areas and the survey finding that planting of trees for households` private consumption was an unimportant motivation to plant trees, are additional factors which pointed to the need for exploring further the economic role of trees and farm household resource allocation characteristics and the need to question the validity of the objectives of the chosen farm forestry approach.

Concerning the second main policy conclusion, it has to be noted that the GOM essentially continued to pursue the chosen farm forestry approach under the SWEP and the WEC1. The spectrum of species supplied was widened but the main additional policy elements were the introduction of incentive payments for growing trees, combined with measures to control fuelwood flows, and of confiscating fuelwood. The latter measure intended to raise fuelwood producer prices to the level of economic tree production costs. For the latter, government gazetted stumpage prices were used as a proxy.

That the incentive scheme was largely unsuccessful may be attributed to a number of factors. A primary likely factor was that farmers' interests in multipurpose trees, and constraints to grow a large number of trees in a woodlot, were ignored. There is also evidence that smaller farmers participated proportionately less than larger farmers, which leads to the policy implication that this approach is likely to be inadequate for the poorer smallholders, even if the bonus scheme had worked. The fact that only about 10% of those farmers who had participated in the scheme did so because of the incentives, shows that the incentives were not needed because the remainder would have planted trees anyway. Another reason may have been the virtual absence of rural fuelwood markets and perhaps unremunerative fuelwood price levels offered by traders supplying urban markets. Whatever the precise reasons, the overall cause of failure has been that the policy approach was formulated on the basis of a lack of knowledge and disregard concerning the economic basis of smallholder tree planting, which was substituted by conjectural assumptions about how farmers would respond to financial incentives.

Concerning the option of controlling the woodfuel market through roadblock controls and confiscation, the evidence from Malawi confirms the evidence from most other countries where such attempts have been undertaken, that such measures are not feasible. Even though some controls may be maintained as a means of discouraging to some extent the transport of bulk woodfuel supplies to cities, other elements of this general policy, namely the confiscation of products produced from forest resources, should be avoided. Confiscation of such products does not have any discernible impact on forest depletion and is likely to constrain the already limited income opportunities of the rural poor.

Where direct controls of illegally produced and traded woodfuels are ineffective, control and collection of stumpage fees of single, valuable forest areas by foresters may be possible. However, this may represent only a very limited solution because such activities are subject to the problem that forestry extension efforts will be adversely affected. As a result, for controlling the utilization of forests on a sustainable basis, for most areas there is no alternative but to pass their control and management to local communities. In view of the experienced partial misuse of authority by local leaders over distribution of access to local woodfuel and land resources by customary authorities and the problems of solving the questions of distributing benefits generated in community projects, in addition to required changes in forest and tree tenure, the main challenge for fuelwood policy lies in developing arrangements which guarantee sustainable management of remaining woodlands.

Urban household energy policy

In the area of urban household energy policy, the general planning questions are: what are the main household energy problems; and which strategy and mix of policies can be designed to adequately address the identified problems given existing constraints and policy objectives? Major urban household energy problems which are typically addressed in policy analysis are: to ensure that the cost of energy, particularly the cost of woodfuels for low-income urban households, are kept low, securing stable supply of fuels; and to mitigate adverse impacts of urban household woodfuel consumption on rural areas. To address these problems several policy options may be considered including interventions in woodfuel markets, fuel conservation (demand management), facilitating interfuel substitution, and increased woodfuel production and pricing policy.

Among the factors influencing interfuel substitution in urban households, access to and availability of fuels, is regarded as a major determinant in addition to income. Multiple fuel-use, and thus the use of multiple stoves, are commonly regarded in the literature as an expression of households' response to insecurity of fuel supplies. The evidence from Malawi suggests that access to, and availability of woodfuels and cooking fuels such as kerosene, have not been constrained significantly. The use of fuelwood instead of cheaper commercial fuels for cooking, which is explained in the literature by constrained access to fuels and insecurity of supply, has also been observed in Malawi but for different reasons. The costs of cooking appliances were found to play the most important role in hindering both the realization of substantial cost reductions for cooking through associated woodfuel energy savings and for switching to cooking with kerosene.

As the affordability of appliances is largely income-determined, income changes have to be regarded as the most important factor impeding the adoption of woodfuel saving measures through the purchase of higher efficiency woodstoves and interfuel substitution. The concept of the energy transition, especially the role of income as a main factor influencing interfuel substitution, has been challenged in the literature. However, the analysis of the situation in Malawi shows that under circumstances where a substantial portion of urban households have incomes which are close to the poverty threshold and where real incomes have been strongly declining for an extended time period, income remains indirectly the major factor determining interfuel substitution.

Fuel price effects are genuinely difficult to isolate from income effects with regard to interfuel substitution. In Malawi, fuel prices seem to have influenced switches between fuelwood and charcoal only in the short-term. This finding confirms the evidence from other studies concerning the role of fuel prices for interfuel substitution.

Various other policy measures were implemented by the GOM to mitigate the impact of rising real fuelwood prices. Substantial subsidization of kerosene had virtually no impact on engineering an increased use of kerosene for cooking but has, of course, lowered the cost of lighting in urban households. However, given the low use of kerosene in low- and even medium-income households in Malawi's cities, the income effects have been rather limited. As such benefits accrue to all consumers and there exists the possibility that diesel has been mixed with kerosene, the limited effectiveness of the kerosene subsidy may have become even more diluted and expensive. Because changes in relative fuel prices, particularly the continuous decline of kerosene in real terms had limited, if any, impacts on interfuel substitution, the subsidization of kerosene as a stand-alone measure cannot be regarded as being effective in influencing the substitution of woodfuels by kerosene.

The general policy conclusion is that more focused measures are needed. Administratively feasible and cost-efficient measures, which ensure that the leakage of subsidies to non-target groups is reduced, are preferable to a general subsidy. Where fuel access problems influence interfuel substitution, improvements of the kerosene supply infrastructure, for example, by reallocating kerosene subsidies, may be considered. The latter option can be primarily considered from the point of view of urban-rural equity considerations, because improved access of rural households to kerosene is likely to lower their fuel costs but may have even more limited quantitative impacts on reducing their fuelwood consumption.

Where urban household woodfuel consumption significantly contributes to deforestation, the subsidization of kerosene as a measure to reduce deforestation impacts through interfuel substitution is unlikely to be a viable policy option, because large fuel-price differentials and thus subsidies will be required to effect the transition from woodfuels. This applies particularly to circumstances where appliance costs represent an important, if not insurmountable, barrier to fuel switching.

Malawi's specific situation, that is rising real woodfuel prices combined with substantially declining real incomes since the mid-1980s, resulted in a massive income-induced switch from charcoal to fuelwood between 1983 and 1990. Given the limited potential of (affordable) kerosene subsidies to address household energy problems, other measures particularly improving the affordability of woodfuel-saving and of kerosene stoves, assume top priority. This conclusion is based on the experiences encountered with other policy options which have been tried in Malawi.

As long as most of the woodfuels supplied to urban areas originate from land clearing operations or agricultural expansion, depletion effects in the form of increasing real woodfuel prices may be contained. When the conversion of woodlands to agricultural land approaches physical limits, urban woodfuel demands are increasingly met from remaining woodlands. This was the case, for example, in the vicinity of the city of Blantyre, where most of the deforestation in the areas around the city has been caused by urban fuelwood consumption. This finding shows that most of the forest and woodland loss can be primarily due to urban woodfuel consumption. Rural households, and most likely the lower-income households, are most affected by deforestation because they were found to rely in various ways on forests and forest resources for consumption and production purposes. However, as in many other developing countries, there is little quantitative information available about the benefits which rural households derive from using forest resources, implying that perhaps a major part of the externalities caused by urban (and other consuming sectors) woodfuel consumption remains uncertain. From a household energy planning point of view the trade-off between the objectives of keeping urban woodfuel prices low and containing deforestation, and thus the detrimental impacts of urban woodfuel consumption on rural areas and households, is an additional important issue in the context of rural-urban equity considerations.

The GOM has pursued several options to deal with this trade-off but has placed the main emphasis on keeping urban woodfuel prices low. Measures to control the flow of woodfuels from forests on customary land intended to reduce the flow of low-cost woodfuels into urban fuelwood markets and to ensure that the government-gazetted stumpage prices would be paid for wood supplies. The implicit objective of the latter is that urban consumers should pay the full economic costs of woodfuels. The stumpage prices of the GOM represented effectively a high-cost proxy of the replacement cost of wood on the stump which did not take regional differences of replacement costs into account. Reducing the flow of wood cut from customary land was necessary as a precondition for smallholders to engage in wood production and implied, if successful, that urban woodfuel prices would tend to increase. The evidence from Malawi has shown that such interventions have very limited chances of success on account of a number of social and logistical factors which are difficult to control.

Because the intervention in the woodfuel market through controls and confiscation failed, incentives for smallholders to produce for urban markets have been impaired. The main implication for developing a viable household energy strategy are twofold. Instead of investing in control measures which tend to be costly and ineffective, priority has to be given to an in-depth understanding of how the rural-urban fuelwood supply chain functions. Measures to improve the efficiency and competitiveness of the fuelwood market will at least contribute to lowering the supply costs of woodfuels with regard to the transport cost elements and trading margins. Introducing measures to make the woodfuel market more competitive do not contribute to solving the problem of adverse impacts of urban woodfuel production on rural areas, because they do not affect procurement of woodfuel from open-access woodlands. Therefore, institutional and legal (tenure) changes need to be instituted as independent or complementary measures which provide incentives to individuals, groups or local communities for controlling, protecting and managing the access to, and use of, remaining woodlands. Existing institutional structures and responsibilities, such as the authority of village headmen in Malawi to grant access and utilization of forest on customary lands, have proven in many instances as too weak to protect access of outsiders to local woodfuel resources.

Whatever legal, institutional, regulatory and management arrangements will have to be introduced to overcome the main problem of overutilization of open-access resources, they are likely to lead eventually to increased costs of woodfuel supplies (because some land rent or the full replacement cost of trees will be charged) unless major inefficiencies in the existing woodfuel supply system that exist can be eliminated. Thus the production economics of fuelwood under a regime of sustainable management of existing woodlands (and from private producers) imply that specific measures are needed to supply subsidized fuelwood to urban low-income households.

Alternative measures which have been tried by the GOM to achieve this objective have met with no success. From a production cost point of view, government-operated fuelwood plantations in Malawi have largely performed badly. This was to some extent due to high technical inefficiencies compared to efficient private producers. Equally important is the fact that in most instances, agricultural and other land uses are of higher economic value. This imposes high opportunity costs of land on the production of fuelwood from peri-urban plantations which impair their economic feasibility. Thus unless the rare situation is created where sufficient land is available in peri-urban areas which is not suitable for agriculture, fuelwood plantations are likely to play but a minor role in solving urban household energy problems. The experiences with government fuelwood plantations and the BCFP project in Malawi support this general view in the literature.

Attempts to provide subsidized fuelwood to low-income urban households by trying to establish a parallel distribution system failed because it ignored the economics of the existing retail marketing system. The rationale of establishing a parallel distribution system was based on perceived high trading margins at the retail stage and the intention to supply subsidized fuelwood to the urban poor without major leakages to other consumer groups. Several sales measures were tried out to reach the target group, but both the excessive costs of the salesyards and the inability of finding a mechanism which would reduce leakages to an acceptable level, prevented these measures from attaining any success. The main policy conclusions which can be drawn from these experiences is that parallel fuelwood retail marketing systems are likely to be non-competitive in comparison to existing modes of supply and that it is also rather difficult, if not impossible, to establish feasible targeting mechanisms in the context of a parallel distribution system. With regard to leakages to non-target groups, such interventions share the main characteristics of subsidized kerosene prices.

The results experienced in Malawi do not imply that the concept of supplying (subsidized) fuelwood to the urban poor is entirely unfeasible. The policy suggestion made, for example, by ETC (1987: 132) and Soussan et al (1990: 577) of establishing urban consumer cooperatives may perhaps represent a feasible option. Although this proposal has been made based on the observation that trading margins at the retail stage are the highest in the fuelwood supply chain, it may be used both to cut supply costs and to supply subsidized fuelwood. However, this option also requires a substantial degree of social cohesion and financial inputs. Their is yet no empirical evidence available about the performance of such schemes, so that their feasibility needs to be explored on a pilot basis.

In summary, there are no generally applicable policy solutions available to deal with urban household energy problems. The subsidization of kerosene appears to have limited financial impacts on the urban poor and is faced with inefficiency and cost problems because of the difficulties of finding feasible mechanisms which allow the magnitude of leakages of subsidies to other consumers to be contained. Establishing parallel fuelwood markets at the retail stage does not appear to be a financially viable option because of the high retail costs compared to the existing woodfuel distribution system. In addition to cost reasons, it has proven difficult to find mechanisms of supplying subsidized fuelwood to the rural poor in the context of a parallel retail marketing system. For cutting high retail trading margins of fuelwood or supplying subsidized fuelwood to the urban poor, consumer cooperatives may be an alternative option which has not yet been tested.

Effecting interfuel substitution through the subsidization of kerosene is an option which is likely to be very costly because fuel price differentials will have to be rather high and need to be consistently maintained to encourage consumers to switch from woodfuels. An additional barrier to fuel switching are the cost of appliances. Under circumstances like in Malawi, where the majority of the urban households are very likely to rely mainly on woodfuels for meeting their main energy needs in the foreseeable future, a priority measure is to improve the affordability of woodfuel and kerosene appliances both to reduce woodfuel consumption of households and to substantially lower cooking costs.

The latter conclusion has to be seen against the background of what contributions other policy options could make towards the main urban household energy problems. Establishing large-scale fuelwood plantations are unlikely to reduce the price of fuelwood because they represent a financially and economically feasible option only under the rare condition where the typical factors facilitating their viability, that is primarily the availability of suitable land, is fulfilled. Woodfuel supply costs may be reduced by improving the efficiency and competitiveness of fuelwood markets. Fuelwood markets in many developing countries are considered as being already fairly efficient, so that the potential for further efficiency gains depends on the country-specific situation in local and regional fuelwood markets. As far as Malawi is concerned, too little research has been carried out in this area while priority has been given to other (costly) measures which were largely unsuccessful. As efficiency improvements in fuelwood markets may be substantial, investigations of the functioning and efficiency properties of woodfuel markets are a key element in designing household energy strategies. Such investigations have also to be considered as one of the first analytic steps because the relative importance and feasibility of main policy options (fuelwood plantations, interventions in fuelwood markets, establishing parallel woodfuel markets, pricing policies) is conditioned or influenced by the economic characteristics of the existing fuelwood system.

Interventions in fuelwood markets such as controls of woodfuel flows into cities have limited chances of success on account of social, administrative, cost and logistical reasons. As a consequence, stumpage fees in general have little practical meaning as market price indicators for potential fuelwood producers, as long as substantial supplies from natural woodlands are available which depress fuelwood prices. In addition, the problem of containing adverse implications of urban woodfuel consumption on rural areas and households can only be addressed by shifting the control and management of open access forest resources to rural user groups or village communities.

The combined effects of improving the efficiency of fuelwood markets, and of shifting control to local entities, are likely to increase the real supply costs of fuelwood towards replacement cost levels. Thus policies which intend both to encourage private production (or management) of fuelwood and to keep woodfuel prices low, as was the case in Malawi, are incompatible. The best options in working towards this goal are to improve the efficiency of woodfuel markets and to improve the affordability of more efficient cooking stoves.

8.2 OPERATIONALIZING INTEGRATED HOUSEHOLD ENERGY PLANNING

The summary of findings and policy conclusions in the previous section already points to methodological implications of this research for developing and operationalizing a conceptual framework for analyzing household energy issues in developing countries. In this final section of the thesis, these theoretical and methodological issues are discussed further.

The Malawi case study shows the complex interlinkages between factors impacting on household energy problems, and that a coherent conceptual framework, adequate data and thorough analysis is needed before embarking on costly policy interventions. At the sector and project level, single measures were implemented. For example, in the urban household sector, peri-urban fuelwood plantations and direct fuelwood sales to the urban poor failed. Other policies were of limited and doubtful effectiveness (subsidizing kerosene), or had greater chances of success (improved woodfuel stoves), but, in practice, had limited positive effects because they were not coordinated with complementary measures to mitigate the main constraints for their success, that is the unaffordability or purchase costs of woodfuel stoves.

Farm forestry policy in the beginning was based on wrong assumptions about the main causes of deforestation and farmers' perceptions of problems, needs and circumstances. A main reason for interim failures to achieve the objectives in the area of farm forestry was again insufficient analysis, and a narrow forestry top-down perspective which focused on making a technical solution (the woodlot approach) feasible, rather than focusing primarily on a deeper understanding of the realities facing diverse farm households. Integrated approaches corrected some of the obvious shortcomings (such as the narrow choice of tree species, government nurseries) but failed because they continued to misjudge farmers' needs and therefore their responses (financial incentives for tree planting had a marginal impact). They were biased in favour of a non-target group (larger farmers) and underestimated the importance of social and logistical elements involved in the rural-urban woodfuel supply chain and the feasibility of effective control. They also were subject to conflicting policy objectives (provision of incentives for private investment and the intention to keep woodfuel prices low); were too optimistic concerning the adverse effects of policy implementation (foresters as policemen, undifferentiated confiscation of forest products) on long-term objectives (sustainable and cooperative forestry extension work); and lacked the political consensus to adhere to the implementation requirements of the chosen policy package (delayed and insufficient increase of government stumpage prices to support private tree planting). Most of the key measures of the policy package failed on their own. The overall design was too risky because conceptually a major failure of one of its components had the potential to jeopardize the whole approach.

One of the conclusions which was drawn in the previous section was that modularity and flexibility in designing fuelwood and household energy policies are required. This applies in the first instance to the design characteristics of a policy package and the technical components of a strategy. The complex linkages of macroeconomic, sectoral and microeconomic issues (at the household level), and the failure of single and coordinated policy measures in Malawi, demonstrates that the problems associated with household energy cannot be approached through single policy measures. An integrated policy analysis and planning approach is needed.

Conceptually, the framework of integrated national energy planning contains the building blocks which are relevant for integrated household energy planning (IHEP). The approach involves: the integration of multiple actors and planning criteria; integrated multi-level analysis (linkage between international issues, national economy, energy sector and sub-sectors) which situates the energy sector within broader economic and development objectives and analysis issues across energy sub-sectors; sectoral demand and supply analysis; analysis of policy instruments and constraints (financial, institutional, political, methodological); and sub-sectoral supply and demand analysis. However, IHEP involves even more complexity due to the nature of the sector and the number of inter-linking factors. A main factor is that household energy is not just a fuel resource, production chain or user sector. Rather it is characterized by lots of cross-linkages (energy, agriculture and forestry), population growth, land-use systems and urban-rural links which accordingly introduce new policy areas (agricultural policy, land tenure, natural resource management) and analytical areas (farm household decision-making behaviour) as well as shifts in emphasis of conventional analysis (for example, land-use and natural resource changes in connection with household adaptations, rural credit and labour markets).

For developing an improved conceptual framework which can be operationalized, an understanding of the linkages and cause-effect analysis, is paramount. The causes of deforestation represent a central starting point for conceptualizing the linkages between macroeconomic and microeconomic issues and analytic areas, concerning household energy in developing countries. With regard to deforestation, the analysis has shown that population growth and the attendant land-use requirements, rural bulk woodfuel consumers and urban woodfuel consumption are contributing most to deforestation. With regard to rural bulk woodfuel consumers, agricultural policy has contributed to expanded land use and the clearance of woodfuel resources. There have been a lack of supply-side policies on estates and a lack of tax policies to increase wood self-sufficiency or to enforce land tenure policies. Thus the need to maintain economic growth and the need to increase export earnings has led to the development of an export-oriented, mainly tobacco-producing, estate sector without giving sufficient consideration to the sustainability of the sector itself. Political fears of jeopardizing this economically vulnerable structure may be the prime reason why policy initiatives to attack the deforestation problem at one of its main roots have been widely ignored (except for fuelwood efficiency measures and some attempts to collect stumpage rates). Thus the orientation of agricultural policy, and lack of political commitment to employ available options for increasing wood self-sufficiency, have been fundamental factors causing excessive deforestation.

Agricultural policies, including limiting access to the production of remunerative tobacco crops and differential prices for maize (below market prices for smallholders, border prices for estates), have limited the growth of income of smallholders. As a result, most smallholders, for which the poverty trap is closely associated with access or accumulation of funds to break through the working capital trap, which in turn constrains them to increase agricultural productivity and income, have been adversely affected. This has to be seen in the context of an undeveloped formal rural credit market and severely constrained access of poor smallholders to existing production credit facilities. In addition, confiscation of wood products further constrained the income-earning possibilities of the rural poor. Thus a mixture of biased agricultural pricing policies, undeveloped credit markets and elements of fuelwood policies all have finally adversely affected the income growth of farm households.

The direct relevance of this process for rural energy problems may not primarily lie in the effects of income on energy substitution because the share of fuelwood in total energy consumption has remained high across income groups in rural compared to urban households. Rather the main impact has been on the crop production choices of households. Farmers who are caught in the working capital trap are typically more land-constrained and more food insecure which leads to an even stronger reliance on erosive maize crops. This contributes directly to productivity stagnation/decline exacerbating policy-induced income effects. Because of their concern for food security, they have no option but to plant more maize than richer farmers. This leaves little land left on their farms which may be used for cash crops, including the planting of trees for markets or for home consumption. In addition, deforestation and forest depletion and reduced access to forest products due to land-use changes induced by agricultural policy (see below), forces them to forego these benefits. Their landholdings, which are already constantly under pressure through the factors influencing land fragmentation, are further squeezed by the need to use additional household resources. Given existing constraints, land use and labour allocation choices become more complex and difficult.

The implicit subsidization of urban food consumption (as a result of suppressed maize prices) is one element of the general rural-urban equity issue, which also includes the consumption of underpriced woodfuels which keep consumption levels high and which offload the consequences of urban woodfuel consumption on rural households. This equity issue has an additional dimension with regard to the access to land and forest resources. Agricultural policy has provided incentives to accelerate the creation of large- and smaller-sized estates. The process of customary land conversion to estate land has mainly benefited new landowners of urban origin, rushing to take possession of land under circumstances where productive agricultural land is getting increasingly scarce. The resultant loss of access to land and forest resources for rural households was facilitated by unclear and insufficient land property rights and weaknesses of local institutions which play a major role in customary land allocation decisions.

The linkages described above may be partly specific to Malawi, but they illustrate and operationalize a methodological approach for IHEP and the starting point that effective fuelwood policies have to be developed in the context of agricultural and rural development policy by giving recognition to macro-policy issues such as population, land distribution, tenure rights, land management issues and urban-rural links. This also shows that explicit household energy or fuelwood policies are a sub-set of the broader issues impacting on the nature and extent of household energy problems in the first place. Thus integrated household energy planning and policy have to rely on a complex set of measures which must be coordinated across energy and economic sectors and policy areas. It has to be acknowledged that, although fuelwood stresses are always influenced by local conditions, some important macro-policies and sectoral-policies, as well as failures to implement policy reforms, always influence local conditions which define the nature and extent of household energy problems.

An important consideration is that these policies, in addition to impacting on land use and deforestation, have the additional dimension of influencing the conditions determining the scope of options to adapt to changed situations and resource stresses. As demonstrated for Malawi, broader policies which contribute to household energy problems, adversely affect concurrently the conditions under which smallholders can respond to these problems. However, determining which elements of a package of technical options will be adequate is not just a question of specific regional or local conditions in a general sense. In many localities there are different types of households which are differently affected by the same environmental conditions and which possess different opportunities to respond to such situations. Finding appropriate fuelwood (farm forestry, agroforestry or communal forestry) or other solutions to rural household energy problems thus rests on the understanding of how different farm households are dynamically affected and which options they have to respond.

Understanding households in a specific context and finding appropriate solutions which are tailored to their needs, requires emphasizing bottom-up approaches. These approaches will primarily have to focus on women who bear most of the burden of household energy problems. However, approaches focusing on women have to acknowledge that they must be embedded into an understanding of the internal decision-making of the household, where areas of resource control and of sole and joint decision responsibility concerning resource allocation may differ considerably by gender and type of household.

The scope and complexity of the issues which have to be considered in integrated household energy planning and policy design shows that effective household energy policies have to rely on contributions from different scientific disciplines and are, in general, rather information intensive. In the literature, the shortcomings of available databases concerning the conventional parameters of household energy planning are regarded as a major impediment for designing fuelwood policies. Major information gaps refer to the knowledge about the efficiency and operational characteristics of fuelwood markets and particular longitudinal data about forest resource changes, quantitative assessments of woodland resources and their importance for households, and particularly about households' responses to changing natural resource situations and market developments. As the case study of Malawi shows, information gaps in these areas which were replaced by largely conjectural assumptions, contributed to the overall failure of the farm forestry policy. This shows that the requirements for developing these needed data, and therefore for increased funding which are always voiced by researchers and policy analysts in this area, cannot be ignored.

It has also to be acknowledged by national governments, development banks and donors who contribute to funding projects and research in this area, that a suitable conceptual framework for household energy planning requires additional information in areas which often have received hitherto less attention. This includes particularly knowledge about tree and local resource management on farms. Not all of such information needs to be developed anew. As the case study in Malawi has shown, there is often a wealth of information available from other research and policy areas, notably from agricultural issues, which can be used for household energy planning purposes. Integrating such information requires the consideration at the institutional planning level that household energy planning is not primarily an effort of loosely coordinated energy, agricultural, forestry and land-use planners and that ways need to be found to link the top-down planners and their approaches and procedures to the requirement of the bottom-up component of planning, that is integration of the final beneficiaries into fact finding, problem definition and creation of solutions.

In summary, an important consideration for developing and operationalizing IHEP is that the complexity of linkages and interdependencies involved, and the different time frames for implementing policies in various areas which need to be coordinated, imply that IHEP cannot be regarded conceptually as a standard step-by-step procedure. Since policies may have widely varying lead and implementation periods, which may affect the scope and magnitude of household energy problems as well as chosen strategies to deal with them, market-related and pricing policies which are likely to affect household energy options faster than long-term changes in macro-variables, have particularly to be scrutinized. For example, significant changes in agricultural pricing policy for maize may exert rather quick and lasting effects on farm forestry.

The main relationships between policy areas involved in IHEP may be summarized as follows. Population policy affects rural-urban migration, land-use changes and land fragmentation. The rate of the latter process is conditioned by land tenure systems and local land inheritance roles. National economic policy usually has a strong linkage to agricultural policy because export-oriented agricultural policies are a typical option and choice for many developing countries. This brings broader land-use changes into the picture. Large-scale estate expansion inevitably reduces the availability of, and access to, land and woodland resources. Where the physical agricultural frontier is approached, that is availability of suitable land for agriculture, competitive elements to gain control over a diminishing land resource base may accelerate existing land-use processes. Again, agricultural policies may provide incentives for accelerating this process. Land reform, or the absence of it, as well as the strength and adequacy of local institutions play a crucial role in this process. Agricultural policies always have to be scrutinized with regard to their potential biases towards the estate sub-sector and the urban sector because the success of an export-oriented agricultural strategy, strong political constituencies in the cities and the need for mobilizing government finance to support growth strategies, always involve a tendency of taxing (explicitly or implicitly) small farmers and adopting a *laissez-faire* approach concerning the development and enforcement of policies to control unsustainable (land, forest, environmental) resource uses of favoured economic sub-sectors. The latter may comprise a whole complex set of policies in the areas of land tenure, estate forestry, taxation, and so on.

Policies which are biased against the smallholder sub-sector usually have direct income effects as well as longer-term income implications. Small farmers are often disproportionally affected. The efficiency and degree of development of various markets (particularly rural credit and labour markets) are primarily important with regard to their relationship to the household economy and its production and consumption choices. Credit markets and funding mechanisms which are relevant for smallholders have a strong relationship to farm household production and thus land-use decisions. The latter, which are also influenced by varying degrees of existing land constraints, influence directly the relevance and design of forestry options (farm forestry, agroforestry). Changes in the macro-variables and market conditions set the external framework for household resource allocation decisions. The empirical analysis of the interaction of the external framework with specific farm resource conditions, as well as culturally influenced gender-related areas of responsibilities and internal bargaining processes, is a major analytical building block for household energy policy formation. Two relationships are crucial in this microeconomic analysis. First, the relationship between women's labour availability and income opportunities. And, secondly, policies in areas which influence women labour requirements (provision of medical services, water supply infrastructure). Generally, the relationships between external developments and on-farm situations need to be analyzed with a focus on those characteristics of farm households which differentiate households with regard to their perception of main household problems, their potential to adapt to changes in the external environment and their response to household energy policy options. This differentiation is linked to their perception of how potentially effective local institutions are in contributing to solving land-use and resource management problems.

The functioning and efficiency of woodfuel markets is primarily of interest with regard to its linkage to the farm household via the price formation process and its results for farm-gate fuelwood prices. In addition, we need to understand the linkages between the composition of sources of woodfuel supply and the organization of the supply infrastructure and the woodfuel price formation process which convey information about forest depletion and likely price trends. This analysis is a further crucial building block of IHEP because it determines the scope of possibilities and requirements of policy interventions in woodfuel markets and strongly influences the priority and feasibility of options for urban household energy policy. Finally, the analysis of linkages between urban household income, fuelwood and other energy prices, access issues and other factors influencing fuel-device choices, and the functioning of urban fuelwood markets are a prerequisite for the choice of intervention options.

As the Malawi case study shows, there is no universal set of policy prescriptions which neatly apply to all household energy issues in developing countries. Nevertheless, the complexity of the inter-linkages between factors impacting on households points to the need for a coherent conceptual framework. IHEP provides this - not in a simple step-by-step set of procedures, but rather in terms of an approach which is sensitive to the range of factors which need to be analyzed and understood. Hopefully this case study and thesis has contributed to providing new knowledge and an improved understanding of household energy problems in developing countries, the development of an adequate methodological framework and the operationalization of some of its important elements.

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323

Annex 1-1

POLICY OBJECTIVES, INSTRUMENTS AND CONSTRAINTS IN INTEGRATED NATIONAL ENERGY PLANNING

The ultimate objective of INEP is to develop a set of consistent policies that meet the often conflicting national and sectoral objectives. Within the multitude of specific objectives INEP has to consider in the policy-making and implementation process, several general objectives pervade all levels of INEP. These objectives are economic efficiency, social and intergenerational equity, environmental considerations and financial viability. In the analytical process of INEP, for example, the analysis of energy issues, strategy formulation and policy-making the trade-offs between these objectives are of key interest. Therefore as a minimum requirement, professionally sound policy analysis and advice to decision-makers has to clarify and evaluate these trade-offs clearly, in addition to the consistency requirement with all other objectives involved in this process. However, difficulties arise in the context of INEP because the general objectives are related to theoretical concepts and methodologies which are beset with a number of theoretical and normative issues and explicit and implicit assumptions, as well as theoretical and practical problems of implementing specific methodologies. In the following, these concepts and their relationships and associated methodological issues, are discussed from the perspective of energy-economic analysis and policy.

1.1 INTEGRATED NATIONAL ENERGY PLANNING: MARKET OR PLANNING?

The notion of integrated planning and national planning in INEP naturally raises fundamental questions about the criteria and structural economic factors that determine the need for a certain mix between the role of the state and the private sector. Empirically there existed, and continues to exist, vast differences in developed and developing countries at different levels of development, as to the relative role of planning within the extreme views of a pure market economy and central planning. For example, France is known to have a high share of public ownership of major private firms and a tradition of centralized decision-making processes involving state bureaucracies and the private sector. Similarly, Japan's Ministries of Finance and International Trade and Industry, are well known to have vast economic planning systems and have coerced the private sector to adopt strategic economic decisions which would have been considered in other developed countries as undue interference into the private sector, or the market economy for that matter. South Korea's state and planning bureaucracy too is known to have adopted a rather heavy-handed approach which was characterized by strategic economic planning and policies and the prescription of tight investment and other guidelines for the private sector.

From a theoretical point of view, the approach to dichotomize the role of planning and the market in terms of an alternative is fundamentally inadequate because inherent market deficiencies which create *inter alia* divergencies between private and social costs, necessitate policy interventions requiring different degrees of national planning and integration under specific circumstances (Kornai 1983: 66-72).

In relation to the general factors that influence the relative role and necessity of integrated planning, in comparison to developed market economies, developing countries are characterized in varying degrees by more pronounced deficiencies in the functioning and the existence of markets and by the lack of structural homogeneity and income inequalities. Against this background, integrated planning can be viewed as a necessary attempt to foster the development of market institutions and to complement their functions. This view is reflected, for example, by Kornai (1983: 72):

> In a developing country, ... markets are frequently only localized, fragmented, and compartmentalized - thereby providing less information. Or a market may not have been established for a certain economic activity. An incomplete or rudimentary development of the market system means that the 'organizational framework' of the economy is inadequate for the transmission of relevant economic information.

A typical outcome of deficient market structures in the goods markets are that producers capture above average rents (profits). Combined with higher income inequalities and poverty there is an inherent potential for policy conflicts. According to de Oliveira and Girod (1990: 534), even though the resolution of such conflicts cannot be solely addressed by energy planning, they nevertheless have to be integrated in the energy planning process.

Superimposed on, and intertwined with, the governmental role to develop a market framework in developing countries are significant macroeconomic effects of energy system development. Such effects, and the fact that energy sector infrastructures are in many countries still at an early stage of development, also contributes to the necessity for conducting integrated national energy planning.

Even though the development of efficient markets refers to all markets, the development of the subset of markets which play a role in woodfuel production and supply, that is the land

and woodfuel markets, are often lagging behind developments in other markets. Deficiencies in these markets, and their induced socio-economic consequences, provide a strong case for integrated household energy planning from a pure market perspective. However, the focus on market structure issues in this discussion does not imply that improvements of urban and rural woodfuel market structures may be the panacea for solving household energy problems.

1.2 ECONOMIC EFFICIENCY, MARKET FAILURES AND ENERGY POLICY

Economic efficiency: technical and allocative efficiency

The concept of economic efficiency plays a central role in energy-economic and policy analysis and thus in INEP. Economic efficiency in the context of neoclassical economics[1] embraces two concepts of efficiency, which represent conditions which have simultaneously to be fulfilled to establish economic efficiency. The first condition refers to technical efficiency. Technical efficiency is an output-maximizing property which is defined by the production-possibility frontier, which represents the maximum attainable output for given alternative factor input combinations and a given technology. This concept is useful for applications in all microeconomic applications. The analysis of technical efficiency or the analysis of production functions in the energy sector, is a key element of energy systems analysis, both on the supply and the demand side. Since technical inefficiencies are cumulative, they may result, for example, in energy price levels which may be much in excess of what may be achieved under conditions of technical efficiency. A typical example of cumulative technical efficiencies in the supply chain of woodfuels is a low conversion efficiency of earth-mound kilns combined with inefficient transport systems for supply to urban markets. On the demand side, the equivalent of technical efficiency in energy-economic analysis is the concept of energy conservation, that is minimization of energy used to serve a given demand of useful energy service.

The second concept, that is allocative or price efficiency relates to the choice of inputs and outputs and relative prices. Efficient allocation of resources under the assumption of competitive markets is characterized by the point on the production-possibility frontier for which the central condition for profit maximization holds, that is where price equals marginal (factor) costs. A fundamental theorem of welfare economics, that is the Pareto

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1 Economic efficiency is a basic economic concept which is explained in every basic economic textbook. For the reader who is interested in the functions of prices and an overview of the properties of efficiency and their role as an analytic tool in a developing country context, the excellent textbook *Pricing policy for development management* edited by Meier (1983), is recommendable.

optimum[2], states that markets operating under certain (restrictive) assumptions generate prices which lead to the optimal allocation of resources. Hence, for energy-economic analysis two areas of analysis are important. First, the analysis of empirical deviations from economic efficiency in its technical and price dimension which may exist either due to simultaneous existence of technical and allocative inefficiencies, or attainment of one type of efficiency and inefficiency in the other. Secondly, the analysis of energy prices and hence energy pricing policy to achieve allocative efficiency, is of central importance. The central implication of both types of inefficiencies is that, to the extent that technical and allocative inefficiency exist, economic growth is below attainable levels.

Efficient pricing of energy should reflect the full incremental costs of resources to the national economy. This implies that energy prices should be set at the highest of either the economic supply costs, opportunity costs of energy in alternative uses and the foregone future value of energy (user costs).[3] The applicability of these general pricing concepts to particular fuels depends on whether they are tradable goods or non-tradable goods. A principal classification of the applicability of either concept to the pricing of all particular fuels and energy carriers is not possible *per se*, because the empirical country-specific circumstances determine whether an energy carrier has the economic characteristics of a tradable or not. An exception consists for the pricing of electricity which is usually considered as a non-tradable good, resulting in the application of the economic supply costs rule that prices (tariffs) should equal the long-run marginal costs of supply.

The concept of economic efficiency also implies the integration of least-cost (efficient) energy supply and least-cost (efficient) consumption of energy, under the umbrella of least-cost energy planning in INEP. This integration takes into account that reducing the

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2 The Pareto optimum is characterized by a situation where the requirements of economic efficiency are fulfilled. In this situation, that is where, under conditions of perfect competition, market prices lead to a Pareto optimum, the welfare of any individual cannot be enhanced without decreases in the welfare of another individual. The applicability of the Pareto optimum or rule is in practice limited because government policy interventions always involve non-neutral distributional effects between individuals. Due to this limitation, additional decision rules for evaluating changes in social welfare have been developed, notably the Kaldor-Hicks rule and Little's rule. A short, but very constructive description of these rules, and their relation to other concepts in welfare economics which provides the theoretical basis for cost-benefit analysis, is contained in Hyman and Stiftel (1988).

3 Throughout this research energy pricing theory and valuation concepts are only explicitly discussed where relevant in practical applications. An overview of general pricing theory is given in World Bank (1981). The theory of electricity pricing is comprehensively discussed in Munasinghe and Warford (1982), while specific aspects for regulated utility pricing inclusive of related issues in financial theory, are explored in deSouza (1981). Alternative pricing policies and analytic procedures for coal pricing are described in World Bank (1985), while woodfuel pricing concepts are discussed in World Bank (1989a).

consumption of a marginal unit of energy to render a required level of energy service, may be economically more efficient than supplying that marginal unit.

Economic efficiency and market failures

Violations of the restrictive assumptions of the competitive market model represent market imperfections/distortions or market failures. In economic theory four types of market failures are distinguished which are associated with specific market disfunctions. Externalities represent the case of incorrect market functioning. Market imperfections refer to market disfunctioning relative to the aspects of market entry, market exit, the number of buyers and sellers and the ability of the market to rapidly convey price information. The case of public goods refers to the absence of a market for a particular economic activity. Finally, market failures exist where the market produces adverse results relative to objectives other than efficient resource allocation. In the context of INEP all four forms of market failures are relevant.

Externalities of production and consumption activities mean that social costs are incurred and externalized to third parties or the national economy. Hence, in the presence of externalities, market prices of energy do not account for the full social or economic costs of production. Internalizing the costs of externalities or the application of the 'polluter-pays-principle' has to cope with the problem of identifying, measuring, predicting and evaluating environmental impacts. The complexity of the issues involved in this chain of assessment activities, introduces a whole range of intricate methodological problems associated with the quantification of environmental impacts.[4] It has furthermore to deal with the problem that certain impacts are not quantifiable because they involve qualitative and ethical judgments. Methodological difficulties involved in quantifying externalities (caused by power plants) with a reasonable degree of accuracy have been demonstrated, for example, by Voss and Friedrich (1993). The limitations of the existing impact assessment approaches do not imply that they are ineffective. Rather they can be applied to provide improved estimates of numerous impacts and can thereby contribute to the rationalization of contentious issues in energy strategy and project analysis.[5]

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4 A comprehensive overview of the economic background of methods available for environmental impact assessment and the limitations of valuation techniques is discussed in Hyman and Stiftel (1988).

5 A recent study of the author in Indonesia (Lahmeyer International 1992) which involved a methodological review of over 30 environmental impact assessment studies for proposed power plants in Indonesia, showed their severe neglect of known and applicable quantitative valuation methods. Different reasons such as financial constraints or the relatively infancy of these methods may be cited. However, personal discussions with some researchers involved in these studies

Market structures range from competitive to monopolistic. Non-competitive markets are due to the violations of the assumptions of the competitive model. Transfer costs such as taxes, duties and subsidies are costs that do not involve economic resource costs. Lack of information, asymmetric access to information, or failure to protect investment in information either distort efficient choices or act as disincentives to invest in technology development due to free rider effects. Several researchers have emphasized the need to properly understand the functioning of the entire woodfuel supply system, because fuelwood and charcoal markets represent the link between rural woodfuel supply sources and urban fuel markets. Woodfuel markets are complex and difficult to understand because dynamic changes in the composition of supply sources and changes in the transport and distribution network create substantial difficulties in understanding whether, and under which conditions, price levels and changes convey information about depletion effects (Barnes 1991).[6] For the urban household energy sector, the woodfuel market is important with regard to its influence on the urban energy transition of interfuel substitution process.[7] From a rural perspective, the efficiency of the woodfuel markets has a range of implications, notably its ability to convey price incentives to producers and the socio-economic and purported environmental impacts of deforestation.

There are numerous sources of possible market failures in particular countries which have a direct and indirect impact on the energy sector. An important consideration from the point of energy policy analysis within INEP is that many market failures which have an impact on energy investment, production and consumer choices are not within the direct realm of energy policy. Such distortions originate from the other goods and factor markets with which the energy system and its economic agents interact. The main cost parameters introducing distortions include the foreign exchange rate, costs of capital, labour costs, transport costs, taxes and subsidies, and externalities. Additionally, imperfections in the

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unambiguously showed that political pressures were a major and common reason for such negligence. This was due to the fear of the bureaucracy that putting a price tag on certain impacts may have had the consequences of internalizing impacts such as adequate compensation of people to be resettled, costly changes of power plant design and/or loss of financing commitments from commercial and development bank sources.

6 Hosier and Milukas (1992), discuss the diverse factors and circumstances involved which intervene in the relationship between the depletion of woodstocks and charcoal prices and demonstrate that it cannot be concluded *per se* that real woodfuel price increases always reflect depletion effects, or that unchanged real prices allow one to conclude the absence of depletion effects.

7 Leach (1992) discusses the relative importance of the determinants of the rural and urban energy transition. With regard to the role of energy prices in the urban household sector, he concludes that there is evidence that they are primarily instrumental in inducing shifts between fuels in households using several fuels.

functioning of these markets act as constraints on certain market participants, such as differential access to credit or differential (gender-related) access and remuneration in labour markets.

As these external distortions, as well as distortions within the energy system, are reflected in market or financial prices which constitute the basis of economic decision behaviour of energy system participants, economic analysis of these prices in terms of shadow prices or opportunity costs has to be carried out. This is accomplished by adjusting financial prices to economic costs. The application and applicability of principal valuation approaches and variants thereof in cost-benefit analysis[8] (CBA) varies according to considerations as to data availability, existence of markets, substitutability characteristics of resources, the degree of precision required, and trade-offs between higher precision and implementation costs.[9]

Market failures and policy approaches

Depending on the type of market failure(s) within the energy sub-sectors and energy markets, economic theory suggests specific policy tools or combinations thereof to remedy such failures. In general, policy instruments are designed to address the specific cause of divergence between private and social opportunity costs by providing a mechanism or intervention to remedy the market failure. There are numerous possible configurations of market failures that have to be addressed within INEP. Specific policy issues and approaches that are relevant to Malawi will be discussed in subsequent chapters. However, several general issues associated with the cause-effect policy design relationship within INEP merit discussion from a methodological point of view.

Within the two dimensions of efficiency, the emphasis and combination of suitable policy instruments is dependent on the extent to which technical or allocative inefficiencies are responsible for market distortions. Price or allocative inefficiencies are by definition primarily tackled by pricing measures. For example, the introduction of stumpage fees are commonly proposed to capture the difference between private and social marginal costs of woodfuel harvesting in common property management regimes characterized as being of the open-access type.[10,11] The introduction of stumpage fees aims at increasing the price of

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[9] There is a large body of literature in the area of CBA. An introduction into basic economic and CBA concepts, including analytic concepts and applications which are used in the analysis of the household sector, are contained in EDI (1990).

[10] See Openshaw and Feinstein (1988) for a discussion of the role of stumpage fees as a policy tool and for a description of alternative valuation approaches for estimating stumpage values.

[11] The common property and open access concepts are further discussed in Chapter 3.

woodfuels to reflect their scarcity and will thus also work as an incentive to improve technical efficiency in production. However, the desired effects of stumpage fees (pricing regulation) will only be reflected in market prices if these fees can be effectively collected. Where effective fee collection is hampered by institutional and manpower constraints, stumpage fees are more likely to be only a partial policy remedy. Alternatively, or as complementary policy options, privatization of woodfuel resources or incentives to enhance community-based management of woodfuel resources, can be considered.

If efficiency is impeded by imperfect or incomplete markets, policy remedies with the objective of improving the functioning of markets, will have to be designed in response to the major causes and relative importance of factors leading to market failure. This may involve regulatory interventions or changes thereof, such as removing market barriers to entry and exit if the market has oligopolistic characteristics leading to the capturing of above-market rents. Additionally financial incentives or financing mechanisms may be used if, for example, the transport of fuels is technically inefficient or if certain chains in the marketing of fuels such as market outlets for charcoal produced from non-indigenous hard or softwoods, is promoted as a supply alternative.

Other regulatory measures are related to informational aspects when information constraints inhibit access to available technical choices. In this case the primary emphasis of policy measures is related to improvements in technical efficiency. This may focus on information programmes about new fuels, subsidies to improve the technical efficiency (energy efficiency) of conversion technologies (charcoal production technologies, improved woodfuel stoves) or mandatory labelling of energy equipment.

Technical efficiency and energy policy

Lack of technical efficiency in energy supply may also be addressed by a number of measures, depending on the specific shortcomings in the energy production. To the extent that technical inefficiencies, for example in government-operated plantations, are due to deficits in the underlying organizational structures and incentives, privatization or leasing schemes under performance contracts may represent the most effective policy choices. Other direct regulatory interventions may address shortcomings in the quality and coverage of supply. For example, oil companies in developing countries may be regulated to meet specific criteria concerning the coverage of fuel supply nationwide or to achieve supply security.

Direct quality-type regulations on the demand side may involve mandatory minimum energy efficiency standards or mandatory technical standards, or even the mandatory use of technologies such as scrubbers or electrostatic precipitators in power plants.

The examples given above cover the main types of pricing and regulatory interventions which can be implemented in different ways. The design of integrated energy policies has to take into account complementarities between single policies. For example, subsidies of seedlings or other inputs to encourage smallholders to produce fuelwood or poles for the market, may be premature or inefficient if fuelwood or pole markets are not competitive enough. Smallholders would be forced into the role of price-takers which may result in traders capturing part of their rents and producers retreating from participation in the market. Likewise, a charcoal supply marketing strategy for supplies from private or government plantations may be futile if effective enforcement of stumpage fee collection or confiscation of illegally produced charcoal cannot be reasonably expected to be enforceable.

Regulatory versus market-oriented policy approaches and efficiency considerations

Within this spectrum of pricing, or price-related and non-price or regulatory measure trade-offs between the efficiency of alternative policy, instruments have to be scrutinized with regard to both their effectiveness to meet objectives and targets and their implementation costs. In this respect, a contentious general issue relates to the question of whether regulations and policies of the mandatory or incentive type that rely on market mechanisms, are more effective. Tahmassebi (1992: 962) has made a strong plea for the comparative advantages of using market forces to achieve environmental goals. He argues that:

> Market forces are driven by economic incentives and profit motives, but regulations seek compliance with a given mandatory measure. The greatest advantage of using market forces over regulations lies in the fact that benefits emerging from economic incentives can be an on-going process. In a regulated environment the stipulated objectives of environmental measures become the ceiling, as the industry perceives them as the maximum requirement it has to comply with because it has no incentives to go beyond. But in a market related environment, the stated objectives of the law become the floor if further improvements are rewarded with higher profits. Thus market related measures not only could cost less to implement, the long-term social and economic benefits could also surpass those of mandated regulations.

This view is supported for almost identical reasons by Fisher and Rothkopf (1989) concerning alternative policies for environmental protection, and evidence provided by Tietenberg (1984)[12] who carried out cost comparisons for alternative approaches by means of empirical and simulation studies. However, the question of relative advantages of these alternative approaches cannot be generally answered, because the effectiveness of different policy approaches needs to be tested in relation to a specific type of underlying market failure and constraints within the relevant dimensions of assessment (implementation time horizon, market penetration, sustainability, leakages, quantitative targets, and so on). Fisher and Rothkopf (1989: 404) take such a differentiated view, for example, by conceding that government interventions of the mandatory type in the form of labelling and mandatory efficiency standards, might prove to be cost-effective options for improving efficient energy conservation. In a similar vein, a study comparing the cost-effectiveness and market penetration of two strategies to promote energy efficient home construction in the United States, that is a hybrid strategy consisting of mandatory codes and standards coupled with incentive payments and a utility-marketing approach also involving incentive payments, concluded that both approaches have different advantages and disadvantages and are therefore of a complementary nature (Brown 1993: 401).

1.3 COST-BENEFIT ANALYSIS AND EQUITY AND ENVIRONMENTAL CONSIDERATIONS

In the context of cost-benefit analysis, economic efficiency is defined and measured without taking into account to whom such costs and benefits accrue and regardless of whether the existing income distribution is considered as desirable or not. However, social equity considerations and objectives are included in every national development programme and have to be considered and integrated in INEP. A key issue in this respect is that virtually any government policy decision has asymmetric direct and indirect impacts on the distribution of income, irrespective of whether equity considerations have been explicitly taken into account in the policy-making process or not. Therefore equity considerations permeate policy analysis at all levels of planning and policy decisions. From the point of view of the planner and policy analyst, the presence of multifold political and private interests associated with government policy decisions, consists in rationalizing the perceived impacts of policy decisions and clarifying the involved trade-offs between objectives in their relevant aspects through an integrated analysis. This role of the policy analyst has been clearly pointed to, for example, by Lutz and Young (1992: 242):

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12 The study carried out by Tietenberg was cited in Fisher and Rothkopf (1989: 400).

> It may be somewhat idealistic to think that decision-making by policy makers is fully objective, equitable, and concerned with sustainability. But whether or not that is the case, economists undertaking policy analysis should supply policy makers with integrated analyses which include consideration of the likely environmental effects and impacts of policy decisions on overall welfare and distribution of income.

As in other policy areas, there are numerous equity issues which may have to be addressed in INEP. For example, gender-specific equity considerations have to be considered in the registration procedures of land titles because access to, and control of land resources, has implications for intra-household income distribution and resource management. Because control of resources is a precondition for reaping economic benefits, equity considerations also play a central role in a whole range of policy issues which have an impact on the ability of local institutions to manage their local resource system. A traditionally controversial area in INEP is the role of subsidizing the prices of kerosene and electricity and of investments, notably in peri-urban and rural electrification schemes, to enhance the access of lower-income groups to these energy carriers. Justifications for such policy measures often rely on common-sense assumptions about the direction of policy impacts but are often also carried out with weak data which conceal which income groups will eventually benefit most. In this respect equity considerations within the realm of energy policy are subject to the same effectiveness considerations as any other policy instrument.

From a methodological point of view, equity considerations enter INEP in connection with the economic concept of the discount rate which is used in the context of cost-benefit analysis for the assessment of energy projects and alternative energy policy options. Discounting implies that benefits and costs accruing at different points in time are compared at their present values. Therefore when maximization of the net present value of alternatives is used as a decision criterion, the choice of a discount rate always involves a value judgment as to the time rate of resource use and intertemporal allocation of resources or, in non-technical terms, about the values and preferences of future generations. The basic problem involved in choosing a discount rate is that benefits of an environmental resource which accrue to society beyond a time horizon of 30 years have hardly any present value, regardless of whether a relatively low or high discount rate is applied. Hence, the interests of future generations have practically no impact on decisions made today.

This issue is of particular importance with respect to private and public policy decisions and projects involving the use of depletable natural and environmental resources. However, the main issues associated with the choice of an appropriate discount rate have not been theoretically resolved in the economic literature. The first issue relates to the fact that private investors use discount rates based on the opportunity costs of capital which are adjusted and finally determined by investment-specific risks and opportunities to diversify such risks in an investment portfolio, while the appropriate concept for public policy decision-making is the social rate of time preference or discount. Besides the fact that the question of whether these rates should be identical is unresolved, the question of how the appropriate rate of discount for public policy decisions should be determined, also remains an unresolved theoretical issue that is practically decided on in the political process as demonstrated by Lind (1987: 5):

> The choice of the discount rate for evaluating public choices is itself a public policy decision. While philosophers, economists, and financial analysts may debate the appropriateness of one rate as opposed to another for public policy decisions, and while their arguments may well be influential, the final choice will often be determined politically. It will depend not only on the merits of the supporting arguments but also on the policy implications of one choice versus another and on the political strength of forces in support of those implications.

As the key theoretical issues remain unsolved, more pragmatic views have been adopted as to the role of CBA in policy analysis. For example, Lind (1987: 88) reminds us that the application of cost-benefit analysis has two important dimensions. First, it is an imprecise tool that is able to assist the broad screening of project and policy alternatives. Secondly, as many other analytic tools, it serves as a framework to establish a learning process to arrive at informed policy decisions which take into account the qualitative or intangible aspects of decision-making. Other authors, such as Hyman and Stiftel (1988: 63) argue that the use of low or zero discount rates in connection with public policy decisions related to natural and environmental resources, is rather ambiguous or even counterproductive and emphasize that the focus on appropriate discount rates is a narrow policy perspective:

> there may be better ways of maintaining the resource base and the quality of the environment than by altering discount rates. Other possibilities include laws and regulations, severance taxes, more research and development, reduced population growth, or maintenance of unforeclosed options for the future.

1.4 INTEGRATION OF MAJOR OBJECTIVES WITHIN INEP

Notwithstanding the methodological problems which are associated with the application of specific methods that are applied in INEP and household energy planning, a rational procedure to accommodate multiple objectives within the INEP framework is a phased and iterative approach. This approach starts with economic efficiency considerations and then takes the other objectives successively into account, that is environmental objectives, equity objectives, financial viability, and so on. The approach is most suitable for identifying the implications of integrating specific policy objectives, and the trade-offs and impacts which are involved in pursuing particular objectives with different levels of emphasis.

The relationship between objectives can be viewed technically either in terms of economic efficiency or least-cost driven economic growth as the main decision criterion, subject to constraints represented by, and derived from, pursuing other objectives or as a multi-attribute or multi-objective decision-making framework. From an analytical perspective, environmental quality, for example, even if it is not a strongly emphasized policy objective in a particular country, is an analytical category *per se* in the form of externalities which are addressed in the context of efficiency considerations. The difference in approach is, in the first instance, more of semantic than practical relevance. Giving more explicit recognition to social and environmental criteria in policy making does not change the real short-, medium- and long-term trade-offs involved in making certain choices. The practical difference, however, lies in the expectation that the trade-offs involved will indeed be made more explicit.

Annex 2-1

Comparative population characteristics: 1966, 1977 and 1987

Region	Land area ('000 km2)	Sex Ratio (1) (males per 100 females)			Population Density (2) ('000 persons per km2)			Population share (percent)		
		1966	1977	1987	1966	1977	1987	1966	1977	1987
Northern Region	**26.93**	**85**	**90**	**94**	**18**	**24**	**34**	**12.30**	**11.70**	**11.40**
Chitipa	3.50	89	89	91	17	21	28	1.5	1.3	1.2
Karonga	2.96	88	90	93	26	36	50	1.9	1.9	1.8
Nkhata Bay	4.09	84	91	96	21	26	33	2.0	1.9	1.8
Rumphi	5.95	83	87	95	8	10	16	1.2	1.1	1.2
Mzimba	10.43	85	90	95	22	29	41	5.7	5.5	5.4
Central Region	**35.59**	**88**	**95**	**96**	**41**	**60**	**88**	**36.4**	**38.6**	**39.0**
Kasungu	7.88	87	107	108	12	25	41	2.4	3.5	4.0
Nkhotakota	4.26	86	94	101	15	22	37	1.6	1.7	2.0
Ntchisi	1.66	87	92	97	40	53	73	1.7	1.6	1.5
Dowa	3.04	91	96	95	60	81	106	4.5	4.4	4.0
Salima	2.20	84	94	99	39	60	86	2.0	2.4	2.4
Lilongwe	6.16	94	98	99	81	114	160	12.3	12.7	12.4
Mchinji	3.36	90	104	105	25	47	74	2.1	2.8	3.1
Dedza	3.62	83	85	86	64	82	113	5.7	5.4	5.1
Ntcheu	3.42	80	86	86	48	66	105	4.1	4.1	4.5
Southern Region	**31.75**	**92**	**92**	**93**	**65**	**87**	**125**	**51.3**	**49.7**	**49.6**
Mangochi	6.27	80	84	90	37	47	79	5.8	5.4	6.2
Kasupe/Machinga	5.96	84	86	89	38	57	86	5.6	6.2	6.5
Zomba	2.58	98	93	91	109	137	170	7.0	6.3	5.5
Chiradzulu	0.77	89	87	86	185	230	275	3.5	3.2	2.6
Blantyre	2.01	110	109	107	118	203	292	5.9	7.4	7.4
Mwanza	2.30	86	89	90	19	31	53	1.1	1.3	1.5
Thyolo	1.72	97	96	94	150	188	252	6.4	5.8	5.4
Mulanje	3.45	92	89	88	116	138	185	9.9	8.6	8.0
Chikwawa	4.76	94	96	99	31	41	67	3.6	3.5	4.0
Nsanje	1.94	88	89	93	52	56	104	2.5	2.0	2.5
Total	**94.27**	**80**	**93**	**95**	**43**	**59**	**85**	**100.0**	**100.0**	**100.0**

Source: NSO, Population Census 1977 and 1987 (Preliminary Report).

Annex 2-2

Population distribution by district: 1966, 1977 and 1987

	Total Population			Urban Population			Urban Population		
Year	1966	1977	1987	1966	1977	1987	1966	1977	1987
Region/District		'000			'000			Percent	
Northern Region	**497.4**	**648.9**	**907.1**	**18.3**	**44.7**	**90.5**	**3.7**	**6.9**	**10.0**
Chitipa	59.5	72.3	96.8	1429.0	3.1	5.2	2.4	4.3	5.4
Karonga	77.7	106.9	147.1	1.1	12.1	19.6	1.5	11.3	13.3
Nkhata Bay	83.9	105.8	136.0	1.2	4.0	6.5	1.4	3.8	4.8
Rumphi	46.6	62.5	94.7	1.9	4.0	7.1	4.1	6.4	7.5
Mzimba	229.7	301.4	432.4	12.6	21.5	52.0	5.5	7.1	12.0
Central Region	**1475.6**	**2143.7**	**3116.0**	**31.5**	**134.5**	**300.4**	**2.1**	**6.3**	**9.6**
Kasungu	97.5	194.4	322.9	1.6	6.5	10.8	1.7	3.3	3.4
Nkhotakota	62.9	94.4	157.1	1.1	10.3	12.1	1.8	10.9	7.7
Ntchisi	66.8	87.4	120.7	1.2	1.7	3.1	1.8	1.9	2.5
Dowa	182.6	247.6	322.1	1.6	2.0	2.7	0.9	0.8	0.8
Salima	86.6	132.3	188.3	2.3	4.7	10.6	2.7	3.6	5.6
Lilongwe	498.5	704.1	986.4	19.4	98.7	234.0	3.9	14.0	23.7
Mchinji	85.3	158.8	248.2	831.0	2.0	4.5	1.0	1.2	1.8
Dedza	230.7	298.2	410.8	2.3	5.6	16.7	1.0	1.9	4.1
Ntcheu	164.7	226.5	359.6	1.1	3.1	5.8	0.7	1.4	1.6
Southern Region	**2067.8**	**2754.9**	**3959.4**	**140.1**	**283.0**	**453.5**	**6.8**	**10.3**	**11.5**
Mangochi	232.7	302.3	495.9	2.8	6.0	22.2	1.2	2.0	4.5
Kasupe/Machinga	226.5	341.8	514.6	2.0	10.1	18.8	0.9	2.9	3.6
Zomba	282.4	352.3	438.2	19.7	24.2	42.9	7.0	6.9	9.8
Chiradzulu	142.2	176.2	210.7	609.0	689.0	1.5	0.4	0.4	0.7
Blantyre	237.3	408.1	587.9	109.5	219.0	331.6	46.1	53.7	56.4
Mwanza	42.6	71.4	121.3	692.0	2.4	4.7	1.6	3.3	3.9
Thyolo	256.6	322.0	431.5	1.4	3.4	4.7	0.5	1.1	1.1
Mulanje	398.9	477.5	638.3	1.2	3.0	7.1	0.3	0.6	1.1
Chikwawa	147.4	194.4	319.8	902.0	7.9	10.0	0.6	4.1	3.1
Nsanje	101.2	108.8	201.3	1.4	6.4	10.0	1.4	5.9	5.0
Malawi	**4040.2**	**5547.5**	**7982.6**	**190.0**	**462.2**	**844.4**	**4.7**	**8.3**	**10.6**

Source: NSO, Population Census 1977 and 1987 (Preliminary Report).

Note: Urban areas include all townships, town planning areas and district centers. An urban area need not be an administrative center, but must have other facilities such as a police post or a post office in addition to trading stores and a market.

Annex 2-3

Internal migration by region and district: 1966-1987

Period Region/District	1966-77 ('000)	Percent of 1977 population	1977-87 ('000)	Percent of 1987 population
Northern Region	**-27.415**	**-4.8**	**-34.756**	**-3.9**
Chitipa			-13.651	
Karonga			1.068	
Nkhata Bay			-9.855	
Rumphi			122	
Mzimba			-12.24	
Central Region	**58.869**	**3.3**	**98.151**	**3.5**
Kasungu			88.774	
Nkhotakota			27.317	
Ntchisi			-7.499	
Dowa			-16.658	
Salima			23.813	
Lilongwe			36.027	
Mchinji			42.322	
Dedza			-55.965	
Ntcheu			40.070	
Southern Region	**-31.479**	**-1.3**	**-63.395**	**-1.7**
Mangochi			12.045	
Kasupe/Machinga			56.379	
Zomba			-38.986	
Chiradzulu			-57.943	
Blantyre			99.897	
Mwanza			-788	
Thyolo			-31.104	
Mulanje			-76.451	
Chikwawa			15.116	
Nsanje			-41.560	

Source: Government of Malawi, Population Census 1977 and unpublished data from the 1987 census. Cited from World Bank (1993b: 4).

Annex 2-4

POPULATION PROJECTIONS, MORTALITY-FERTILITY RELATIONSHIPS AND FACTORS INFLUENCING FERTILITY PARAMETERS

1 POPULATION PROJECTIONS

Two main population projections were recently prepared for Malawi. These are projections made by the World Bank (1991) in the context of the Malawi Population Sector Study and by the Population and Human Resources Development Unit of the Department of Economic Planning and Development (DEPD) in 1992 (DEPD 1992). Given the recent vintage and the underlying in-depth analysis of existing demographic trends for these projections, they combined may be considered as a reasonable base for estimating a realistic range for population growth in Malawi.

1.1 Projection assumptions

Population projections in Malawi have to deal with a number of data shortcomings and future unknowns.[1] In addition to projections related to the major forecasting variables of mortality and fertility, two other major uncertainties relate to estimates for the human immune deficiency virus (HIV) prevalence rate as well as the demographic impact of an estimated 0.94 and 0.33 million Mozambican refugees in 1987 and 1991 respectively (GTZ/UNHCR 1992: 3). These four variables are the main scenario parameters of the DEPD and World Bank projections. The underlying assumptions for these variables are reviewed in the following in order to identify whether any particular set of projections or scenarios have specific merits.

Repatriation of refugees

The DEPD and World Bank projections differ in their assumptions as to the integration of refugees in that the latter excluded refugees completely by assuming that they would not permanently settle in Malawi (World Bank 1992a: 29), while DEPD considered scenarios with and without refugees. At the time when both projections were made, there was no real basis to justify either of the assumptions. The assumption made in the World Bank study may reflect a legalistic perspective because a contingency plan for the repatriation of refugees was jointly adopted in 1990 by the United Nations High Commission for Refugees

[1] These problems are discussed in detail in DEPD (1992: Chapters 1-3).

(UNHCR) and the governments of Malawi and Mozambique in which the principle of voluntary repatriation was accepted. The views of the authors of the DEPD study, although not explicitly mentioned, may have taken cognisance of the fact that the existing strong ethnic relationships between the Malawian population and the refugees, most of which originate from the border hinterland in the proximity of the present refugee camps (GTZ/UNHCR 1992: 5), were unlikely to encourage the GOM to support measures, other than moral persuasion, should the refugees choose to stay in Malawi.

Additionally, the outcome of peace talks between the warring parties in Mozambique was unpredictable. However, in January 1994 about 400 000 refugees were reported to have left the country, which tends to support *ex post* the assumption made in the World Bank study.

HIV prevalence and incidence

HIV prevalence used for both base year projections (1987) and medium scenario projections, vary considerably. The World Bank assumes a national HIV prevalence rate of 2.2% while DEPD assumes a much higher rate of 9.6% for the adult population over the age of 15 years, based on the conclusions drawn from the analysis of sample surveys conducted by the AIDSTECH/AIDS Secretariat of the Ministry of Health in Malawi in 1989. DEPD also rated other available estimates as being of low statistical quality due to the small sample sizes from which they were drawn (DEPD 1992: 4). However, the summary findings of survey results reported in Shanmugaratnam et al (1992: 43)[2] which were apparently undertaken after completion of the World Bank study, provide additional evidence that the prevalence of AIDS may be considerably higher than estimated by the World Bank, and that increased urban infant mortality rates are causally linked to AIDS.

The Bank's study accommodates the uncertainties related to the actual level of HIV prevalence with varying assumptions in five scenarios. Their 'high threat' scenario, for example, assumed the actual number of AIDS cases to be 18 000 in 1990, equivalent to an underreporting of 60%. Figures for reported AIDS cases cited by Shanmugaratnam et al (1992: 43) amounted to 22 000 cases in 1991. However, the HIV prevalence figure of 10% which was estimated by the Ministry of Health for 1993 (UNDP 1993: 25) indicates that the DEPD base estimate was more appropriate, albeit too high, for 1987. This figure also indicates that the 'worst case' starting assumption of a 9% HIV prevalence rate for 1990 in the World Bank study was most accurate, although also too high for 1990.

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2 These results were based on information provided by a senior World Health Organisation AIDS specialist in Lilongwe.

Regardless of the different assumptions used in both projections, it is important to note that the future impact of HIV prevalence in both population projections also differs, because different projection methodologies are employed. The Bank employed an epidemiological-demographic model, while DEPD used the Demographic Projection Model (DEMPROJ)[3] and relied on exogenous assumptions as to the spread of HIV.

Mortality and fertility

Both projections use only one mortality scenario because the focus of both studies was on fertility. The DEPD life expectancy assumptions are only slightly lower for comparable projection intervals[4] than those of the World Bank, which is partly due to the anticipated impact of a renewed upsurge of malaria in Malawi. Until the end of the projection period in 2002, average life expectancy is assumed to reach 48.4 years by DEPD and about one year more by the World Bank. The much larger uncertainties which are related to the future development of fertility rates are reflected in three fertility scenarios (constant, moderate and rapid decline) that were used for both projections in combination with a constant mortality scenario. Differences between these scenarios rely mainly on different assumptions about the governments commitment and investment in population control measures and programmes, contraceptive use and socio-economic trends. For the last projection period the TFR assumptions in fertility scenarios 'moderate' are both about 6.8 and vary only in the rapid decline scenario (DEPD-TFR: 5.8; World Bank-TFR: appr. 5.2).[5]

1.2 Population growth scenarios and results

As discussed above, the lower base assumptions as to HIV prevalence in the 'medium threat' scenario which was coupled with the fertility scenarios, leads to higher population growth rates in the World Bank study compared to the DEPD projections, while the DEPD assumptions concerning the repatriation of refugees result in an overestimation of future population growth. However, even if current HIV infection levels were known with more accuracy, long-term impacts of AIDS on mortality and population growth could vary tremendously on account of uncertainties relating to variables which determine the future course of the epidemic (World Bank 1992a: 6). These uncertainties, and uncertainties relating to the future TFRs, make it extremely difficult to assign superior predictive quality to any

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3 The DEMPROJ population projection model was developed by the Futures Group, Washington DC, USA. The model uses the standard cohort component method. A description of the model is given in Futures Group (1990).

4 The World Bank five-year projection intervals range from 1985 to 2005 (and beyond), while those of DEPD cover five-year periods from 1987 to 2002 to coincide with the official government planning periods.

5 The World Bank data for 2002 were interpolated. See DEPD (1992: 12, 37) for a description of the total fertility rate scenarios for both projections.

specific scenario. Yet it has to be taken into account that the constant fertility and the rapid fertility decline scenarios were deliberately constructed to ascertain lower and upper bounds for future population growth.

Population growth projections are not an end in themselves but are used to analyze the broad socio-economic implications of alternative scenarios for planning and policy in all sectors. Based on the above discussion, results from selected population scenarios which best capture the likely range of the population development are shown in Table 2-3 (see Chapter 2). The DEPD figures refer to the year 2002, while the World Bank figures are for 2005.

The most interesting result of comparing the main scenarios is the large variation in the final outcomes until 2002. Even under the assumptions of the lowest and less realistic scenario, the average annual population growth rate would still remain significant at 2.2%. Within the more likely context of a moderate decline in fertility levels, combined with the reality of the HIV/AIDS epidemic in the country, population growth rates of around 3% or more are likely to prevail until 2002. This represents in absolute figures, an increase from 7.98 million in 1987 to at least 12 million people in Malawi, even if most of the refugees were repatriated.

2 MACRO- AND MICRO-VARIABLES OF REPRODUCTIVE BEHAVIOR

The main uncertainties in demographic projections are normally related to mortality and fertility parameters and their dynamic relationship. Because of the important role these demographic variables play, it is necessary to analyze these variables in relation to macro- and micro-variables which determine reproductive behaviour.

Macroeconomic variables and mortality and fertility rates

The evidence of a broad inverse relationship between income per head and fertility which was already cited above (Dasgupta 1992) is used as the starting point for the following discussion. The curve shown by Dasgupta relates income per capita (in 1980 US$) to fertility rates. The 1980 US$ equivalent[6] of the 1987 income per capita for Malawi of US$178.1 would predict a total fertility rate of 6.6 using Dasgupta's curve. This rate is lower than the actual rate of 7.6 in that year. Such a deviation could possibly be explained by a higher Gini-coefficient, a measure of the degree of income inequality for Malawi relative to the sample, or directly by Dasgupta's additional qualification of his findings that the actual observations for most sub-Saharan countries lie above the regression line.

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6 1987 per capita income for Malawi from the *African Development Indicators* published by UNDP/World Bank (1992: 32) was converted to 1980 US dollars by using the GDP deflator (US dollar series) from the same publication, Page 39.

The conventional wisdom as to the dynamic relationship between fertility and mortality rates, commonly referred to by demographers as the demographic transition process, is that sharp declines in mortality rates precede similar declines in fertility rates (Dasgupta 1992: 99). Three key issues are important in this respect, that is the determinants of mortality and fertility rates and the linkage between mortality and fertility rates over time.

Such linkages are hypothesized in the demographic transition theory (DTT). Recent research carried out by Bengtson (1992) questions the validity of the conventional assumptions and predictions of this theory. The DTT conceives that prior to the transition, both mortality and fertility rates are high, and that the start of the transition is indicated by a decline in mortality rates. Malawi has experienced a declining mortality since 1977, accompanied by an almost constant fertility rate which is one of the highest in the world. This raises the question of whether the transition is still pending, in the process of taking place or soon to occur. Bengtson's first caveat based on historical evidence in Europe is that, because mortality varies, it is not a reliable indicator for fertility changes. Moreover, the DTTs supposed positive correlation between increased income and mortality at the onset of the demographic transition cannot be maintained, as mortality declines were observed over half a century in Europe without concurrent significant increases in living standards. Because Malawi's average real wage income decreased between 1968 and 1987 (World Bank 1990b: 31), the onset of the demographic transition cannot be supported on grounds of income.

Concerning the link between mortality and fertility, Bengtson (1992: 24) has observed faster changes of mortality rates than of fertility rates, that is a fertility decline usually lags behind a decline in mortality. The very high and almost constant fertility level experienced in Malawi can therefore also not be interpreted *per se* as an indication of the absence of the onset of the demographic transition.

The relationship between fertility levels and other macro-variables is also generally hypothesized to be strongly correlated with the implementation of family planning programmes and the education level of women. As to the first factor, fertility rates cannot be expected to be more moderate because the GOM has not yet implemented a fully-fledged family planning programme. Rather, existing activities are mainly confined to the National Child Spacing Programme (NCSP), the objective of which is to lengthen the child-birth interval by reducing maternal and child mortality and morbidity. Lengthening the interval between births may affect the fertility rate; this is a necessary but not a sufficient condition. There are also other important parameters involved which influence household fertility decisions as was recently demonstrated by research conducted by M'manga and Srivastava (1991). Using data from the Family Formation Survey (1984) in a linear multivariate analysis, they derived the following findings as to determinants of fertility rates in urban and rural areas.

The coefficient of determination for rural and urban females was found to be 62% and 57% respectively for the relationship between fertility and age of first marriage, child survival rate, number of children desired and current age. Most interestingly, women with a child survival rate of 100% had 4.6 children on average and those who had lost one child had a fertility rate commensurate with the national average of 7.6. Such an abrupt change in this relationship is implausible, pointing to the existence of a non-linear relationship.[7] Additional variables such as women's education, husbands education and level of contraceptive use were found to have virtually no statistically significant impact on fertility levels.[8] This statistical result is rather surprising with regard to the conventional assumption about the education-fertility relationship which is expressed, for example, by Ferguson-Bisson (1992: 93):

> The strong, inverse relationship between level of education, particularly for women, and fertility rates, has long been empirically documented. The depressor effect of female education operates through increased use of family planning and through improved health and hygiene practices, lowering infant mortality.

Even though the possibility cannot be excluded that biases in the underlying statistical data may have led to an underestimation of the relative importance of female education levels for fertility decisions, recent research suggests that the absence of this relationship is not altogether implausible under certain conditions. Shanmugaratnam et al (1992: 44) have pointed out that for female education to become an effective mechanism of fertility reduction, a minimum level of female's education has to be attained. Their experience from Kenya suggests that a minimum of five years of primary education seems to be required to make the link operative. By 1987 only 20.1% of the female population in Malawi had attained an education level of four years or more, while 64.3% never attended school (NSO 1991). This tends to support the above statistical findings.

Two additional conditions have to be considered in the fertility-education relationship. First, a higher educational level may not be fertility reducing *per se* unless appropriate information is disseminated as to family planning techniques and health and hygiene practices. Secondly, enhanced dissemination of information in these areas can only be

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7 The authors conceded that the relationship between fertility and some of the explanatory variables, including the child survival rate, is indeed non-linear.

8 This finding was derived from a 0 and 1% increase of the coefficient of determination by adding the above variables in the estimation equation for urban and rural females respectively.

expected to exert an impact on mortality if combined with widespread and affordable supply of enhanced medical services, safe water supplies and sanitation improvements. Access to health services, including maternal and child care, are considered as being inadequate by policy makers and the research community (DEPD 1990). This is demonstrated, for example, by the estimated access levels to health services which were 60% and 25% for the urban and rural population respectively in 1988 (UNDP/World Bank 1992: 325).

Microeconomic fertility considerations

Of the four variables that were found in the study of M'manga & Srivastava to be the most important decision variables at the household level, the variables current age, child survival rate and age at first marriage can be addressed by the type of policy measures discussed above. The fourth factor, namely number of children desired, is however more closely linked to the economic fertility motivations of households. This leads to the necessity of analyzing the reproductive behaviour of families from the perspective of the household.

Dasgupta (1992: 98-9) who interprets the fertility behaviour of rural families from the point of view of economic demography suggests that in addition to the two prominent determinants of reproductive behaviour in poor countries, that is children providing old-age security[9] and continuation of lineage considerations, a third motivation can be inferred from the role of children as producer goods. From this point of view, fertility decisions are explained as rational household choices where the fertility decision is determined by the labour contribution of children over their life cycle. Particularly under conditions where households operate under labour constraints, the involvement of children in household chores and economic activities becomes essential for survival. To cope with these chores under conditions of a deteriorating natural resource base including declining woodfuel availability, Dasgupta (1992: 99) has suggested that a relationship between fertility decisions and resource availability may exist: 'Each household needs many hands, and it can be that the overall usefulness of each additional hand increases with declining resource availability'.

This hypothesis is problematic to test because it is inherently difficult to isolate the effects of all three motivations of reproductive behaviour. Testing this proposition for Malawi is not possible because of a lack of representative data. As discussed in Chapter 4, children in rural households were found to contribute a substantial amount of labour both on agricultural

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9 Future insecurity is also considered to be an important factor for fertility decisions in Malawi. See Shanmugaratnam et al (1992: 45). Dasgupta (1992: 98) reports that studies by other researchers have shown that lineage considerations are an important factor for explaining why fertility reductions have been so difficult to achieve in most sub-Saharan countries.

tasks and on time-intensive household chores such as fuelwood gathering and water collection. However, most of the few household time-use studies which were carried out in Malawi[10] focus mainly on the issues of gender-specific intra-household labour allocation and women's time use. In addition, no studies have been conducted which are sufficiently disaggregated to provide information on local resource degradation. Thus research in this area is needed to explore this relationship. Available information as to children's contribution to the household labour budget and the degradation of forest resources, which is analyzed in Chapter 5, suggest that it cannot be ruled out that the link between fertility decisions and resource deterioration exists in the rural areas of Malawi.

[10] See the literature sources which are referenced and discussed in Chapter 4.

Annex 4-1

Cropping patterns on smallholder farms between 1982/83 and 1992/93

	Growing season										
Crop	**1982/83**	**1983/84**	**1984/85**	**1985/86**	**1986/87**	**1987/88**	**1988/89**	**1989/90**	**1990/91**	**1991/92**	**1992/93**
Maize	**74.0%**	**69.7%**	**69.4%**	**68.0%**	**64.9%**	**66.7%**	**68.0%**	**69.9%**	**70.2%**	**70.9%**	**64.3%**
-local	74.0%	63.4%	63.5%	62.9%	62.1%	62.5%	62.1%	61.6%	60.2%	59.0%	48.3%
-composite	n.a.	1.5%	1.3%	1.1%	0.8%	1.0%	1.3%	1.3%	1.0%	0.7%	0.2%
-hybrid	n.a.	5.3%	4.5%	3.9%	2.0%	3.2%	4.6%	7.0%	9.0%	11.2%	15.8%
Rice	1.3%	1.3%	1.3%	1.3%	1.0%	1.2%	1.4%	1.5%	1.7%	0.9%	1.9%
Groundnuts	9.3%	8.6%	8.2%	10.0%	11.5%	11.1%	7.5%	2.5%	3.5%	3.3%	3.0%
Tobacco	1.7%	2.7%	2.8%	2.2%	1.8%	1.3%	1.1%	1.6%	1.7%	1.7%	2.2%
Cotton	2.1%	3.0%	3.5%	3.0%	1.9%	2.4%	2.6%	2.5%	3.0%	3.0%	2.6%
Sorghum	1.4%	1.3%	2.0%	1.8%	1.7%	1.7%	1.6%	1.6%	1.6%	1.4%	2.1%
Millet	0.7%	0.9%	1.1%	1.0%	1.0%	1.1%	1.0%	1.0%	0.8%	0.8%	1.2%
Pulses	5.2%	5.4%	4.8%	6.5%	8.4%	8.8%	8.0%	11.2%	9.6%	11.3%	12.8%
Cassava	3.8%	4.8%	4.9%	4.2%	3.6%	3.4%	3.9%	3.2%	3.6%	3.3%	3.6%
Other	0.5%	2.3%	2.0%	2.1%	4.2%	2.3%	5.0%	4.9%	4.4%	3.3%	6.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Erosive crops	**81.5%**	**80.2%**	**80.6%**	**77.2%**	**72.2%**	**73.8%**	**75.6%**	**77.2%**	**78.4%**	**78.9%**	**72.7%**

Source: Malawi Agricultural Statistics (1993: Table 2-2).
Erosive crops include maize, tobacco, cotton and cassava.

Annex 4-2

Cropping patterns on smallholder farms by ADD in 1987/88 (percent)

Crop	KADD	MADD	KADD	LADD	SADD	WAD	BADD	NADD	Malawi
Local Maize (1)	27.1	16.2	45.3	30.9	40.9	47.9	44.2	28.2	37.2
Local Maize (2)	2.5	22.6	9.6	17.5	10.5	15.4	3.7	0.0	12.1
Hybrid maize (2)	3.1	11.4	9.9	9.4	1.1	0.9	0.6	0.7	5.5
Composite maize (2)	1.7	2.9	4.5	1.3	7.3	0.3	0.6	0.0	1.9
Maize mixtures	14.0	11.4	4.1	14.2	4.1	12.9	19.8	4.0	12.1
Total maize	**48.4**	**64.5**	**73.4**	**73.3**	**63.9**	**77.4**	**68.9**	**32.9**	**68.8**
Rice	14.2	0.4	0.0	0.0	3.6	2.9	1.8	1.6	1.6
Millet	4.7	7.3	0.4	1.4	0.8	0.7	0.6	17.1	2.4
Sorghum	0.2	0.0	0.0	0.0	0.2	1.6	2.9	26.5	2.3
Roots	14.6	9.6	2.0	1.4	12.5	5.8	7.4	0.5	5.0
Groundnuts (3)	0.1	3.2	13.1	8.4	1.0	1.4	0.2	0.0	4.9
Groundnuts Other	4.0	5.2	1.6	3.7	5.4	5.2	3.9	1.3	3.8
Pulses/beans	10.6	9.0	3.1	6.2	0.4	2.8	12.9	1.1	6.1
Cotton	2.9	0.0	0.0	0.2	12.2	1.9	0.9	19.1	2.4
Tobacco (4)	0.0	0.1	4.0	4.0	0.0	0.3	0.4	0.0	1.9
Tobacco Other	0.0	0.6	2.3	1.4	0.0	0.0	0.0	0.0	0.8
Coffee/tea	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.1
Total (5)	**100.0**	**100.1**	**100.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.1**	**100.1**

Source: World Bank 1992b, Vol. II, Table 3.1.

Notes: (1) Unfertilized, (2) Fertilized, (3) Chalimbana variety, (4) Dark-fired tobacco, (5) Totals greater than 100 percent are due to rounding.

Annex 4-3

Share of total land planted with maize in Zomba district in 1985/86

Holding size (ha)	Number of households	Total area cultivated (ha)	Area planted in maize (ha)	Area planted in maize (%)
< 0.5	14	0.42	0.38	90.5%
0.5 - <1.0	47	0.77	0.66	85.7%
1.0 - <1.5	78	1.25	0.99	79.2%
1.5 - <2.0	29	1.76	1.44	81.8%
2.0 - <3.0	31	2.35	1.89	80.4%
> 3.0	10	3.56	2.60	73.0%
All households	**210**	**1.45**	**1.17**	**80.7%**
Household Head				
Female-headed	137	1.29	1.12	86.8%
Male-headed	73	1.53	1.19	77.8%

Source: Peters & Herrera (1989)

Annex 4-4

Fertilizer use by land holding size and Agricultural Development District in 1987/88

Holding size (ha)	KRADD %	MZADD %	KADD %	LADD %	SLADD %	LWADD %	BLADD %	NADD %
< 0.5	11	15	27	15	7	10	21	n.a.
0.5 - <1.0	19	24	27	29	12	16	28	n.a.
1.0 - <1.5	26	31	32	32	17	15	35	n.a.
1.5 - <2.0	18	32	41	36	25	23	38	n.a.
2.0 - <2.5	11	31	49	46	27	13	32	n.a.
2.5 - <3.0	26	41	47	30	27	31	32	n.a.
>3.0	33	39	45	45	30	44	44	n.a.
Total	**20**	**33**	**41**	**34**	**20**	**17**	**29**	**n.a.**

Source: Annual Survey of Agriculture 1987/88

Annex 4-5

Comparison of gross margins per hectare (current MK)

Year	1991/92	1991/92	1992/93	1992/93	1992/93
Source	DARUDEC	MOA	Simler	IFAD	MOA
Crop	(1)	(2)	(3)	(4)	(3)
Local maize (NOF)	216.5	235.7	379.4		352.5
Local maize (HA-FER)		318.6	446.0		483.0
Hybrid dent maize (NOF)			333.8		
Hybrid dent maize (HA-F	578.2	665.8	713.1	498.4	1013.6
Rice		285.5			298.5
Cotton	473.4	757.4		248.4	774.0
Groundnuts	387.1	333.1			481.9
Burley tobacco	1772.6	2312.3	7717.6	1562.5	2233.6
Beans	148.3				
Cassava	440.7				

Gross margins per man-day

Year	1991/92	1991/92	1992/93	1992/93	1992/93
Source	DARUDEC	MOA	SIMLER	IFAD	MOA
Crop	(1)	(3)	(2)	(4)	(3)
Local maize (NOF)	1.92	5.55	2.92	4.53	8.45
Local maize (HA-FER)		5.65	2.48		8.40
Hybrid maize (NOF)	3.78		2.57		
Hybrid maize (HA-FER)		8.30	3.96	4.53	12.65
Rice		1.80			1.85
Cotton	2.96	2.75		1.51	2.80
Groundnuts		3.65		5.97	5.30
Burley tobacco	6.45		18.60	7.74	
Beans	3.71				
Cassava	4.41				

Sources:

(1) DARUDEC (1992), cited in: CODA (1993, Annex 5: 70)

(2) Simler (1993b, Annex A: 1).

(3) Ministry of Agriculture (1993), "Indicative Smallholder Gross Margins".

(4) IFAD (1993, Annex 7: 4)

Note: Gross margins/man-hour from source (2) were converted to gross margin per man-day by assuming that a man-day consists of 5 man-hours.

(NOF): Non-fertilized; (HA-FER): Fertilized with high analysis fertilizer.

Annex 4-6

Comparison of annual labour requirements for main crops (man-days per hectare)

Crop	DARUDE (1)	SIMLER (2)	MOA (3)	IFAD (4)	JOHNSON (5)	LLDP (6)
Local maize (NOF)	113	130	42		129	153
Local maize (FER)		180	60			
Hybrid maize (NOF)		130				
Hybrid maize (FER)	153	180		110		
Rice	318	188	160	165	202	
Cotton	160	289	198			
Groundnuts	125	284	91	76	231	298
Burley tobacco	275	415		201	342	643
Beans	40					
Cassava	100				72	

Sources:
(1) DARUDEC (1992), cited in: CODA (1993: Annex 5: 70)
(2) Simler (1993b, Annex B: 1). Data used by Simler were taken from a UNDP/FAO agricultural mechanization study which was not cited.
(3) Ministry of Agriculture (1993), "Indicative Smallholder Gross Margins".
(4) IFAD (1993, Annex 7: 4), (5) Johnson (1982) cited in MOA (1994: 28).
(6) Sample Survey of Agriculture 1977/78, cited in Chipande (1983: 46).
Note: Data from sources (3) and (6) were converted from man-hours to man-days by assuming that a man-day consists of 5 man-hours.
(NOF): Non-fertilized; (FER): Fertilized.

Annex 4-7

Comparison of gross margins per man-day for main crops (current MK)

Year	1991/92	1991/92	1992/93	1992/93	1992/93
Source	DARUDEC	MOA	Simler	IFAD	MOA
Crop	(1)	(3)	(2)	(4)	(3)
Local maize (NOF)	1.92	5.55	2.92	4.53	8.45
Local maize (HA-FER)		5.65	2.48		8.40
Hybrid maize (NOF)	3.78		2.57		
Hybrid maize (HA-FER)		8.30	3.96	4.53	12.65
Rice		1.80			1.85
Cotton	2.96	2.75		1.51	2.80
Groundnuts		3.65		5.97	5.30
Burley tobacco	6.45		18.60	7.74	
Beans	3.71				
Cassava	4.41				

Sources:

(1) DARUDEC (1992), cited in: CODA (1993, Annex 5: 70)

(2) The data for Simler were calculated by dividing gross margins from Annex 4-5 by labour requirements for crops which are shown in Annex 4-6.

(3) Ministry of Agriculture (1993), "Indicative Smallholder Gross Margins".

(4) IFAD (1993, Annex 7: 4)

Note: Gross margins/man-hour from source (2) were converted to gross margin per man-day by assuming that a man-day consists of 5 man-hours.

(NOF): Non-fertilized; (HA-FER): Fertilized with high analysis fertilizer.

Annex 4-8

Seasonal labour requirements for major crops per hectare

	Months/Period							
	June-Sep	Oct-Nov	Dec	Jan	Feb-Mar	Apr-May	Total	Oct-Jan
Crop	**Man-days**							**% of total**
Local maize (NOF)	23	49	10	17	4	27	130	58.5
Local maize (FER)	29	49	20	27	20	35	180	53.3
Hybrid dent maize (NOF	23	49	10	17	4	27	130	58.5
Hybrid dent maize (FER	29	49	20	27	20	35	180	53.3
Rice	12	39	13	32	33	59	188	44.7
Cotton	78	56	34	17	32	72	289	37.0
Groundnuts	81	68	18	31	20	66	284	41.2
Burley tobacco	77	77	33	32	106	90	415	34.2
Maize intercropped	18	57	10	22	13	27	147	60.5

Source: Simler (1993b, Annex B: 1). Data used by Simler were taken from a UNDP/FAO agricultural mechanization study which was not cited.
Note: (NOF): Non-fertilized; (FER): Fertilized.

Annex 5-1

Comparison of forest cover data for major forest categories by ADD: LREP and FMRBA studies (1990)

Forest Category	Agricultural Development Division								
	KRADD	MZADD	KADD	SLADD	LADD	LWADD	BLADD	NADD	Total
					(FRMBA data)				
Fe (1)	9453	47743	502	6036	292	3002	14478	1091	**82596**
Fbh (2)	367689	430789	69663	256812	132719	254116	101662	75401	**1688851**
Fbf (3)	20326	164009	208671	22712	45062	72702	47907	151746	**733135**
Total	**397468**	**642540**	**278836**	**285560**	**178073**	**329820**	**164047**	**228238**	**2504582**
					(LREP data)				
G1=Fe	5600	2500	250	100	0	2200	8200	0	**18850**
G6-8=Fbh	269400	345800	107700	178350	148900	253100	177500	175200	**1655950**
G2-4=Fbf	96000	531200	293150	142350	56100	0	21900	0	**1140700**
Total	**371000**	**879500**	**401100**	**320800**	**205000**	**255300**	**207600**	**175200**	**2815500**
				Differences in ha (FRMBA minus LREP)					
Fe (1)	3853	45243	252	5936	292	802	6278	1091	**63746**
Fbh (2)	98289	84989	-38037	78462	-16181	1016	-75838	-99799	**32901**
Fbf (3)	-75674	-367191	-84479	-119638	-11038	72702	26007	151746	**-407565**
				LREP data as percentage of FRMBA data					
Fe (1)	59.2%	5.2%	49.8%	1.7%	0.0%	73.3%	56.6%	0.0%	**22.8%**
Fbh (2)	73.3%	80.3%	154.6%	69.4%	112.2%	99.6%	174.6%	232.4%	**98.1%**
Fbf (3)	472.3%	323.9%	140.5%	626.8%	124.5%	0.0%	45.7%	0.0%	**155.6%**

Sources: FRMBA data were taken from Satellitbild (1990: Appendix 30). LREP data were taken from Eschweiler (1993: 47). The comparison of land cover classes was based on the legends from Satellitbild (1990: Appendix 13) and from Eschweiler (1993: 48).

(1) Evergreen forest; (2) Brachystegia in hilly areas; (3) Brachystegia in flat areas.

Annex 5-2

Estimate of sustainable annual wood supply in 1990
(cubic meters)

	Forest category			
	Evergreen	Hilly areas	Flat areas	Total
Region	**Standing Volume (thousand cubic meters)**			
Northern	12833	97287	19374	129494
Central	1518	53180	29792	84490
Southern	6258	37368	16861	60487
	Volume per hectare			
Northern	224,2	122,3	105,1	
Central	224,3	123,3	109,2	
Southern	335,9	81,4	61,1	
	Forest area (hectares)			
Northern	57239	795478	184339	1037056
Central	6768	431306	272821	710894
Southern	18631	459066	275957	753654
	Mean annual increments (cu.m./ha/year)			
Northern	1,2	1,1	1,1	
Central	1	0,9	0,9	
Southern	1	0,75	0,75	
	Annual increment/supply (cubic meter)			
Northern	68687	875026	202773	1146486
Central	6768	388175	245538	640481
Southern	18631	344300	206968	569898
Total	**94085**	**1607501**	**655279**	**2356865**

	Adjustments for non-availability of supplies (cubic meter)			
	Parks/reserves		**Forest reserves**	
Northern	367200		103950	471150
Central	412000		113850	525850
Southern	250000		103500	353500
Total	**1029200**		**321300**	**1350500**

	Supply from plantations (cubic meter)			
	Government		Private	Total
	Pine	Other	Eucalyptus	
Northern	1060000		45000	1105000
Central		240000	65000	305000
Southern		240000	220000	460000
Total supply	1060000	480000	330000	1870000
Avail. supply	**127200**	**480000**	**330000**	**937200**

	Supply from forests in croplands & croplands in forests (cu. m.)	
Northern	416256	416256
Central	787661	787661
Southern	621639	621639
Total	**1825556**	**1825556**

	Total sustainable supply (cubic meter)	**6052422**
Northern		2667742
Central		1733142
Southern		1651538
	Unavailable supply/subtractions (cu. m.)	**2283300**
Northern		1403950
Central		525850
Southern		353500
	Net available sustainable supply (1)	**3769122**
Northern		1263792
Central		1207292
Southern		1298038

Sources and assumptions: see text in Chapter 5.
(1) Supply available for woodfuel and pole consumption.

Annex 5-3

Deforestation rates by district and forest class (1972 -1990)

Forest Class	Chitipa	Karonga	Rumphi	Mzimba	Nkhata Bay	Kasungu
Fe (1)	0.9%	3.5%	-4.0%	3.2%	-6.6%	0.0%
Fbh (2)	-25.7%	-9.9%	-29.1%	-32.9%	-29.0%	-61.6%
Fbf (3)	-81.7%	-92.5%	-22.5%	-43.4%	-23.2%	-59.0%
	Nkhotakota	**Ntchisi**	**Mchinji**	**Lilongwe**	**Dowa**	**Salima**
Fe (1)	2.2%	-10.4%	0.0%	-100.0%	0.0%	0.0%
Fbh (2)	-11.5%	-55.0%	-8.5%	-21.9%	-80.0%	-59.5%
Fbf (3)	-82.3%	-100.0%	-97.1%	-14.6%	-99.3%	-89.3%
	Dedza	**Ntcheu**	**Mangochi**	**Machinga**	**Zomba**	**Mwanza**
Fe (1)	-100.0%	-51.4%	2.3%	136.7%	-63.8%	0.0%
Fbh (2)	-25.3%	-55.6%	-11.6%	-29.7%	-46.6%	-49.4%
Fbf (3)	-67.1%	-98.1%	-84.8%	-70.1%	-100.0%	-54.8%
	Blantyre	**Chiradzulu**	**Mulanje**	**Chikwawa**	**Thyolo**	**Nsanje**
Fe (1)	-100.0%	0.0%	-6.8%	0.0%	-7.8%	-5.3%
Fbh (2)	-34.7%	-31.9%	-49.7%	-48.6%	-97.2%	-49.2%
Fbf (3)	-53.3%	-100.0%	-27.5%	-35.2%	-100.0%	-12.9%

Source: Calculations based on forest change data in Satellitbild (1993: Appendix 30)
(1) Evergreen forest; (2) Brachystegia forest in hilly areas; (3) Brachystegia in flat areas

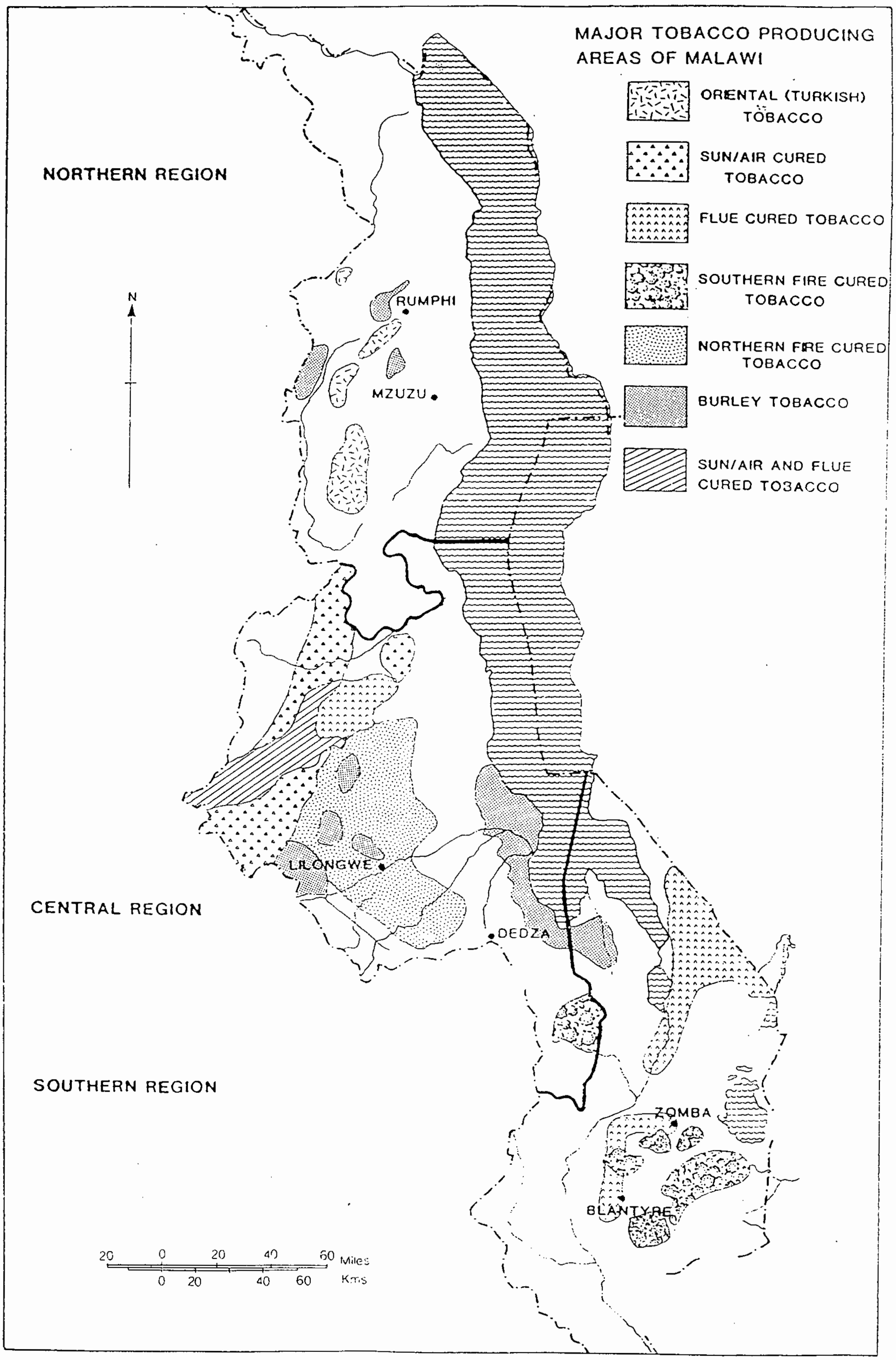
Annex 5-4

Fuelwood consumption in the flue-cured tobacco industry by region between 1975 and 1990 (solid cubic meter)

	Northern Region			Central Region			Southern Region			Malawi		
Year	**Flue-cured**	**Burley**	**Total**	**Flue-cured**	**Burley**	**Total**	**Flue-cured**	**Burley**	**Total**	**Flue-cured**	**Burley**	**Total**
1975	22527	2639	25166	202746	19433	222178	150182	1919	152101	375455	23991	399446
1976	24451	2380	26831	220055	17525	237580	163004	1731	164735	407509	21636	429145
1977	30520	3293	33813	274677	24249	298926	203465	2395	205860	508662	29937	538599
1978	27367	3423	30790	297713	25836	323549	200315	2496	202811	525395	31755	557150
1979	44881	5058	49939	334782	33966	368748	253512	5616	259128	633175	44640	677815
1980	49090	6471	55561	364594	36246	400840	249077	7341	256418	662760	50058	712818
1981	28526	7965	36491	269086	40356	309442	199181	8088	207269	496793	56409	553202
1982	27418	11406	38824	313337	59142	372479	228992	12258	241250	569747	82806	652553
1983	27846	16302	44148	280350	86349	366699	237611	21960	259571	545807	124611	670418
1984	19757	15501	35258	337554	61218	398772	270472	13218	283690	627782	89937	717719
1985	22000	14769	36769	329666	65784	395450	209815	10563	220378	561481	91116	652597
1986	20462	15192	35654	336924	66288	403212	197341	9090	206431	554728	90570	645298
1987	30960	19263	50223	229176	81243	310419	180198	9861	190059	440334	110367	550701
1988	18486	23910	42396	224838	97491	322329	129132	13011	142143	372456	134412	506868
1989	20286	28089	48375	203094	130860	333954	123966	16083	140049	347346	175032	522378
1990	20064	25212	45276	176141	142797	318938	90988	18378	109366	287192	186387	473579
Total	**434640**	**200873**	**635513**	**4394732**	**988783**	**5383515**	**3087250**	**154008**	**3241258**	**7916622**	**1343664**	**9260286**

Source for tobacco production data: Ministry of Agriculture.
Specific fuelwood consumption for flue-cured tobacco (cu. m. stacked): until 1986: 42.0; 1987: 30.0; 1988-89: 22.0; 1990: 20.0.
Specific fuelwood consumption for burley tobacco (cu. m. stacked): 1975-90: 5.0.
Conversion factor (cu.m solid /cu.m. stacked): 0.6.

Annex 5-5


MAJOR TOBACCO PRODUCING AREAS OF MALAWI
ORIENTAL (TURKISH) TOBACCO
SUN/AIR CURED TOBACCO
FLUE CURED TOBACCO
SOUTHERN FIRE CURED TOBACCO
NORTHERN FIRE CURED TOBACCO
BURLEY TOBACCO
SUN/AIR AND FLUE CURED TOBACCO
NORTHERN REGION
CENTRAL REGION
SOUTHERN REGION
N
RUMPHI
MZUZU
LILONGWE
DEDZA
ZOMBA
BLANTYRE
20 0 20 40 60 Miles
0 20 40 60 Kms

Annex 5-6

Estimated required woodland area on tobacco estates for woodfuel self-sufficiency
(1975 - 1990)

	Northern Region			Central Region			Southern Region			Malawi			Tobacco	Estimated	Required	Wood Self-
Year	Flue-cured	Burley	Total	Flue-cured	Burley	Total	Flue-cured	Burley	Total	Flue-cured	Burley	Total	Production	Estate area	Wood area	sufficiency
	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	tonnes	ha	% of total	%
1975	3469	406	3876	31223	2993	34215	23128	296	23424	57820	3695	61515	17740	127626	48,2%	29%
1976	3765	367	4132	33888	2699	36587	25103	267	25369	62756	3332	66088	22500	161871	40,8%	34%
1977	4700	507	5207	42300	3734	46035	31334	369	31702	78334	4610	82944	24275	174640	47,5%	29%
1978	4215	527	4742	45848	3979	49827	30848	384	31233	80911	4890	85801	30261	217705	39,4%	35%
1979	6912	779	7691	51556	5231	56787	39041	865	39906	97509	6875	104384	33906	243928	42,8%	32%
1980	7560	997	8556	56147	5582	61729	38358	1131	39488	102065	7709	109774	32534	234058	46,9%	29%
1981	4393	1227	5620	41439	6215	47654	30674	1246	31919	76506	8687	85193	30879	222151	38,3%	36%
1982	4222	1757	5979	48254	9108	57362	35265	1888	37153	87741	12752	100493	39507	284223	35,4%	39%
1983	4288	2511	6799	43174	13298	56472	36592	3382	39974	84054	19190	103244	53115	382122	27,0%	51%
1984	3043	2387	5430	51983	9428	61411	41653	2036	43688	96678	13850	110529	42153	303259	36,4%	38%
1985	3388	2274	5662	50769	10131	60899	32312	1627	33938	86468	14032	100500	47706	343209	29,3%	47%
1986	2251	2340	4590	37062	10208	47270	21708	1400	23107	61020	13948	74968	44163	317719	23,6%	58%
1987	4768	2967	7734	35293	12511	47805	27750	1519	29269	67811	16997	84808	51301	369072	23,0%	60%
1988	2847	3682	6529	34625	15014	49639	19886	2004	21890	57358	20699	78058	68642	493827	15,8%	60%
1989	3124	4326	7450	31276	20152	51429	19091	2477	21568	53491	26955	80446	83503	600741	13,4%	60%
1990	3090	3883	6973	27126	21991	49116	14012	2830	16842	44228	28704	72931	74035	532626	13,7%	60%

Assumptions:
Mean Annual Increment (cu. m./ha/a): 6.5 in all regions.
Specific fuelwood consumption for flue-cured tobacco (cu. m. stacked): until 1986: 42.0; 1987: 30.0; 1988-89: 22.0; 1990: 20.0.
Specific fuelwood consumption for burley tobacco (cu. m. stacked): 1975-90: 5.0.
Conversion factor (cu.m solid /cu.m. stacked): 0.6.

Annex 5-7

Estimated annual deforestation due to estate sector wood consumption for tobacco curing by region

(1975-90)

		Region		
Year	**Northern**	**Central**	**Southern**	**Malawi**
	ha	ha	ha	ha
1975	150	3964	3618	7732
1976	148	3932	3635	7715
1977	200	5302	4868	10370
1978	167	5256	4393	9816
1979	282	6246	5852	12380
1980	327	7072	6032	13431
1981	195	4952	4423	9570
1982	197	5677	4903	10778
1983	180	4485	4233	8898
1984	183	6195	5876	12253
1985	162	5227	3884	9273
1986	123	4185	2857	7165
1987	167	3100	2531	5798
1988	141	3223	1895	5260
1989	161	3340	1867	5368
1990	151	3189	1458	4799
Total	**2934**	**75346**	**62326**	**140606**
Average (1)	173	4432	3666	8271
Average (2)	207	2216	1375	3798

Assumptions:

Calculations were based on wood self-sufficiency rates from Annex 5-6.

(1), (2): Based on yields for indigenous forest reserves (see Table 5-1).

Annex 5-8

Customary forest area equivalents to meet fuelwood consumption for tobacco curing in the smallholder sector (1977-1990)

(ha)

Year	Northern Oriental	Central Dark-fired	Central Sun/Air	Central Total	Southern Dark-fired	Malawi Total
1977	6	8122	71	8193	352	8551
1978	6	6912	99	7011	625	7642
1979	4	4979	84	5063	734	5801
1980	3	3877	40	3918	505	4425
1981	6	4468	40	4508	538	5051
1982	6	2934	35	2970	362	3338
1983	0	3409	20	3429	485	3914
1984	3	6601	58	6659	898	7560
1985	1	7282	56	7338	1200	8539
1986	1	5930	29	5959	767	6727
1987	1	5342	29	5371	375	5747
1988	2	3316	17	3333	475	3810
1989	3	2826	11	2837	305	3145
1990	2	4948	42	4990	242	5234
Total	**44**	**70945**	**632**	**71577**	**7864**	**79485**

Sources: Tobacco production data: Ministry of Agriculture and Tobacco Control Commission.
Assumptions:
Woodland Yields (cu.m./ha): Northern, Central and Southern Regions: 120, 60 and 40.
Specific Fuel Consumption (solid cu.m. per tonne of tobacco cured): Sun/Air/Oriental: 1.2;
Northern District Dark-Fired (NDDF) and Southern District Dark-Fired (SDDF): 18.

Annex 5-9

Forest land area equivalents of urban woodfuel consumption in Blantyre city (1983 - 1990)

Year	Fuelwood demand tonnes	Supply from Customary land percent	Land area equivalent ha	Charcoal demand tonnes	Land area equivalent ha	Total Land area equivalent ha
1983	80000	70	47250	47655	7354	54604
1984	110000	65	60328	42000	6481	66810
1985	150000	60	75938	38000	5864	81802
1986	200000	55	92813	32000	4938	97751
1987	250000	50	105469	27000	4167	109635
1988	300000	45	113906	22000	3395	117301
1989	350000	40	118125	18000	2778	120903
1990	403495	35	119157	14689	2267	121424

Sources and assumptions:

Woodfuel consumption data for 1983: MUES (1984: 27).
Woodfuel consumption data for 1990: Ng`ong`ola (1992: 68-69).
Yield of customary land forests: 80 cubic meter/ha.
Density of indigenous wood: 0.675 kg/cubic meter.
Charcoal earth kiln yield (weight-based): 0.12 t/t.

Annex 5-10

Estimates of agricultural residue supply, utilization and consumption in 1993

Crop/Residue	Crop area ha (1)	Yield t/ha (1)	Residue t/t (2), (3)	Total tonnes	Utilized Cooking t (4)	Utilizable Other uses t (5)	Calorific Value MJ/kg	Wood equivalent Cooking t	Wood equivalent Heating t
Maize (stalks,cobs)	1327038	1505	2.0	3994384	47661	3946723	12	38129	3157378
Cotton (stalks)	53691	586	5.0	157315	157315	0	12.5	131096	0
Groundnuts (stalks)	61040	622	2.3	87324	47661	39662	15	47661	39662
Groundnuts (shells),(6)	61040	622	0.5	18983	0	0	14.5	0	0
Tobacco (stems)	44981	741	1.0	33331	33331	0	14.5	32220	0
Total	**1547790**			**4291337**	**285968**	**3986385**		**249106**	**3197041**

Sources and assumptions:

(1) Malawi Agricultural Statistics 1993, several tables.
(2) Residue-to-crop ratios were based on Leach & Gowen (1993: 112)
(3) The residue-to-crop ratio for tobacco was assumed.
(4) Utilization of maize and cotton stalks was assumed to be 25% of the total amount of cotton and tobacco residues used.
(5) Total availability of residues for water and space heating was calculated as residual.
(6) Groundnut shells are not used.

Comparison of calculated data with the survey data from CODA

Item		**Source:**
Mid-year rural population (million)	8.55	MAS (1993:1)
Agricultural Residues		
Total annual per capita availability for cooking (kg)	33.44	Calculated
Mean consumption days of residues per year	105.00	CODA (1993: Annex 24: 103)
Average daily per capita consumption for cooking during use period (kg)	0.32	Calculated
CODA average daily per capita consumption during period of use (kg)	0.64	CODA (1993: Annex 24: 103)
Maximum average use for cooking (kg wood equivalent/capita/day)	0.08	Calculated
Average daily per capita consumption of fuelwood (kg)	1.86	Calculated from Nyirongo & Mhango (1993)
Maximum contribution of residues to daily energy consumption for cooking during use period (Percent of fuelwood consumption)	14%	Calculated
Total use of agricultural residues based on CODA data (tonnes)	573755.99	Calculated
Utilization rate of residues based on CODA consumption data	13%	Calculated
Utilization rate of residues for non-cooking end-uses based on CODA	50%	Calculated
Residue consumption for non-cooking end-uses (percent of total annual wood consumption) based on CODA consumption data	4%	Calculated
Calorific value of air-dry fuelwood (MJ/kg)	15	

Annex 6-1

Frequency and canopy cover of mature trees found in croplands in Lilongwe ADD

Tree/shrubs species	Number per 100 ha	Percentage of total trees	Ranking by % of total	Canopy m2/100 ha
Acacia macrothysa	4	0.09		23
Acacia polyacantha	40	0.89		322
Albizia lebbeck	8	0.18		127
Allophylus africana	24	0.53		23
Azanza garckeana	208	4.61	5	276
Bauhinia thonningii	428	9.48	2	1482
Cassia didymobotrya	4	0.09		10
Cassia petersiana	4	0.09		3
Cassia siamea	224	4.96	4	570
Combretum collinum	168	3.72	6	1525
Combretum zeyheri	12	0.27		54
Commiphora mossambicensis	4	0.09		n.a.
Cordyla africana	24	0.53		23
Cussonia kirkii	40	0.89		102
Dichrostachys cinera	44	0.97		125
Diplorynchus condylocarcpon	4	0.09		23
Dombeya rotundifolia	28	0.62		97
Erythrina abyssinica	264	5.85	3	2397
Euphorbia tirucalli	12	0.27		18
Faidherbia albida	40	0.89		1410
Ficus natalensis	84	1.86	11	555
Ficus sycomorus	80	1.77	12	1216
Ficus verruculosa	28	0.62		641
Gliricidia sepium	96	2.13	10	61
Gmelina arborea	136	3.01	7	1796
Kigelia africana	64	1.42	15	483
Inula glomerata	48	1.06		122
Longocarpus capassa	40	0.89		126
Mangifera indica	1648	36.49	1	13245
Markhamia obtusifolia	100	2.21	9	346
Melia azedarach	48	1.06		85
Parinari curatellifolia	20	0.44		318
Pericopsis angolensis	72	1.59	13	654
Psidium guajava	12	0.27		31
Psorospernum febrifugim	16	0.35		n.a.
Pterocarpus angolensis	20	0.44		318
Rauvolfia caffra	68	1.51	14	308
Ricins communis	4	0.09		20
Salvadora persica	4	0.09		n.a.
Stegantaenia araliacea	28	0.62		18
Strychnos spinosa	108	2.39	8	665
Syzygium cordatum	4	0.09		1
Terminalia sericea	12	0.27		191
Toona ciliata	64	1.42	15	243
Trichelia emetica	4	0.09		41
Vaguelia amygdalina	36	0.80		28
Vaguelia infausta	40	0.89		71
Vitex doniana	24	0.53		n.a.
Ximenia americana	4	0.09		3
Zahna africana	20	0.44		n.a.
Total	**4516**	**100.00**		**30196**

Source: Compiled from Minae (1992a: Table 18 and Annex 3).

Memo items:

Fruit trees as percent of total	60.32
Indigenous fruit trees as percent of total	23.56
Fifteen most numerous trees as percent of total	77.41
Indigenous fruit trees as percent of fifteen most numerous trees	74.00

Annex 6-2

Uses of indigenous and exotic fruit trees found on farms in Lilongwe ADD (percent)

Indigenous species	Number of uses	Fruits	Fodder	Soil impro-vement	Fuel-wood	Building materials	Medicine	Other
Adansonia digitata	4	2.4			2.4		7.3	2.4
Azanza garckeana	5	51.2	2.4			24.4	4.9	19.5
Bauhinia petersiana	5	9.8	7.3			14.6	4.9	4.9
Bauhinia thonningii	6	73.2	46.3	36.6		34.1	46.3	41.5
Bridella micrantha	5	17.1	4.9			9.8	9.8	2.4
Cussonia kirkii	7	26.8	9.8	4.9	2.4	2.4	12.2	9.8
Dyosporus mespilif.	4	2.4		2.4		2.4		2.4
Ficus natalensis	5	31.7	22	14.6			14.6	9.8
Ficus sycomorus	6	36.6	26.8	9.8		7.3	12.2	17.1
Ficus verruculosa	1		17.1					
Flacourtia indica	5	19.5	2.4			2.4	9.8	2.4
Garcinia huillensis	5	2.4	2.4		2.4	2.4	2.4	
Lannea discolor	4	17.1				9.8	4.9	2.4
Oncoba spinosa	3	4.9				7.3	4.9	
Parkia filicoidea	4	9.8	4.9			7.3	2.4	
Scelerocarya birrea	5	17.1	4.9			9.8	24.4	7.3
Strychnos spinosa	4	56.1	4.9			9.8	19.5	
Syzigium cordatum	5	9.8	2.4	2.4		4.9	2.4	
Tamaridus indica	2		2.4				2.4	
Uapaca kirkiana	3	7.3				2.4	4.9	
Vagueria infausta	4	17.1				4.9	7.3	2.4
Vitex doniana	2	4.9					2.4	
Ximenia caffra	3	9.8				7.3	4.9	
Zahna africana	4	19.5				7.3	9.8	2.4
Exotic species								
Annona senegalensis	6	22	2.4	1.9		7.3	9.8	2.4
Carica papaya	4	22	4.9				14.6	2.4
Casmiroa ssp	5	9.8	7.3		7.3	4.9		2.4
Citrus limonium	5	12.2	4.9		4.9	2.4	4.9	
Citrus reticulata	4	7.3	2.4	2.4	2.4			
Citrus sinensis	6	26.8	7.3	2.4	9.8	2.4	12.2	
Mangifera indica	5	78	19.5		51.2	17.1	29.3	
Morus nigra	5	2.4	2.4		2.4	2.4		12.2
Mulus domestica	3	2.4			2.4			2.4
Musa paradisiaca	4	31.7	14.6	2.4			2.4	
Persea americana	2	2.4						4.9
Prunus persica	3	4.9			2.4	2.4		
Psidium guajava	6	48.8	17.1		26.8	14.6	14.6	7.3

Source: Compiled from Minae (1992a: Tables 14 & 15)

Annex 6-3

Characteristics of the tree planting incentive bonus scheme

Year	1991(1)				1992 (2)			
	Number of			Average	Number of			Average
	Farmers	Trees	No. of	Planted area	Farmers	Trees	No.of	Planted area
Region/District			trees	(ha), (3)			trees	(ha), (3)
Northern	**2030**	**702541**	**333**	**0.19**	**2148**	**854975**	**358**	**0.20**
Chitipa	422	158885	377	0.22	528	221905	420	0.24
Karonga	346	93423	270	0.15	459	123125	268	0.15
Mzimba	885	327636	370	0.21	751	378662	504	0.29
Nkhatabay	176	54345	309	0.18	172	28253	164	0.09
Rumphi	201	68252	340	0.19	238	103030	433	0.25
Central	**2561**	**1335706**	**566**	**0.32**	**4025**	**2716053**	**627**	**0.36**
Dedza	208	104794	504	0.29	373	182168	488	0.28
Dowa	131	83301	636	0.36	142	88742	625	0.36
Kasungu	409	144227	353	0.20	602	365368	607	0.35
Lilongwe	825	447475	542	0.31	1353	1162318	859	0.49
Mchinji	169	137306	812	0.46	184	162430	883	0.50
Nkhotakota	256	84254	329	0.19	581	276612	476	0.27
Ntcheu	213	161083	756	0.43	497	321076	646	0.37
Ntchisi	303	140299	463	0.26	221	120674	546	0.31
Salima	47	32967	701	0.40	72	36665	509	0.29
Southern	**3238**	**1489363**	**457**	**0.26**	**3823**	**2024393**	**505**	**0.29**
Blantyre	540	405085	750	0.43	528	484717	918	0.52
Chikwawa	104	77159	742	0.42	77	54797	712	0.41
Chiradzulu	151	55055	365	0.21	236	90789	385	0.22
Machinga	279	95635	343	0.20	508	216051	425	0.24
Mangochi	213	73139	343	0.20	213	43373	204	0.12
Mulanje	715	382081	534	0.31	1001	696972	696	0.40
Mwanza	274	117627	429	0.25	334	200431	600	0.34
Nsanje	19	6857	361	0.21	34	18846	554	0.32
Thyolo	164	72296	441	0.25	376	177615	472	0.27
Zomba	779	204429	262	0.15	516	40802	79	0.05
Malawi Total	**7829**	**3527610**	**452**	**0.26**	**8376**	**5595421**	**1489**	**0.28**

Sources: (1) DOF (1992: Table 11); (2) DOF (1993: Table 13)

Notes: (3) Average area planted was calculated assuming a tree survival rate of 70 percent and planting of 2,500 trees per hectare.

Annex 7-1

Development of monthly nominal and real wages in urban areas (1980 -1990)

	Statutory Minimum Wage		Monthly Average Earnings	
Year	MK Nominal	MK Constant 1980 (1)	MK Nominal	MK Constant 1980 (2)
1980	11.7	11.7	43.7	43.7
1981	18.2	16.9	49.3	44.7
1982	21.1	17.7	55.2	45.9
1983	21.1	15.0	54.3	39.8
1984	21.1	12.8	54.6	36.1
1985	26.0	14.5	62.3	35.8
1986	28.9	13.9	68.2	34.2
1987	28.9	11.3	80.6	31.9
1988	28.9	8.5	87.2	26.2
1989	56.4	14.4	100.0	26.6
1990	56.4	12.6	99.3	22.3

(1) Nominal values were deflated by the Blantyre Low Income Price Index from MSB (1991); (2) Nominal values were deflated using the Composite Consumer Price Index from MSB (1991).

Annex 7-2

Comparative useful energy costs of urban household cooking options 1990

Location/stove	Fuel price (MK/unit) (1)	Units	Energy content (MJ/unit) (2)	Price per unit (MK/MJ) (3)=(1)/(2)	Assumed efficiency (%) (4)	Effective price (MK/GJ) (5)=(3)/(4)	Device cost (MK) (6)	Lifetime (months) (7)	Annual stove cost (1) (MK) (8)	Annual stove cost/GJ (2) (MK/GJ) (9)	Useful energy cost (MK/GJ) (10)=(5)+(9)
Blantyre											
Firewood (8%), (3)	0.26	kg	15.5	0.017	8	208.1	0	12.0	0.0	0.0	208.1
Firewood (10%), (3)	0.26	kg	15.5	0.017	10	166.5	0	12.0	0.0	0.0	166.5
Firewood (12%), (3)	0.26	kg	15.5	0.017	12	138.7	0	12.0	0.0	0.0	138.7
Firewood (12%), (4)	0.26	kg	15.5	0.017	12	138.7	10	36.0	5.1	1.7	140.4
Firewood (25%)	0.26	kg	15.5	0.017	25	66.6	15	36.0	7.7	2.6	69.1
Charcoal (12%), (4)	0.36	kg	29.0	0.013	12	104.3	10	36.0	5.1	1.7	106.0
Charcoal (25%)	0.36	kg	29.0	0.013	25	50.1	17	36.0	8.7	2.9	53.0
Kerosene (30%)	1.12	l	36.0	0.031	30	103.7	40	48.0	16.9	5.6	109.3
Electricity (65%)	0.12	kWh	3.6	0.033	65	51.3	200	48.0	97.6	32.5	83.8
Electricity (65%)	0.21	kWh	3.6	0.058	65	89.7	200	48.0	97.6	32.5	122.3
Lilongwe											
Firewood (8%), (3)	0.22	kg	15.5	0.014	8	180.6	0	12.0	0.0	0.0	180.6
Firewood (10%), (3)	0.22	kg	15.5	0.014	10	144.5	0	12.0	0.0	0.0	144.5
Firewood (12%), (3)	0.22	kg	15.5	0.014	12	120.4	0	12.0	0.0	0.0	120.4
Firewood (12%), (4)	0.22	kg	15.5	0.014	12	120.4	10	12.0	5.1	1.7	122.1
Firewood (25%)	0.22	kg	15.5	0.014	25	57.8	15	36.0	7.7	2.6	60.4
Charcoal (12%), (4)	0.62	kg	29.0	0.021	12	178.5	10	36.0	5.1	1.7	180.2
Charcoal (25%)	0.62	kg	29.0	0.021	25	85.7	17	36.0	8.7	2.9	88.6
Kerosene (30%)	1.12	l	36.0	0.031	30	103.7	40	48.0	16.9	5.6	109.3
Electricity (65%)	0.12	kWh	3.6	0.033	65	51.3	200	48	97.6	32.5	83.8
Electricity (65%)	0.21	kWh	3.6	0.058	65	89.7	200	48	97.6	32.5	122.3
Mzuzu											
Firewood (8%), (3)	0.09	kg	15.5	0.006	8	70.1	0	12.0	0.0	0.0	70.1
Firewood (10%), (3)	0.09	kg	15.5	0.006	10	56.1	0	12.0	0.0	0.0	56.1
Firewood (12%), (3)	0.09	kg	15.5	0.006	12	46.7	0	12.0	0.0	0.0	46.7
Firewood (12%), (4)	0.09	kg	15.5	0.006	12	46.7	10	12.0	5.1	1.7	48.4
Firewood (25%)	0.09	kg	15.5	0.006	25	22.4	15	36.0	7.7	2.6	25.0
Charcoal (12%), (4)	0.55	kg	29.0	0.019	12	158.9	10	36.0	5.1	1.7	160.6
Charcoal (25%)	0.55	kg	29.0	0.019	25	76.3	17	36.0	8.7	2.9	79.2
Kerosene (30%)	1.12	l	36.0	0.031	30	103.7	40	48.0	16.9	5.6	109.3
Electricity (65%)	0.12	kWh	3.6	0.033	65	51.3	200	48	97.6	32.5	83.8
Electricity (65%)	0.21	kWh	3.6	0.058	65	89.7	200	48	97.6	32.5	122.3
Zomba											
Firewood (8%), (3)	0.11	kg	15.5	0.007	8	90.0	0	12.0	0.0	0.0	90.0
Firewood (10%), (3)	0.11	kg	15.5	0.007	10	72.0	0	12.0	0.0	0.0	72.0
Firewood (12%), (3)	0.11	kg	15.5	0.007	12	60.0	0	12.0	0.0	0.0	60.0
Firewood (12%), (4)	0.11	kg	15.5	0.007	12	60.0	10	12.0	5.1	1.7	61.7
Firewood (25%)	0.11	kg	15.5	0.007	25	28.8	15	36.0	7.7	2.6	31.4
Charcoal (12%), (4)	0.54	kg	29.0	0.019	12	156.1	10	36.0	5.1	1.7	157.8
Charcoal (25%)	0.54	kg	29.0	0.019	25	74.9	17	36.0	8.7	2.9	77.8
Kerosene (30%)	1.12	l	36.0	0.031	30	103.7	40	48.0	16.9	5.6	109.3
Electricity (65%)	0.12	kWh	3.6	0.033	65	51.3	200	48	97.6	32.5	83.8
Electricity (65%)	0.21	kWh	3.6	0.058	65	89.7	200	48	97.6	32.5	122.3

(1) Annualized using a discount rate of 25%. For electricity an amount of MK 13.0 was added for internal wiring based on costs for internal wiring (MK 50.0) using a lifetime of 20 years and a discount rate of 25%.
(2) For calculations an annual consumption of 3.0 GJ was used.
(3) Firewood three-stone stove.
(4) Traditional metal stove using fuelwood or charcoal.