PATTERNS OF RURAL HOUSEHOLD ENERGY CONSUMPTION AND FUEL PREFERENCES: A CASE STUDY IN OYO STATE, SOUTH-WESTERN NIGERIA

by

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A Thesis
submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree
of Master of Arts

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Montreal, Québec

31 March, 1988

ABSTRACT

This study investigates patterns of rural household energy consumption and fuel preferences in the rainforest and forest-savanna regions of Oyo State, south-western Nigeria. Its origins can be traced to the United Nations University and Obafemi Awolowo University Rural Energy Systems Project established in Nigeria, in 1979. The study describes the socio-economic and environmental context of energy use and fuel preference, and provides an energy-information base that can be used to guide rural energy conservation policies. This study is based on findings derived from a rural energy survey questionnaire. Firewood and kerosene are important fuels in the rural areas and are used extensively in domestic cooking and lighting. Bottled gas and electricity are the preferred substitutes. Respondents earn an annual income below 2,500 Naira. Analysis of firewood consumption across income groups shows little variation among households. The size and function of the urban centres to which the sampled areas adhere are important. Respondents in Ibadan are more aware about possible alternative energy forms. Their fuel preferences are more realistic. Different ecosystems in the areas determine the availability, quantity and species of firewood. Findings indicate that rural households procure traditional fuels by self-collection. Women and children household members travel on average two and one half kilometers for fuel collection. Finally, the results suggest that the most promising relevant and appropriate strategies that will alleviate rural household energy problems include; conservation of existing supply areas through reforestation, implementing conservation programes and strategies such as afforestion and augmentation of village land adequate for future supplies of firewood; and improvement in end-use (wood stoves) and energy conversion (biomass to methane gas, wood to charcoal) technologies.

Résumé

Cette étude porte sur les différentes types d'utilisation d'énergie familiale et les préférences en combustible par les populations rurales dans les régions de forêts tropicales humides et des savanes boisées de l'Etat d'Oyo au Nigéria. Son origine remonte à l'établissement du "Rural Energy Systems Project" à l'Université de Obafemi Awolowo en 1979. L'étude basée sur les résultats d'matière de combustible et l'utilisation de l'énergie dans le contexte socio-économique et environnemental. Elle procure une base d'information pouvant servir de guide dans les politiques de conservation d'énergie rurale. Il a été démontré que le bois de feu et le pétrole sont largement utilisés pour la cuisson et l'éclairage, bien que l'électricité et le gaz sont leur substituts préferés. Le revenu moyen des pépondants se situe au-dessous de 2,500 Naira et la consommation de bois de feu varie peu entre les familles à niveaux de revenu différents. Dans la zone rurale d'Ibadan, on est plus au courant des différentes alternatives énergétiques et les choix en énergie sont plus réalistes. Les différents écosystèmes des régions déterminent la quantité etles types de bois de feu consommés. Il a été vérifié que les ménages ruraux s'approvisionnent eux-mêmes en combustibles traditionnels, femmes et enfants parcourant jusqu'à deux kilomètres et demi à cet effet. Enfin, les résultats obtenus suggèrent que les stratégies les plus pertinentes et prometteuses qui soulageraient les ménages ruraux des problèmes énergétiques, comporteraient: le reboisement des zones existantes d'approvisionnement en bois de feu, la mise en oeuvre de programmes de conservation, et d'expansion des zones de reboisement pour utilisation ultérieur, l'amélioration des foyers servant à la cuisson des aliments et le développement technique des systèmes de conversion tels la biomasse, la fermentation méthanique et la carbonisation.

ACKNOWLEDGEMENTS

This study materialized from the earlier and more extensive investigation of Rural Energy Systems in South-western Nigeria by the United Nations University, Tokyo, Japan and Obafemi Awolowo University, Ile-Ife, Nigeria. It would not have become a reality without the assistance and guidance of many individuals.

I wish to express my gratitude to; Dr. Walter Shearer, Senior Program Officer, The United Nations University, Tokyo Japan, for providing me with the opportunity to work on the Project from 1983-1984 and for making available to me the data of the study; and, Professor J.O. Adejuwon, Chairman, Department of Geography, Obofami Awolowo University (formerly the University of Ife), and the-then Co-ordinator of the Rural Energy Systems Project in Nigeria, for introducing me to the 'other energy crisis', and for the hospitality he extended to me during my stay in Nigeria.

I wish to especially thank my teacher, colleague and supervisor Professor Warwick Armstrong, Department of Geography, McGill University, for his valuable comments and advice on my work, and for being my friend.

I am deeply indebted to Maria Marcone, Graduate Secretary, Department of Geography, McGill University and to Sheila Zeepvat, my colleague in the Department, for their professional and wonderful work on the tables and maps and final editing of the thesis.

I am also indebted to my colleagues and friends in the Department of Geography, McGill University, for creating an amicable environment conducive for research. In particular; Professor Gordon Ewing for taking the time to converse on non-geographic topics - I bet he knows what I mean; Mario Daoust for being Mario Daoust; and, Professor Sherry Olson, for giving me one last chance to make good use of my office.

Finally, my greatest debt of gratitude, sincere appreciation, and deep respect go to my dear friend Dr. Thomas A. Lawand, Director, International Operations, Brace Research Institute, for giving me the opportunity to work in Nigeria - which eventually was instrumental in helping me to focus on my career interests. In his inimitable style, he encouraged me, advised and commented on my work, and made sure I did not 'stray from the path', although at times it may have appeared that that was the case.

To my family and other friends whom I have not named in person, you are in my heart.

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INTRODUCTION

Dwindling reserves of fossil fuels, oil-tanker wars in the Middle East, increasing prices of petroleum and cunning manipulation of its distribution is the stuff that permeates people's consciousness through eye-catching media headlines. Yet, to more than half of the world's population residing in the developing areas, the energy crisis to them is the daily struggle to find the wood they need to cook their food. To many, it is also the scramble to find the food essential to their survival.

In these areas, men, women and children spend a considerable portion of their time cutting and felling trees, gathering twigs and branches, and tending their fires to provide energy for cooking, space heating, and, to a lesser degree, lighting.

For the people who live in villages away from organized urban markets the trials of finding energy sources are even more acute. Traditional fuels such as firewood, animal dung and crop residues provide them with the most basic of energy necessities.

The energy crisis facing the poor is by no means the only daily struggle confronting them. Inadequate medical care, squatter-like shelter conditions, the lack of access to food supplies (and subsequent hunger) are constant reminders of their poverty and dire nature of their existence.

The syndrome of rural poverty has attracted the attention of many scholars in development studies. Recently, world attention has been focused on helping the victims of hunger in Ethiopia. little attention, however, was given to documenting the energy situation of the region.

Even if the people are provided ~~with~~ adequate food supplies, what will be the fuel they use to cook with? This low level of energy production and consumption, therefore, is a major characteristic of the syndrome of poverty.

Moreover, the energy crisis - the lack of sufficient fuel supplies to carry out daily activities requiring energy - has been always linked to processes of deforestation in vulnerable geographical and ecological regions such as the Sahel in Africa and the Himalayan slopes in Nepal. Although the causes of deforestation in these areas differ, their effects are the same - sharply decreasing fuelwood reserves and reduced arable land for agriculture. However, very few investigations, dealing exclusively with the energy problems facing the rural poor in humid tropical environments, have ever been carried out.

Energy investigation in the Third World have always drawn too much attention to fuelwood - the most widely consumed traditional source of energy in rural areas. Therefore, the apparent qualities of firewood in terms of being renewable, accessible, and relatively cheap did not merit the focus of comprehensive research. Furthermore, the diverse and rich vegetation complex in tropical rainforests diverted away from the humid tropics research into the role of fuelwood in the energy systems of rural areas. In addition to the low priority attributed to this area of research, the roles of other existing fuel alternatives such as crop residues, in meeting increasing demands for energy sources, have not been thoroughly analyzed.

In 1979, in response to this concern, the United Nations University (UNU) and its Nigerian associate Obofami Awolowo University - formerly the

University of Ife - established the Rural Energy Systems Project in Nigeria. Its objectives are, chiefly, to examine energy production and consumption in the humid tropics, and to appraise the potential of wind, solar energy, biogas, and fossil fuels - the total energy mix which can be provided in rural settings (Ojo, et al., 1981).

The area chosen for this study was Oyo State (Figure 1), a densely forested tropical region in south-western Nigeria and the site of Obafemi Awolowo University. In particular, three zones were selected according to pre-set criteria; contrasting ecosystems, and the size and function of the urban centres to which the proposed sample of villages adhered. The Ife and Ogbomoso zones located in the rainforest and forest-savanna environments respectively, and the Ibadan zone also in the rainforest - but with the largest urban centre of the three zones - provided the sample bases of the investigation (Figure 2).

The author's interest in this investigation, which culminated in this thesis, stemmed from his brief tenure (October 1983 to August 1984) as UNU Consultant to the Project. Moreover, it stemmed from the desire to analyze the information obtained from the rural energy survey questionnaire - conducted as part of the Project objectives.

The thesis comprises six chapters. The first chapter contains a literature review of rural energy investigations carried out in the Third World. Fuel end-use, factors in energy consumption, and energy efficiencies of fuel use are outlined. Rural energy consumption and production in Nigeria in general, and Oyo State in particular, are also investigated. Definition of the concept of 'rural energy' is provided.

Problems encountered in conducting surveys, especially rural energy surveys in the Third World, are reviewed in Chapter Two. Furthermore, a brief analysis is given of how and why local conditions, imposed by the physical and human elements within which rural energy consumption and production are taking place in the Third World, modify the methodologies and approaches of energy surveys commonly used in the more developed nations.

The evolution of the research context, detailing the origins of the United Nations University and Obafemi Awolowo University Rural Energy Systems Project is presented in Chapter Three. Also presented in this chapter are the origins of the thesis, its objectives and thesis hypotheses.

General background information on Nigeria, its physical landscape, and how it has been modified by human settlement is outlined in Chapter Four. Specific background information on Oyo State, with regard to ecosystem characteristics, is detailed. Description of the towns and sampled villages within each zone is also given.

Chapter Five describes the methodology and fieldwork of this investigation. Particulars of the rural household energy consumption and fuel preference survey questionnaire are explained in detail, and its preparation for computer analysis is outlined.

Results of the survey questionnaire and subsequent analysis are presented in Chapter Six. They are followed by a discussion of the findings and summary conclusions are drawn.

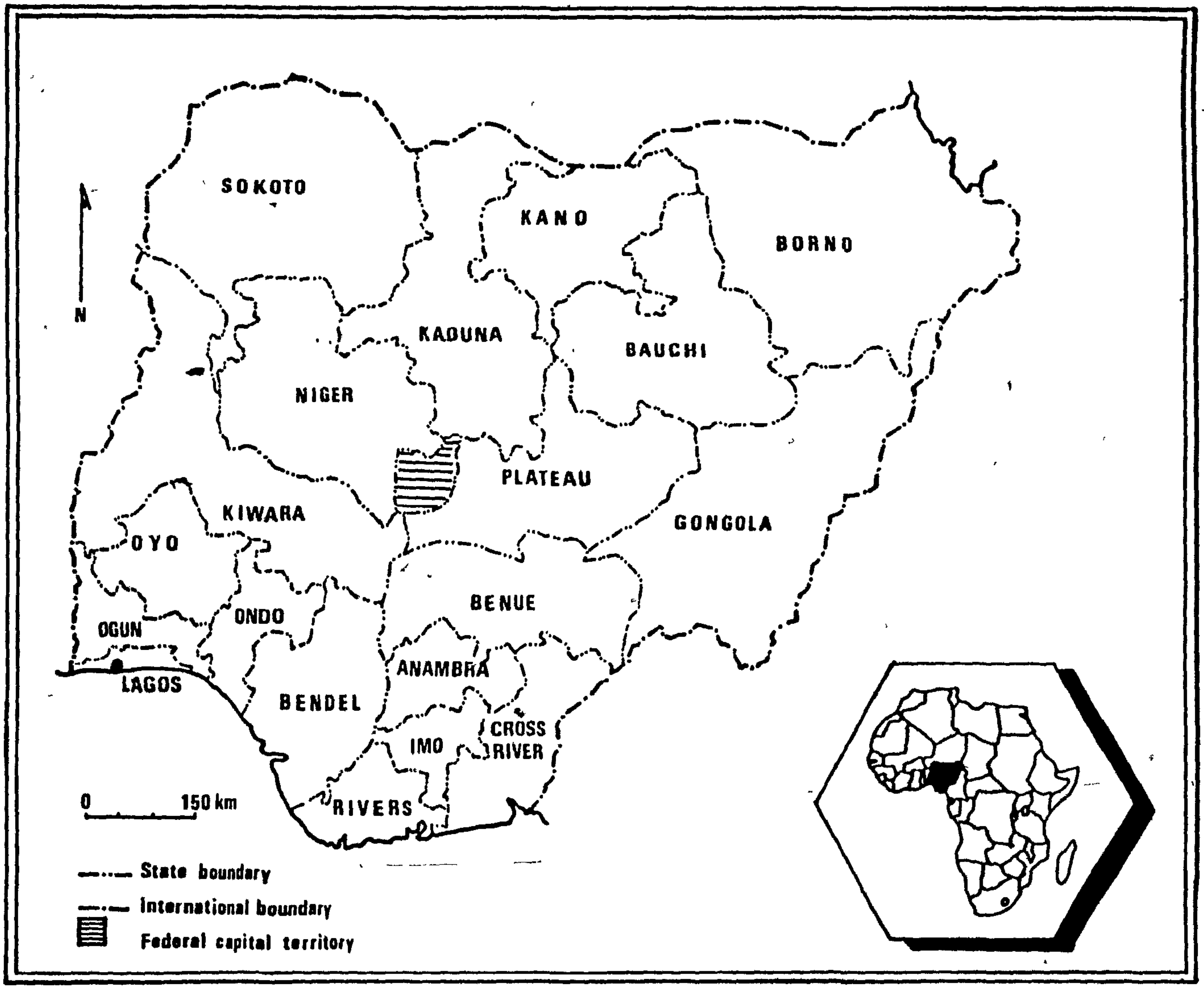

Figure 1: Nigeria in Africa.

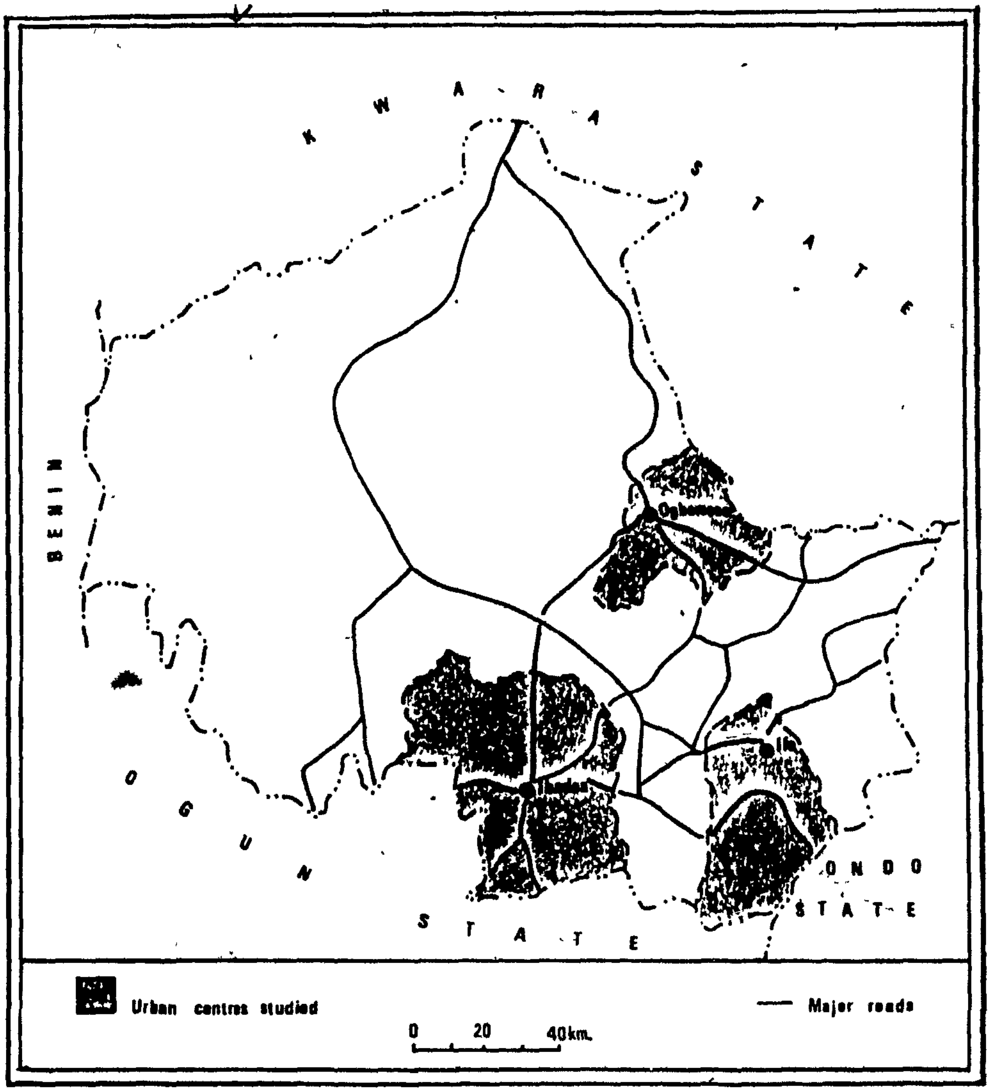

Figure 2: The study area - Oyo State - South-western Nigeria.

Chapter One

RURAL ENERGY -- AN OVERVIEW

"Wood is the poor man's oil"
(Makhijani & Poole, 1975, p. 1).

While a number of industrialized nations agonize over the possibility of eventually exhausting the global oil supply, parts of Asia, Africa, Latin America, and other developing areas on earth are beset with another kind of energy crisis - a growing scarcity of wood used as fuel in cooking, lighting, and other related domestic and commercial activities.

Rising populations and an ever-increasing demand for sources of energy are steadily depleting African forests - the major source of supply for the continent's demand for fuel. Of the ten nations in the world with the fastest rates of deforestation, five are located in Africa. The Ivory Coast and Nigeria head the list with annual rates of 6.5 percent and 5 percent respectively (Brooke, 1987).

In Ethiopia, as a result of natural and man made causes, less than three percent of the land is now forested, compared with 40 percent at the turn of the century. Moreover, further estimates (cited by Brooke, 1987) place forest losses each year in Africa, tropical Asia, Central and South America at about six-tenths of one percent or 1.3 million hectares.

Energy resources are essential to the socio-economic development of any nation. There appear to be direct positive relationships between energy consumption and the level of development, and between the level of development and enhanced productivity (Arnold & Jongma, 1978, Iglesias, 1981, Ki-Zerbo, 1981, Hosier, 1985). Economic growth, therefore, has come to be seen as an urgent and necessary requirement for nations striving to improve their standards of living. In addition, economic growth as measured by GNP increase can be achieved "only with increased consumption of energy" (Abdu, 1984, p. 1).

The oil crisis of the 1970's brought to the forefront of world attention the realization that fossil fuel resources, especially oil and natural gas, are finite in nature. Consequently, countries were forced to explore the possibilities of using other sources of energy, thereby establishing an appropriate energy mix to meet their energy demand for development.

The pressing need to develop renewable sources of energy is most marked in the developing areas of the world. In these regions, especially in their rapidly modernizing urban sectors, the impact of increased oil prices has been varied so leading to acute fuel shortages in some areas and to curtailed industrial activities and cutbacks in essential services in others. Higher oil prices have also depleted the foreign exchange reserves of most of those oil-importing nations and brought on higher fuel and fertilizer costs for agriculture. The costs of boiler fuel, gasoline for industrial production, electricity generation and transportation have also been adversely affected (UNEP, 1981).

In the rural areas, however, where often the majority of the population lives, the energy crisis is of a qualitatively and quantitatively different nature. It is, namely, the continued dependence on rapidly depleting indigenous wood resources and other traditional sources of fuel such as biomass (plant residue and animal waste) to meet the local demand for energy.

According to a report by the World Bank (1980, p. 4):

> a large majority of the low income countries [ie. GNP per capita below US $360 in 1978] which are totally dependent on oil imports for their supply of commercial energy, [and] which are already seriousely short of fuelwood or depend heavily on fuelwood and other traditional sources of energy...are the countries that face a double energy crisis.

The notion of a 'double energy crisis' facing many Third World countries has been brought to world attention by UNEP (1981), Hall et al. (1982), Foley (1985 and 1986) and Mwandosya and Luhanga (1985) among others. Its effects are more acutely felt in the rural areas where dependence on traditional, non-commercial fuels by the whole rural population is often almost total.

Rural areas in the developing world often continue to be neglected by the majority of national development plans, especially in times of acute national crises. Energy consumption patterns in these areas are on a totally different scale and dimension than those found in urban centres. According to 1978 statistics, world consumption of roundwood totaled about 2600 million cubic metres - of which approximately 47 percent was used as woodfuel (firewood/fuelwood and charcoal) (Arnold & Jongma, 1978, de Montalembert & Clement, 1983). This figure, however, is underestimated since it does not take into consideration the non-commercial aspects of wood and charcoal - which are self-collected or produced by the rural poor. A conservative figure of 5000 million cubic metres of 'global wood consumption' per year may be more realistic; of this, an estimated 2300 million cubic metres is used annually as fuel by Third World nations (UNEP, 1981). The latter figure is roughly about 86 percent of all wood consumed annually in the Third World (Arnold & Jongma, 1978, Openshaw, 1978).

Subsistence in the rural areas of the developing regions in the world depends heavily on the surrounding nearby forests to meet the demand for energy. A large majority of rural people in Nigeria, especially those living in the sparsely-vegetated savanna environment, are facing an energy crisis of some kind. This crisis is a direct result of increasing costs of commercial fuel sources such as kerosene and bottled gas, and a rapidly dwindling base of renewable fuels (firewood, plant and animal wastes).

In several parts of Nigeria, including the south-western state of Oyo, population pressures and a rising demand for fuel by rural and urban consumers have alarmingly diminished locally available fuel supplies, thus increasing the burden of finding fuel. It is worth noting that securing a supply of woodfuel is not the only, or necessarily the most important, issue facing the poor in Nigeria. Sustainable food systems (security and availability), water resources, shelter, health care systems, education, and the need to make provisions for the future all demand equal attention and a share of family resources. The luxury of specialization in any one particular problem is not one that most families can afford (Foley, 1986, p. 69).

The theme of this research relates to synoptic issues associated with rural use of different energy sources in two ecologically unique environments in the State of Oyo, south-western Nigeria. Specifically, it examines patterns of domestic energy consumption by rural households in their daily subsistence activities. It also seeks information on fuel preferences as a guideline in future energy policy planning. One reason for this research is to make the rural energy problem of south-western Nigeria more explicit. Given that this particular region of study is typical of other humid tropical and savanna environments in the Third World, this investigation will contribute to the development of possible solutions to the rural and urban energy needs of these nations.

The major issues addressed in this investigation are closely associated with a growing body of inquiry into rural energy systems in general, and energy consumption in particular. This chapter reviews the available literature on energy studies in an attempt to draw a picture of existing patterns of energy consumption of the rural poor in the Third World. A synoptic view of the energy situation is first presented, followed by an outline of the present energy systems in Nigeria, particularly in the State of Oyo.

1.1 *Energy Perspectives in the Third World*

It is widely accepted that the world in general, and developing areas in particular, are experiencing an energy crisis in varied degrees and forms. The crisis in the developing regions is a product of two aspects of energy. The first is an international factor concerned with price fluctuations of the non-renewable, often imported petroleum and associated by-products. This results in pressures being exerted on the balance of payments of many developing countries in that a good number spend more than half of their foreign exchange capital for the procurement of fossil fuels (Eckholm, 1975, World Bank, 1980, UNEP, 1981, O'keefe & Raskin, 1985, Foley, 1986). The second, and more important, aspect of the energy crisis is closely related to population growth and the pressures this places on the environment for the provision of food and the fuel with which to cook it.

The security of woodfuel and other renewable forms of energy such as plant residues and animal waste, to meet the daily demand for energy, is crucial for over 80 percent of the population living in the Third World. This is especially true of the poor majority who live in the rural countryside.

In regions such as the densely populated Indian sub-continent, the semi-arid Sahelian stretches of Central Africa fringing the Sahara desert, most of the Andean regions in South America, Central America, and in parts of Asia and the Caribbean the energy crisis has reached alarming proportions. Hundreds of millions of people who rely exclusively on firewood, in one form or another, to meet basic energy requirements, are living in a situation where supplies of this renewable resource are being diminished at rates that exceed its replenishment. In addition, since woodfuel consumers in these countries have minimal political power or influence to effectively implement conservation programmes and design projects to offset these problems, the incidence of woodfuel shortages is being compounded at an increasing rate.

In a global perspective, woodfuels account for about 10% of the total energy used in the world every year (Foley, 1986, p. 66). In comparison to the major energy forms consumed, it places fourth behind oil, coal and natural gas, but provides over twice as much energy as nuclear power (Openshaw, 1978, Foley, 1986). In the Third world, however, woodfuel accounts for a significantly higher proportion of the total energy used at the national level, and along with biomass, it account for nearly all of the fuel consumed by the poor in rural areas (Shanahan, 1986).

The woodfuel crisis has been receiving continuous attention by the Food and Agricultural Organization (FAO) of the United Nations for over three decades. The organization constantly publishes statistical information on woodfuel production and consumption in its Yearbook of Forest Products and other related technical reports (e.g., de Montalembert & Clement, 1983). The figures cited in these reports are, however, substantially underestimated because of the inaccuracy in the methods of reporting and recording the required information (Openshaw, 1978). Furthermore, no attempt had yet been made to examine to what extent the volume of woody material available for energy and accessible to the people was sufficient to cover their requirements (FAO, 1983, p. 1). Arnold (1978), Cecelski et al. (1979) and Abdu (1984) have repeatedly stressed that current data on energy related patterns are largely based on estimates, as the greater part of woodfuel production and consumption occurs outside commercial channels. That is to say, a large percentage of the woodfuel is either locally self-collected or self-produced by members of the household. Thus, very little information on the fuel collected in this manner appears in national surveys.

Regardless of the inherent weaknesses in the available data on woodfuel production, researchers [Arnold and Jongma (1978), Openshaw (1978), Cecelski et al. (1979), The World Bank (1980), Palmberg (1981), UNEP (1981) and de Montalembert and Clement (1983),] constantly use them to evaluate woodfuel consumption patterns in the developing world.

Woodfuel and other traditional sources of energy are mankind's oldest energy sources (Hall et al., 1982, p. 8). Their collection and use form an integral part of the daily lives of the poor in the Third World, particularly those in the rural sector. These energy forms are extensively used in the preparation of food, lighting, and household space heating - especially in places where winter and night temperatures are often low. In a number of countries, wood is used exclusively to meet the energy needs of village industries such as tobacco curing, tea drying, fish smoking, pottery and blacksmithing (Mnzava, 1981, Noronha, 1981, Hall et al., 1982).

However, the proportion of people relying on these sources of energy, especially firewood, varies substantially between countries. These proportions reflect differences in energy needs, consumption patterns, agricultural practices, fuel security (cost and availability) and cultural and socio-economic factors.

Arnold and Jongma (1978) summarized the best estimates of woodfuel consumption for a number of developing regions in the world. They found that in the regions where wood resources are easily obtainable and conveniently distributed relative to the populations, as in Southeast Asia, parts of Africa south of the Sahara and in South America, the average annual consumption of woodfuel per capita is close to one cubic metre. Conversely, in the regions where either through population pressures or as result of inherently poor natural forests wood is scarce, as in China, South Asia, the Near East and North Africa, woodfuel consumption dropped to below 0.5 cubic metre per capita. It is in the latter regions that other renewable sources of energy such as crop residues and animal dung are often used to supplement woodfuel in having to meet the local demand for energy.

Moreover, energy consumption patterns within countries are also far from uniform. They commonly reflect regional variations (Eckholm, 1975, Openshaw, 1978, Mnzava, 1981, O'Keefe et al., 1986), differences in income (World Bank, 1980, Reddy, 1983, Hosier, 1985, O'Keefe & Raskin, 1986), and family size (Hosier, 1985). The types of traditional fuels used can also vary according to seasonal fluctuations in fuel availability (Hall et al., 1982).

On the basis of the sketchy information currently available, the main characteristic of consumption of traditional energy sources in the Third World is in its primary application for domestic activities, agricultural practices and local small-scale industries.

A number of studies have shown that in Kenya (Hosier, 1985, O'Keefe & Raskin, 1985), Tanzania (Nkonoki, 1983, Mwandosya & Luhanga, 1985), Burkina Faso (Chauvin, 1981, Ki-Zerbo, 1981), West Africa in general (Moss & Morgan, 1981, Lambert et al., 1984), India (Makhijani & Poole, 1975, Arnold & Jongma, 1978), Bangladesh (Islam, 1980), Ethiopia (Lawand, 1979), Zambia, Sri Lanka, Nepal and Thailand (Eckholm, 1975, World Bank, 1980, UNEP, 1981, de Montalembert & Clement, 1983, Foley, 1986) and in other parts of the Third World, about 85 percent of the energy consumed by the poor in rural areas is supplied by woodfuel and other renewable forms of biomass. Hall et al. (1982, pp. 177-200), compiled a substantial list of information on energy consumption patterns from various case studies carried out in Latin America, Asia and Africa that shows domestic activities, chiefly cooking, consume on average well over 80 percent of the total energy required.

According to Cecelski et al. (1979, p. 7), a thorough analysis of energy use by the poor requires three types of information:

> the tasks which energy performs ... the amount and type of each form of energy used in performing each task... [and] the efficiency with which that task is performed... [furthermore] data currently available on energy consumption by the poor falls well short of the ideal in all three respects.

1.1.1 Energy Tasks

In much of the developing world, the pattern in which energy is consumed is closely related to the tasks it is intended to perform. For the rural and urban poor, the tasks are invariably domestic in nature, particularly cooking and lighting - of which cooking for domestic and commercial activities represents the single most important basic need. In many parts of the Third World, cooking and industrial uses place the greatest demands on energy sources, most of which are met by traditional, non-commercial based fuels (Figure 3).

Cecelski et al. (1979, p.7), Nkonoki and Sorensen (1984, p. 52), and O'Keefe and Raskin (1985, p. 220) estimate cooking energy consumption to be in the order of 80 percent or more of total energy consumed. These figures may increase even further in rural areas.

In another study, Makhijani and Poole (1975), found that energy from woodfuel in selected villages in Asia, Africa and Latin America, is equivalent to the total domestic use of energy - of which cooking is the more dominant. They also show that it is equivalent to 75 percent of all energy in use. Arnold and Jongma (1978) found that non-commercial organic

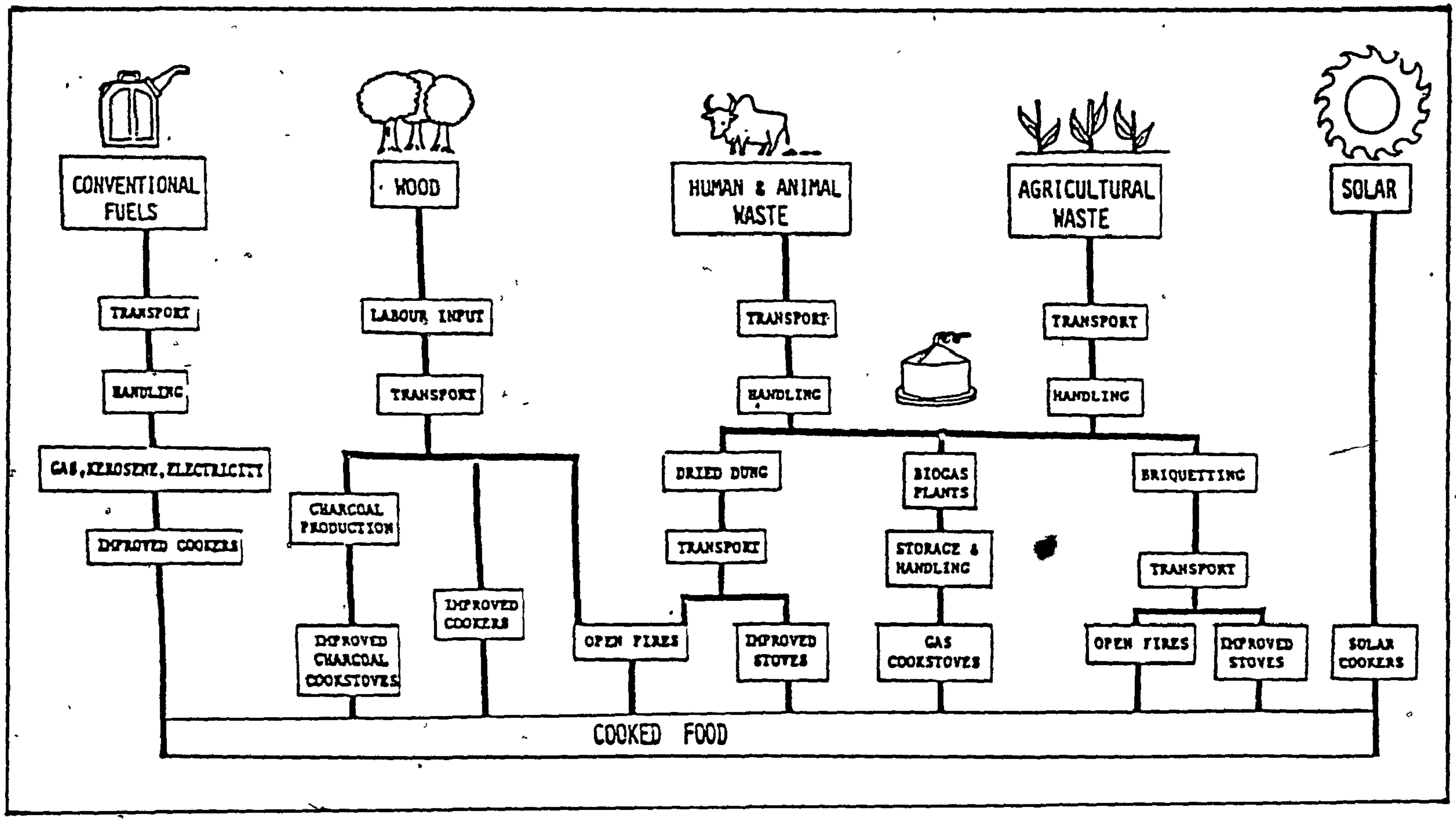

Figure 3: Processes involved in the use of cooking fuels, (Alward, 1982, p. 15).

fuels including woodfuel, animal dung, and plant waste, in India, account for 56 percent of total energy consumption and 93 percent of rural domestic energy requirements.

In predominantly rural settings, woodfuel is also crucial in powering local village industries and small-scale businesses (Barnard & Zaror, 1986). In Tanzania, for example, curing tea, smoking fish, brick and pottery making, brewing and baking are typical activities that rely heavily on the use of woodfuel (Openshaw, 1978, Mnzava, 1981, Mwandosya & Luhanga, 1985). Such demand for woodfuel along with current increases in these wood demand oriented activities are creating an energy crisis in Tanzania where "wood energy needs are on a collision course with the natural environment" (Mnzava, 1981, p.24).

Other basic survival activities that consume energy, but at substantially lower rates than cooking, include lighting, space heating, ironing, water pumping, and power generation (Lawand, 1974). In many areas these needs are often integrated with other energy uses to make fuel consumption more efficient.

1.1.2 Factors in Energy Consumption

Concrete data on the energy comsumed to fulfill various tasks is often lacking. Although a substantial amount of information on commercial fuels exists, it is rarely broken down by end-use (Cecelski et al., 1979, deLucia, 1983). Similarly the situation with regards to non-commercial fuels is even less satisfactory (Cecelski et al., 1979, p. 8).

The distinction between commercial and non-commercial fuels, though more readily identifiable in the literature, is not entirely discerned in field surveys. Commercial fuels, commonly recognized as petroleum and petroleum products (especially kerosene), coal, bottled gas and electricity are relatively straightforward to identify. These forms of fuel are bought from organized markets where producers are distinct from consumers, and the intermediary roles of the middlemen are recognized (Openshaw, 1978). However, in some developing areas, some so-called 'non-commercial' fuels, such as fuelwood and charcoal for example, are also bought and sold in organized markets - within or at the perimeters of urban centres (Ay, 1980, Hosier, 1986).

Moreover, the collection of fuelwood and crop waste from the surrounding forest, although without monetary cost to the collector, constitutes a social price. Fuel collection diverts time and energy from other activities of possibly greater actual or potential productivity. These activities include education in the case of children, and handicrafts in the case of women - the two groups which collect much of this fuel (Cecelski et al., 1979, p. 9).

Therefore, the distinction between 'commercial' and 'non-commercial' fuels is vague. In the sections that follow, unless otherwise specified, energy consumption and production will always include non-commercial, renewable and traditional sources of energy such as firewood, animal dung and crop residue.

Domestic Energy Requirements

A crucial factor in patterns of energy consumption is the amount of energy required by different activities. Domestic energy requirements in many areas of the developing world vary with household size, cultural preferences for certain fuels, cooking habits, climate and income (Arnold & Jongma, 1978, Hosier, 1985).

In a recent study, Cecelski et al.(1979) estimate non-commercial energy consumption, by the rural and urban poor in parts of Asia and Africa, amounts to about 7.6 kiloWatt-hour (kW-h) equivalent per capita per day - roughly 10 gigajoules per capita per year. This value is in the range necessary for adequate provision of energy for cooking food in outlining areas, using available simple cooking technologies.

In another study, Islam (1980) estimates total per capita consumption of fuels in Bangladesh in 1977-1978 at 4.7 kW-h equivalent per person per day, of which 82 percent of the energy consumed comes from non-commercial sources.

Research into the demand and consumption of wood and other fuel sources for cooking in the Third World were undertaken in Dakar, Senegal, by the Brace Research Institute (BRI) (1976), in Tunisia, by Tschinkel and Tschinkel (1975) and in Katmandu, Nepal by Shakya (1986). The BRI and Tschinkels' studies show combined charcoal and firewood consumption rates between 3.5 to 7.5 kW-h equivalent per person per day. Similarly, Shakya (1987) in Nepal found that mean cooking energy consumption of firewood per person per meal of rice, using traditional stoves with two potholes, was in the order of 2.3 kW-h equivalent per person per day.

This order of per capita consumption of fuelwood for cooking purposes is fairly high. It must be remembered, however, that cooking on open wood fires or using traditional technologies is very inefficient. Shakya, moreover, found that the energy consumed in cooking when traditional stoves were replaced by improved (Magan) type, was roughly 1.9 kW-h equivalent per person per day (a saving of 18% over the traditional stove). Invariably, the caloric values of different fuel forms, the efficiency of cooking equipment, the chemical properties of the foods to be cooked, in addition to other factors, influence the amount of energy required for cooking.

In a controlled laboratory experiment, Desai (1985) calculated the heat requirements for cooking various food using electric hot plates (extremely energy efficient appliances). He found that 450 grams of boiled rice require the equivalent of 0.35 kW-h of energy; 450 grams of dal (beans) require 0.38 kW-h energy equivalent; 800 grams of boiled potatoes consume 0.29 kW-h of energy; and 36 chapatis (bread) from 800 grams of wheat flour, require 0.74 kW-h of energy.

In a another experiment, which assessed the amount of energy consumed during parboiling, milling, flaking, cooking and other related aspects of rice processing and consumption, Narasimha et al. (1984), record an energy requirement of about 0.87 kW-h equivalent for cooking one kilogram of parboiled rice, using electric hot plates. This value closely corroborates the Desai findings cited above.

Energy requirements for cooking in developing areas of the world, therfore, are influenced by a variety of factors; the transformation efficiency of existing cooking technologies; the caloric values of different fuels; the amount and chemical properties of the foods to be cooked; and, cultural tastes for preferred cooking methods. Present woodfuel energy consumption in representative regions of the developing world, ranging from 3.5 to 7.5 kW-h equivalent per person per day, is relatively high in comparison to available fuel supplies. This range, however, reflects the low-efficiency of cooking methods and appliances - where over 80 percent of fuel energy, in energy transformation processes, is lost to the environment (Makhijani & Poole, 1978).

Energy Consumption and Socio-Economic Factors

In many parts of the developing world, the level of woodfuel consumption is largely determined by its availability (Arnold & Jongma, 1978, p. 3). Moreover, in rural Kenya, for example, woodfuel availability and consumption are largely determined by social organization and land-use patterns (Hosier, 1985, p. 226).

General variations in the rates of per capita consumption of traditional fuels, within and between countries, reflect the seasonal availability of the fuels (Ernst, 1978), cultural patterns (Nkonoki & Sorensen, 1984), and the presence of alternative renewable sources of energy (Mwandosya & Luhanga, 1985). Climatic and ecological factors are also important in that net primary productivity and potential productivity of the ecosystem, in addition to the amount of harvestable biomass and the standing stock of tree species, are positively correlated with rainfall (Abdu, 1984).

Rural energy surveys have also shown that per capita consumption of woodfuels in the Third World are inversely related to income. For example, based on findings of urban energy consumption surveys, O'Keefe and Raskin (1985, p. 220) conclude:

> consumption of the lowest income urban households is almost entirely wood-based ... Low to middle-level ... use kerosene for lighting and to a more limited degree for heating....Use of bottled gas is also evident at middle income levels...with rising income, electricity is used for an increasing variety of appliances.

However, there are exceptions in switching between fuel forms - depending on regional and intra-regional variations in fuel availability. Openshaw (1978, p. 7), for example, concludes that, regardless of wealth, there "appears to be a much slower switch rate [to other fuels] in rural as opposed to urban areas". Similarly, Hosier (1985, p. 226), in Kenya, also concurs that income has no demonstrable effect on wood consumption, but can be seen to be positively related to paraffin consumption.

Therefore, uniform relationships between income and woodfuel consumption either do not exist, or cannot be clearly discerned from national level surveys. Commenting on India, Reddy (1983, p. 41) states:

> The more affluent sections of society always prefer cleaner and more convenient cooking fuels to wood. The poor know that there is a hierarchy of cooking fuels and they view changes from fuelwood to charcoal to kerosene to electricity or gas as steps in the quality of their lives.

In general, the major economic obstacle in substitution to alternative fuel forms, in the rural areas as well as in towns and cities, is simply due to the fact that the majority of people are too poor to buy the necessary equipment to use them (Arnold & Jongma, 1978, p. 34).

In addition to income, cost of fuel is another important socio-economic factor linked to rural domestic energy consumption. If the cost of wood is represented by the time it takes people (commonly women and children) to trek long distances to gather fuel, then fuelwood consumption will decrease as its cost rises (Hall et al., 1982, Hosier, 1985, Mwandosya & Luhanga, 1985). In these circumstances, households which find themselves spending an increasing portion of their daily routine gathering fuelwood will search for other ways to decrease their current level of energy consumption. Some of these ways include fuel conservation or fuel substitution. In fuel substitution, the observed general pattern of change is first to charcoal and then to other more convenient non-wood fuels such as dung and plant residue (Arnold & Jongma, 1978, Openshaw, 1978). Many women prefer charcoal over other non-commercial fuels because of its high caloric value per unit of weight of dry wood (almost twice as much), and because its application is more energy efficient and environmentally less damaging relative to other fuels. In some areas it may actually be cheaper than fuelwood. Charcoal is also smokeless when burned, imparts flavor to foods, and is easy to store and transport (Arnold & Jongma, 1978, Ki-Zerbo, 1981). Fuel substitution invariably depends on the relative price and convenience of the competing fuels, as well as cultural preferences.

Household size is clearly another dominant factor in domestic energy consumption, according to Hosier (1985, p. 226):

> as household size increases...the amount of fuel consumed by a household decreases on a per capita basis.

Therefore, by virtue of size, larger households use energy much more efficiently than smaller households, and, in a rural labour context, a larger household means less labor for each individual since collection and procurement is shared among the household's members (Abdu, 1984, p. 15).

Another factor in domestic energy consumption relates to the intrinsic cultural characteristics of different ethnic groups and the dietary patterns of individual households. Hosier (1985, p. 226), for example, found that in some parts of Kenya households that rely heavily on a boiled whole grain diet (a local traditional dish) demonstrate an average annual [wood]fuel consumption that is 1,350 kilograms greater than that of those households relying largely on other foods.

The quantity of wood used to prepare a particular meal, therefore, depends on a number of parameters; the food to be cooked; cooking appliances used; and, the cooking method applied.

Moreover, in large towns, tradition and culturally-ingrained habits also determine the choice of fuel form used. For example, in Nairobi, Dar es Salaam and most East African cities, charcoal is the most popular fuel consumed, whereas in Niamey, Ouagadougou and other West African cities, wood is more widely used (O'Keefe et al., 1986). Similar variation in patterns of fuel consumption are also found in Asia. In Bangkok, for example, charcoal is almost exclusively consumed, while fuelwood, animal dung, and plant waste are more commonly used in Madras and most Indian cities.

The relationships between traditional, non-commercial energy consumption and the socio-economic factors discussed above, are not always clearly defined. It is generally agreed that one of the most important factor influencing fuelwood consumption is the time required to gather the fuel (an indication of the physical availability of the resource). As the time requirement increases, consumption tends to decrease (Arnold & Jongma, 1978, Openshaw, 1978, Hosier, 1985). Household size is another important factor, followed by dietary patterns, traditional preferences and interpersonal variations (Hosier, 1985, p. 226).

When faced with energy shortfalls, however, common sense dictates that most rural and some urban households would first turn to what is locally available in their areas, before committing any part of their irregularly flowing income into buying commercial fuels (Abdu, 1984, p. 12).

1.1.3 Energy Efficiencies of Fuel-Use

The third component of the energy consumption system is the efficiency with which these fuels are used. A cursory examination of fuel-gathering and fuel-use practices in the Third World shows them to be highly inefficient and wasteful.

Traditional methods of cooking using fuelwood result in great amounts of energy being wasted. With the traditional three-stone arrangement commonly used by the rural poor, it is estimated that only about five to eight percent of the heat released by wood combustion is used for cooking. The rest of the energy generated by combustion is lost to the atmosphere (Ki-Zerbo, 1981). Also, cooking on open fires with firewood requires more than five times as much energy as cooking on kerosene stoves (UNEP, 1981).

In many developing areas of the world, the most regularly-used cooking stoves have efficiencies of between six to ten percent (i.e. from 90 to 94 percent of the total heat value of fuelwood is wasted). Consequently, attempts have been made to increase the efficiency of wood stoves. In Indonesia, for example, the Singer type stove with an efficiency of 27 percent led to substantial savings in wood combustion (UNEP, 1981). Various other improved simple and inexpensive stoves include, the Indian Jumagdah stove (30% efficiency), the Guatemala Lorena types (15-20% efficiency), the East African Jiko (25-30% efficiency) and the New Nepali Chulo (about 20% efficiency). However, for a number of reasons, of which the principal one is infrastructure, these stoves have yet to be widely disseminated in their local habitats (World Bank, 1980).

Charcoal making is also another highly inefficient process of energy conversion (Booth, 1981, Hall et al., 1982). In many cases, charcoal making is carried out by people without any access to investment capital and, therefore, relies on cheap and wasteful traditional methods of conversion. These methods are generally fairly basic, employing either covered wood-piles (in which wood is corbonized in pits dug in the ground or the side of a hill) , or simple earthen kilns (in which a pile of firewood is covered with mud or earth).

In any case, they are both highly inefficient processes as energy losses during conversion may reach as high as 80 percent of the original energy content of the wood (Hall et al., 1982, Mwandosya & Luhanga, 1985). According to Lawand (1979, p. 70):

> from a useable energy point of view, it would perhaps be best to use the wood directly as fuel rather than to convert it first to charcoal, since it requires somewhat more than 2 kgs of wood to produce 1 kg of charcoal in the first place.

Nevertheless, charcoal production and consumption offer a number of distinct advantages than firewood. Charcoal is easier to transport, store and distribute. It also burns more efficiently and produces very little smoke (an essential requirement for cooking and heating in closed places). Charcoal also has a higher caloric value than fuelwood (almost twice as much), and is traditionally preferred for a number of domestic uses as well as industrial activities.

Although charcoal is more of an urban fuel, firewood will, nevertheless, continue to be a major source of energy, especially in many rural areas of the developing world, for the foreseeable future.

1.2 *Rural Energy Perspectives in Nigeria*

This section deals with a review of literature on and research into Nigeria's energy sector in general, and some aspects of its rural energy in particular. The bulk of the information is gathered from published papers by members of a research team at Obafami Awolowo University (formerly known as Obafemi Awolowo University), Ile-Ife, Nigeria. The team has been investigating the dynamics of rural energy systems in south-western Nigeria since 1979 and has completed the initial phase of the project (refer to Chapter Three for additional information).

1.2.1 Energy in Nigeria: A Macro-Analysis

Nigeria, unlike many of its neighbours, is fortunate in possessing a variety and abundance of energy resources essential to its económic and social development (Schatzl, 1980, Morgan, 1981). These resources include substantial reserves of crude oil, natural gas, coal, lignite, hydro power and standing forest stocks.

Nigeria's crude oil reserves are considerable. Conservative calculations carried out in 1971 by Shell/BP placed the ultimate recovery of the oil fields for the entire industry at about 1.5 [billion] tons (Schatzl, 1980, p. 1). Another independent calculation carried out in 1976 by Exxon estimated Nigeria's proven crude oil reserves at 2.6 billion tons and inferred reserves at least another 1.5 billion tons (cited in

Schatzl, 1980). Most of these oil fields are located in Nigeria's eastern region which includes the inland states of Anambra and Imo, as well as Rivers State along the shore and Cross Rivers State bordering Cameroon. Approximately two thirds of the proven reserves are on the mainland and the remaining one third on the continental shelf.

Nigerian crude oil, in comparison with oil from other Oil Producing and Exporting Countries (OPEC), is of a higher quality. The low sulphur content of Nigerian oil is ideal for the production of lubricating oils and it is highly sought after by the industrialized countries. According to Schatzl (1980), Morgan (1981) and Adeniyi et al. (1987) almost all Nigeria's crude oil is exported. Most of it, about 60 percent, is destined for North and Latin America and the remaining 40 percent is shared by West European nations. Since the exploitation of crude oil in the early seventies, the petroleum sector accounted for over 90 percent of Nigeria's total exports and for more than 95 percent of its total revenue (Schatzl, 1980).

The discovery of crude oil, coupled with the birth of an export-oriented petroleum industry, created "a development planning opportunity which paved the way for Nigeria's enhanced spending power on development projects and programmes" (Adeniyi et al., 1987, p. 3). Furthermore, increased revenue from oil sales during the world-wide energy crisis in 1973 acted as a catalyst in Nigeria's socio-economic and potential development (Adeniyi et al., 1987, p. 3). However, the oil glut of 1980 and 1981 resulted in a sharp decline in oil earnings. Consequently, some development schemes and programmes in the plan had to be either cancelled or suspended and stringent austerity measures were imposed on the nation by the government.

Nigeria, in order to pay its debt to external creditors, applied for a loan in 1982 from the International Monetary Fund (IMF). The loan was granted tentative upon Nigerian acquiescence to imposed IMF conditions - essentially comprising of economic reforms including the devaluation of Nigeria's currency. The-then military government rejected the conditions, but implemented an IMF-style reform package that led to a liberal re-scheduling of foreign debts, and eased Nigeria's financial crisis" (The Montreal Gazette, May 23, 1987, p. B5).

In addition to crude oil reserves, Nigeria also enjoys accumulations of extremely rich natural gas deposits. A 1971 estimate of proven natural gas reserves by Shell/BP placed these accumulations for the entire industry at 1.4 thousand billion cubic meters, most of which are found in association with crude oil deposits (Schatzl, 1980).

Unfortunately, much of Nigeria's natural gas production has had to be flared-off during the early period of rapid escalation of oil production. In 1976, for example, over 97 percent, about 20 billion cubic metres, of the total production of oil field gas was flared, and about 0.7 billion cubic metres was used in Nigeria for domestic activities (Schatzl, 1980).

Although prospects for future gas sales within Nigeria are limited, there are, however, good prospects for exporting natural gas in liquified form to North and Latin America as well as to a number of West European nations. To that end, Nigeria is seriously considering plans to construct natural gas liquifying plants.

The crude oil reserves and associated natural gas accumulations are Nigeria's primary resources of commercial non-renewable forms of energy, Other less important forms include sub-bituminous coal deposits and lignite seams. However, the susceptibility of coal and lignite to weathering and handling, especially under tropical conditions, makes them less profitable to extract. Moreover, the thinness of the seams, the low quality of the coal, the difficult mining conditions and the unfavourable location, further lower the appeal to economically extract these resources (cited in Schatzl, 1980, p. 2). Nigeria's non-renewable energy sector, therefore, is entirely dependent on its crude oil production and the potential to economically exploit its natural gas reserves.

The consumption of non-renewable resources of energy (mainly petroleum and petroleum by-products) in Nigeria has been steadily increasing for the past two decades. Consumption in 1966, for example, has increased to 2.6 tons Bituminous Coal Equivalent (BCE) from a value of 0.8 tons BCE in 1950 (1). It was increased further to 7.7 tons BCE in 1976. According to Schatzl (1980), Nigeria's annual growth rate of energy consumption, between 1950 and 1976, amounted to about nine percent. However, since the majority of the population is rural-based, or maintains rural links, at least two thirds of Nigeria's total energy requirements are still met by fuelwood (Schatzl, 1980, p. 8). In 1975, estimates derived from fragmentary sources (cited in Schatzl, 1980, p. 8), placed the range of per capita non-commercial fuelwood consumption from 0.2 tons BCE to 0.5 tons BCE, compared to 0.1 tons BCE of commercial energy consumption. Furthermore, other estimates for the period between 1966 and 1976 have shown annual growth rates of fuelwood consumption to range from two to three percent, whereas the growth rates of competing fuels have been much higher - 17 percent for petroleum and gas, 16 percent for household electricity and 9 percent for kerosene.

1.2.2 Defining the Concept 'Rural Energy'

The use of the concept "rural energy" invariably suggests that energy systems in the rural areas of Nigeria (and for that matter rural areas of other Third World nations) are distinct from those of urban centres (Adejuwon, 1985). In practice, however, this dualistic approach to energy research and planning, which emphasises a modern urban energy sector and a comparable traditional rural one, is difficult to sustain. In nearly all social functions and energy-related sectors, there exists a dynamic interchange between the urban centres and thei rural environs. Indeed, it is often the urban demand for fuelwood and not the rural demand that largely accounts for the degradation of the rural environment.

The concept of rural energy as often used in energy-related research, therefore, suffers from imprecise definition (Adejuwon, 1985, p. 123). Moreover, the problem of defining rural energy lies with both the 'rural' and 'energy' aspects of the concept, in that it is not very clear that rural energy can be distinguished from other forms of energy. Accordingly, it is more appropriate to study rural energy from geographical, socio-economic, cultural and ecological contexts with which it is produced and consumed (Adejuwon, 1985).

The aim of the following section, therefore, is to clarify the concept of rural energy and to outline the problems associated with rural energy production.

A practical definition of rural energy encompasses energy used by rural settlements, or energy resources derived from rural environments, or as energy derived from and used by rural communities (Figure 4). With reference to Nigeria, the actual types and sources of energy used are the same in rural and urban areas - although the proportions and the manner in which fuel is consumed and produced may vary (Adejuwon, 1985, p. 123). These energy sources include fuelwood, charcoal, electricity and bottled gas - used for cooking, lighting, drying, space heating and, in some places, air conditioning.

In south-western Nigeria, the main source of energy in the rural areas is fuelwood-based. Fuelwood is obtained from forests, fallow lands and croplands. It is transported to urban markets where it is used by the majority of urban inhabitants for cooking and other domestic and commercial activities.

The geographical and demographic contexts of rural energy essentially bring into proper focus and definition the concept of rural communities. At the present time, government-oriented energy planning development policies to bring electricity to rural settlements appear misguided (Adejuwon, 1985, p. 124). The problem lies with the failure to define adequately the 'real rural communities', which are, in form, size, and social structures "worlds apart from the settlements now being electrified under the rural electrification scheme" (Adejuwon, 1985, p. 124). An aspect of rural energy is, therefore, coming to a consensus with what constitutes rural communities.

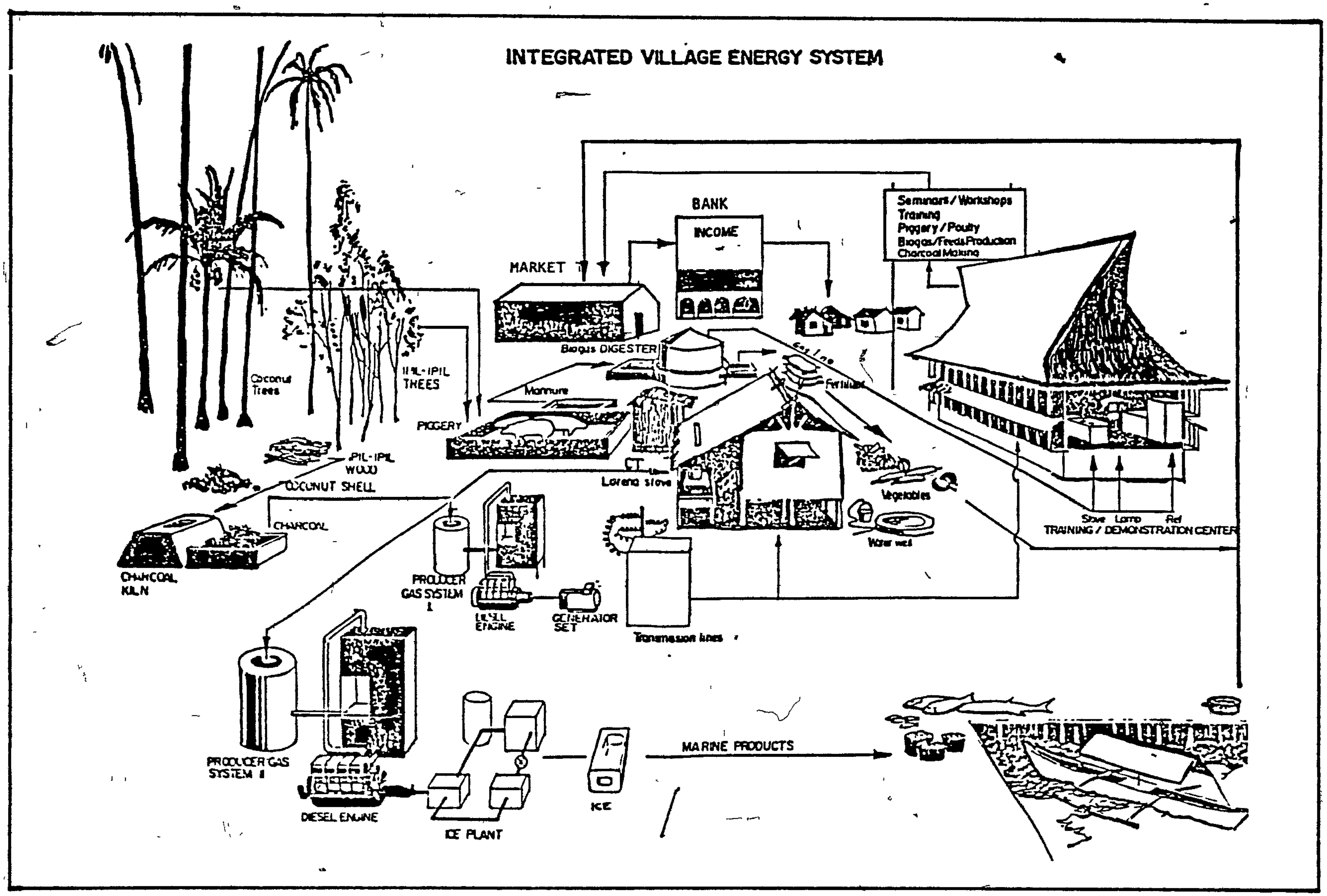

Figure 4: Integrated village energy system - Philippines, (INRESA Newsletter No. 14, p. 33).

The ecology of rural energy, essentially, is concerned with appropriately allocating agricultural resources to rural inhabitants to meet basic requirements for food and energy. Morgan (1981), Moss (1981) and Adejuwon (1985) cite three possible solutions to this process; planned special forestry plantations to increase the supply of fuelwood; use of the rotational bush fallow system (shifting cultivation) to optimize the production of energy and food through simultaneous use of the same land; and, the gathering of agricultural wastes such as crop residue, weeds and animal dung, from lands primarily used for food production, to produce biogas.

Understanding the problems of rural energy production and consumption, therefore, is best achieved by first clarifying the concept 'rural energy', and, accordingly, implement conservation plans. The geography, ecology, economy and sociology of rural energy of rural areas need to be investigated and integrated into conservation studies.

1.2.3 Rural Energy Production and Consumption

> "The rural energy production problem of tropical Africa is essentially the maintenance of the existing wood supply to serve a rising demand and, in relation to energy alternatives, chiefly kerosene, the changing state of the market, the threat of dwindling resource and problems of ecology and environment" (Morgan, 1981, p. 17).

Energy use (domestic and small-scale industrial) in Nigeria, particularly in the rural areas, continues to rely heavily on fuelwood and other traditional fuels (Uwujaren and Fajana, 1981). Quantitative information on rates of fuelwood production and consumption in Nigeria vary considerably. Much of the published data is simply based on guesswork. Nevertheless, United Nations statistics (cited in Morgan, 1980, p.11) estimate that fuelwood production provides almost two-thirds of the total (rural and urban) energy consumed in Nigeria. Current estimates further indicate adequate supplies of fuelwood. Unfortunately, fuelwood production in Nigeria is seriously constrained by an underdeveloped transportation network and high transportation costs. Fuel availability and accessibility, therefore, become important factor in fuelwood production and consumption (Morgan, 1980, p. 11).

Nigerians, particularly the dominant Yoruba tribe in the south-western sector, tend to be heavily concentrated in built-up towns and cities. This creates a high demand for fuelwood in the town markets - as prices of other available fuel forms such as bottled gas and kerosene, including the costs of associated appliances, are often beyond what the majority of people can afford to pay.

According to Morgan (1980, p. 11), if present trends continue, the outlook of Nigeria's energy sector is not very promising as:

> a doubling of the population in the next 26 years, combined with increasing upward migration and further rural concentration as agriculture becomes more commercialized could, lead to serious fuelwood shortage and localized damage to Nigeria's woodlands and forests.

1.2.4 Rural Energy in South-Western Nigeria

Rural energy in south-western Nigeria is largely derived from wood-based sources. The main supply of fuelwood in that region is from forest clearance for cultivation and from regrowth of savanna woodland on farmland left fallow (Morgan, 1980, Adejuwon, 1985). Other sources of fuelwood supply include forest and woodland clearance for purposes other than agricultural, and from activities associated with timber felling. In the rural areas, fuelwood production is almost always gathered from nearby surroundings on a subsistence basis. Conversely, in the larger towns and cities, a number of tree plantations, usually located at the centres' peripheries, supply the urban markets with fuelwood.

In Oyo State, south-western Nigeria, as in other parts of the Third World, fuelwood activities determine, in part, the methods and processes of fuelwood production. Domestic activities, for example, use roundwood which is either cut from felled trees or pollarded. Conversely, small-scale industrial and institutional activities such as bakeries, tobacco drying, hospitals and prisons use split logs obtained by cutting down and drying standing trees, then cutting and splitting them (Morgan, 1980). The latter process of fuelwood production for industrial use has resulted in the elimination of certain tree species within a radius of 15-60 km of urban centres (Morgan, 1980, p. 11) (2).

The type of labour and the mode of transport involved in the cutting and distribution of fuelwood in south-western Nigeria varies. In the rural areas, most of the roundwood used for cooking and heating is cut and gathered by farmers or members of the household. Conversely, almost all of the energy derived from split logs and charcoal, and conveyed to urban centres to meet the urban demand for energy, is carried out by organized labour and an established transportation network. Those living on the outskirts of large towns and cities along roads accessible to motor vehicles use lorries and small vans to convey their fuelwood home. Conversely, larger lorries are used to transport wood produced at the outskirts of the towns, directly to urban markets. Therefore, the distance to markets accounts for a large proportion of the total costs of fuelwood and charcoal supplies sold in towns.

1.3 Summary

Information on the characteristics of rural energy, such as the mode of fuel production (traditional and commercial), energy requirements for domestic and industrial use, and energy efficiencies of fueltypes, in the Third World has been presented. The data base from which this information is distilled is often drawn from previous research by investigators in this field who, invariably, employ energy surveys in their quest to gather primary information. However, working conditions in the Third World require survey methods to undergo constant modifications to adapt to these local conditions.

The following chapter reviews the issues and methodologies that must be considered before carrying out rural energy surveys in the Third World.

Chapter Two

ENERGY SURVEYS FOR DEVELOPING COUNTRIES- A NOTE ON ISSUES AND METHODOLOGIES

> "Information on the supply of non-commercial energy is not good...For consumption the situation is even worse. Very few actual studies have been done, so estimates are largely based on guesses and suppositions" (Palmedo et al., 1978, pp. 77-78).

The objectives of this section are twofold; to acquaint the reader with the available literature on criteria and related issues of energy surveys in the Third World; and, to show that in carrying out rural energy surveys "no methodological blueprint can ever be devised which can be applied to all rural energy investigations" (Howes, 1985, p. 63).

'Rural energy surveys', in practice, often meant 'rural fuel surveys'. Fuel, in turn, has been widely accepted as energy from wood (firewood and charcoal) and from other traditional sources (crop residues, dung and other forms of organic matter). Therefore, earlier responses to the fuelwood crisis advocated forestry solutions such as afforestation strategies. The realities of the situation that preceded such programmes, however, showed that fuelwood supply and usage are entrenched in an intricate system of relationships within which most of the factors affecting the ability to respond to the fuelwood crisis are non-forestry in nature. They are primarily human factors related to the ways in which people conduct their daily existence with each other and the physical environment. According to a recent publication by FAO (1983, p. ii):

> To simply measure wood fuel use and the tree resource, while a necessary part of the whole, will by itself

> give very little indication of what can and should be done...in order to provide an adequate information base for planning effective fuelwood related projects, it is necessary to draw as well upon the techniques and experiences of other disciplines used in the study of rural and urban problems and development.

To address the issues and methodologies of rural energy surveys, significant contributions to the subject have been made by the Food and Agricultural Organization (FAO), the U.S. National Academy of Sciences (US-NAS), and the Canadian International Development Research Centre (IDRC).

2.1 *Energy Surveys: Needs, Roles and Approach*

Rural energy surveys, are concerned with the acquisition of primary information and data on quantities and types of fuel consumed, resource base supply, and the identification of relationships between various dimensions of the energy situation. Surveys stem from two basic needs; the realities of the energy crisis facing these regions in the light of the global oil situation and the immediate response by national and international concerns to adequately address these problems; and, the lack of representative information on rural energy on which solutions can be formulated and implemented. The survey should not only furnish quantifiable data for statistical interpretation, but also address the complex questions raised by the need for alternative forms of energy that can substitute for each other, For example, in addition to determining the amount of charcoal consumed in urban centres to meet a specific end, the investigator will eventually want to know the impact of increased charcoal prices on different income groups, the total demand of that resource for future consumption, and, equally important, the degree to which other fuels such as kerosene, will substitute for charcoal. Therefore, in gathering information, Palmedo (1980, p. 5) states:

> our concern is with providing information that can improve energy policy decisions - decisions that, as we are now aware, can have a strong influence on human well being.

Unfortunately, the absence of this basic information permeates all aspects of the energy crisis. The absence is especially felt in acquiring an understanding of the patterns of traditional energy consumption in the villages and towns, and the subsequent ecologic, social and economic impacts of this consumption. The role of rural energy surveys, therefore, is to provide a solid, comprehensive foundation of such information through which energy needs of target groups can be assessed and analyzed. It is hoped the survey will help policy makers and project planners to satisfactorily implement rural energy policies and develop projects accordingly.

Rural energy surveys (for specific case studies, see Howes, 1985, pp. 147-170) demonstrate that a synoptic approach in the investigation of the energy crisis yielded relatively more useful information than an empirical approach (Arnold 1978, Desai, 1985). The underlying concern often encountered relating to this is that:

> "...the potential gain from a good data base of energy information is great. The potential damage [in the form of inappropriate projects and mismanaged resources] from faulty or incomplete information is considerable...it is worth devoting resources to collecting energy information in a systematic manner to clarify issues on which energy policies must be based" (US-NAS, 1980, p. 3).

2.2 *Energy Surveys: Identification and Methodology*

A successful survey is one that has clear set of objectives with feasible and attainable methods of investigation. Insufficient understanding of the objectives and the means of accomplishing them often yields to misleading information. In order to obtain an information base from surveys, that adequately represents the reality of the phenomena surveyed, it is essential to address a number of key questions, pertaining to content and methodology, prior to carrying out the task of data gathering.

The first question researchers should ask themselves is a simple one: what is it that they wish to survey, i.e., on which aspect(s) and element(s) of the energy crisis do they wish to focus their research efforts, time and funds. They may, for example, wish to study patterns of fuel consumption; assess physical and human factors affecting the supply of biomass fuels; investigate the broader economic and social contexts within which fuel use and supply take place; observe the traditional and cultural implications in energy form usages; and, look at the technical aspects of forestry-related issues. Whatever the objectives are, they need to be clearly defined within the context of a general understanding of the region's energy situation.

A subsequent question should address the scale at which the inquiry is to be carried out. There must be a definite indication ascribed in the sampling procedure at the onset of the survey as to whether the investigation will encompass national, regional, community or village level(s) of information gathering. This is a significant consideration, especially in deciding the allocation of research funds and human resources. Invariably, the choice of scale, the objectives, and the means to accomplish them out are intertwined.

Since rural energy studies are primarily concerned with determining levels and patterns of fuel consumption, a significant component of rural energy surveys must, therefore, focus on obtaining information that leads to an understanding of these dimensions (Cecelski & Dunkerely, 1985, Desai, 1985, FAO, 1983, Howes, 1985).

Therefore, a thorough analysis of rural energy consumption requires essential information on the various uses of energy. The analysis will also require information on the amount and type of each form of energy used in performing each task, and the efficiency with which that task is performed (Cecelski et al., 1979) (refer to Chapter One for detailed information).

There are several methodologies available, on gathering information related to energy consumption, for use in energy surveys. One frequently-used method takes into consideration the ability of the users to recall specific information on the various forms of fuel expended in tending to their household chores. Another method involves the direct physical measurement of these fuels.

Recall Methods

In employing recall methods, a list of available fuels within the research area should be compiled and each fuel identified along opposing characteristics. This process should be completed prior to identifying the users and tasks of these various energy forms. For example, fuel composition can be broken down to (regular versus irregular); procurement (purchased versus gathered); and, availability (seasonal versus perennial) (Howes, 1985).

Moreover, the activities various fuels are used to accomplish should also be identified. For example, activities could encompass direct energy use (e.g. firewood for cooking) versus non-direct energy use (e.g. straw for fodder, dung for fertilizer). If it is direct, then is it for industrial or for domestic activities? If it is for domestic chores, is it in the form of exchange (traditional home industries) or subsistence? If it is for subsistence is it used for cooking or for other necessities? etc. After having established the types of available fuels and the tasks in which they can be used, a questionnaire matrix combining both dimensions can be constructed to yield an extensive base of information. Recall methods have been successfully applied ion previous rural energy surveys (see Chapter One).

Physical Measurement Methods

In employing physical measurement techniques to determine the quantities of fuel consumed, the most common form involves recording the weight or the volume of fuel used to accomplish an activity. This technique, although accurate, is unfortunately time consuming, and, therefore, is more frequently employed in small-scale energy consumption surveys.

It follows that the major advantage recall methods have over physical measurement techniques, is in the higher number of interviews that can be carried out in the same time that it would take to obtain relatively similar information through physical measurement. The major drawback, however, is that recall techniques are almost certain to be less accurate, especially when absolute measures of consumption are required. Circumstances favouring the use of respondents' recall ability include; regularity in fuel composition; fuel measurements made in standards understood by the respondent; in situations where fuel is purchased rather than gathered; and, in circumstances where the fuel is storable.

Commenting on the merits of both methods, Howes (1985, p. 37) states:

> none is without its disadvantages and...in practice will depend in large measure upon the degree to which users understand or sympathize with the objectives of the research and are prepared to offer their cooperation.

Fuel Consumption: Variation Through Time

Researchers of rural energy consumption surveys should also consider a mechanism they can employ in their methodology of investigation by which they can measure and form an impression of how end-uses and fuel types are likely to vary through time. This is a very significant aspect of rural fuel surveys, especially at the stages of implementing policies and designing projects to offset the future impacts of the energy crisis.

Although short-term variations (daily, weekly, monthly) in energy consumption are significant for policy planning at the village or community level, they have not been adequately represented in rural energy surveys (Howes, 1985). The major reason for the lack of adequate representation in the literature of short-term studies is best demonstrated by Ernst (1978) in Burkina Faso, by Best (1979) in South Africa and by Bialy (1979) in Sri Lanka. They all point out the high degree of day-to-day variations in fuel consumption and the difficulties of measuring such variations in a statistically meaningful way.

Researchers should, therefore, make initial inquiries to ascertain the fuel types peculiar to locations, and devise, accordingly, appropriate sampling procedures to document patterns of energy consumption in these areas.

In contrast, seasonal variations in domestic fuel consumption are more adequately dealt with in rural energy surveys than short-term variations. This imbalance results because fuel uses complement the seasonal availability of fuel types, and because consumption patterns vary according to seasonal needs (Cecelski et al., 1980, Desai, 1985, Howes, 1985, US-NAS, 1980).

Seasonal variations in fuel availability can reflect the time of harvest of certain crops, and the yield of plant residue which is an essential source of fuel in rural areas. They can also reflect, in part, weather conditions at the time that fuel is gathered and, in part, agricultural-related activities requiring animal dung (for fertilizer) that would have been otherwise used as fuel.

Seasonal variations in fuel activities are also a common feature of rural energy consumption patterns. Fuel can be used to heat water in winter, provide space heating in places where winter temperatures are low, and meet the high energy demands consumed in preparing food for festivities on several occasions throughout the year. Invariably, variations in energy tasks are dependent on the availability and security of fuel types, in time and place.

On a much longer time scale (yearly), variations in fuel consumption, arising as a consequence of synoptic climatic disturbances and environmental imbalances, should also be incorporated in rural energy surveys. Past surveys covering this scale of variation are few. Nkonoki (1983), whose investigation of Tanzania's rural energy consumption spanned more than a period of two years, collected data for the entire period of the study. Only to have the data presented in an aggregate format that made it virtually impossible to ascertain what differences in consumption, if any, might have existed between the two periods.

Prior to undertaking rural energy consumption surveys, consensus and decisions on the various dimensions of fuel-related issues discussed earlier must be clearly defined. For example, with regard to the way in which fuel uses vary through time, there are choices between measuring fuel consumption on single days versus a continuous series of block days, single versus multi-year investigations, or single interviews of the respondent versus several interviews. The final decisions, nonetheless, will be influenced by the extent of human, institutional, governmental and other resources available to the investigator.

Summary

An attempt was made in this section to foster an understanding and appreciation of the various dimensions ascribed to rural energy surveys in the Third World, and the methodologies employed in carrying them out. There are, of course, other valid methods for assessing fuel consumption to which very little attention has been paid to in past surveys. Desai (1985, p. 1), for example, contends:

> Apart from estimating the quantities of fuel consumed, rural energy surveys must throw light on its cost -

> how high it is, and whether it is rising...fuel, like all consumer goods entails a cost to the consumer... It is in terms of cost that fuel scarcity may be given a meaning.

Fuel scarcity, in that sense, becomes a function of consumers' ability to maintain purchasing power for present and future energy needs. Fuel consumption is, therefore, equated more with consumer's economic accessibility to the resources, rather than to lack of fuel availability. Although there is merit in this approach in areas where energy prices are largely determined by market forces, (as is the case in urban centres, where there exists a mix of energy sources), it is less applicable in rural areas where the majority of the population is concentrated, and where firewood, the dominant energy resource, is collected. Nonetheless, should ecological scarcity of firewood force rural people to purchase their energy requirements from an organized market, economic factors will then become very important.

In measuring the physical dimension of fuel supply in rural energy surveys, it is suggested that researchers should initially identify various general agricultural factors of biomass production that occur under different systems of fuel extraction (eg. shifting cultivation and/or continuous use of tree resource). Care must be taken, however, not to isolate agricultural factors from the social and cultural contexts of fuel production.

2.3 *Energy Surveys: A Note on Sampling*

The underlying concern of sampling in rural energy surveys is to save on time, cost, research effort and human resources. Rural energy surveying involves collecting data and gathering information from a sample that equally applies to the larger population from which the sample is drawn. It is, therefore, a prerequisite to ensure that the sample is representative of the population.

Statistically, randomly drawn samples (i.e., samples that have equal probability of being chosen) can give significant, close unbiased estimates of the population parameters - as long as the variables of fuel consumption under investigation are normally distributed. In much of the Third World, income, assets and other associated factors are not, statistically, normally distributed in the population. Wealth, for example, is concentrated in the hands of the few, whereas the majority of the people are landless and of low income levels. Likewise, similar distributions can be assumed for patterns of fuel consumption in rural areas.

In situations where statistical normality cannot be assumed, a sampling technique through which reliability of population estimates can be improved, is by stratification. This form of sampling, in effect, involves dividing the population into categories with respect to non-normally distributed variables (such as income level and educational background), and then randomly selecting samples from each category. Samples and sub-samples are then used to estimate population parameters and proportions. Some of the commonly employed sampling frames in stratification include census records, electoral registers, multi-purpose survey maps and land revenue records.

2.4 *Energy Surveys: The Questionnaire*

The questionnaire-based survey, according to Howes (1985, p. 127):

> provides an economical way of obtaining answers to questions which can be precisely formulated in advance. It works best in relation to phenomena which have clearly been identified as significant within a particular problem area, and where there is a need for these to be measured across an extensive range of information.

Studies yielding relevant information require a medium of exchange between ideas and facts and between hypotheses and evidence. A questionnaire form of rural energy survey, by nature, favours a uni-directional path of communication on fuel-related issues, commencing from the respondent to the interviewer to the interpreter (Desai, 1985). Therefore, it is inherently implied that the questionnaire's hypotheses are formulated prior to asking the questions.

The questionnaire, in this context, can only confirm or reject ideas more often than it can yield new ones. It is essential, therefore, that extensive exploratory research into the fuel crisis of developing countries precede the carrying out of the questionnaire so that pertinent hypotheses can be formulated and representative data collected.

Other measures through which researchers can improve the quality of questions asked and raise the rate of response are suggested by Cecelski et al. (1979),Desai (1985), and Howes (1985). They stress the relative importance on part of the interviewer to maintain a two-way communication link with the respondent. The interviewer must be able to anticipate difficulties that may arise during the question period and tries to resolve them. In this manner, some 'defective' questions may be identified and re-worded for future interviews.

They also propose to interviewers to establish a positive personal rapport with respondents as an effective way of gaining their cooperation. Its success, however, would depend on the personal characteristics of the interviewer, as well as the content of the questions asked with respect to respondents' perceived interests.

Finally, they stress that the relationship between the interviewer and the respondent would benefit if the interviewer sought support from the village chiefs, district and regional officials or any other individual in a position which commands respect and influence over the people being interviewed. In these circumstances, the researcher must ensure that these middlemen will not obstruct or bias the inquiry.

In many rural energy surveys using the questionnaire method to collect data, carrying out small-scale pilot surveys prior to the main survey are extremely beneficial to the overall study. Pilot surveys help identify questions that are difficult to answer, attract biases or result in low returns. Such questions can then be corrected or omitted from the larger survey. To help further establish a degree of confidence in the results of the questionnaire, Desai (1985), FAO (1983), and Howes (1985) suggest that a number of questions should be formulated in a manner that allows the use of cross-checking. In other words, should a response to a question imply an answer to another, then the results of both questions taken together will provide a consistency check.

Anatomy of the Questionnaire

There is a consensus among investigators dealing with rural energy surveys as to the material that should constitute the beginning of the questionnaire. There is, however, no general consensus on the remaining body of the questionnaire.

The questionnaire should begin by establishing respondents' identities, and exact personal information on some of their basic characteristics. This is accomplished with the respondents' full knowledge that the information will only be used in the analysis of the data to help elicit information on general and specific aspects of the rural energy situation in their regions. This section ensures that respondents can be traced by the research investigators should the analysis require further sampling and cross-checking Identification of respondents also allows sample characteristics to be checked against the known population characteristics. Should the survey procedure include stratification sampling techniques, then the inclusion of respondents in the survey will largely depend on which category of specified characteristics in the stratification scheme to which they belong.

The remaining part of the questionnaire should primarily concentrate on collecting data and collating the results on energy consumption with reference to tasks, quantities and types of fuel used, and the efficiency with which tasks are being performed. There are a number of suggestions that can enhance information gathering; engage respondents' interest at the initial stages of the interview, by asking them questions that will be of interest to them, and on which they will likely have strong opinions; ensure that the interview will not exceed one hour in length, otherwise, there may be a risk of having the respondent terminate the interview, (this implies, a maximum of 100 to 150 questions can be asked with a relatively high probability of completing the questionnaire); and, question respondents in isolation from their neighbours, so as to reduce the number of false replies likely to be given in their presence (Desai, 1985).

Chapter Three

THE RESEARCH CONTEXT

3.1 *Evolution of the United Nations University and Obafemi Awolowo University Rural Energy Systems Project*

Current trends to adopt a multi-disciplinary approach of research into the various pressing problems facing the majority of people in the Third World, has led the United Nations University (UNU) in 1978 to establish a project in several countries and whose objectives are to investigate one such problem - the energy crisis.

Traditional research into fuelwood production and consumption has concentrated in regions where the rate of wood production is low, as is the case in the regions comprising the Sahel in Africa, and in the northern Regions of India. Recently, however, the claim was made by a growing number of scientists, [in particular Eckholm (1975), Arnold and Jongma (1978), and Moss and Morgan (1981)], that the destruction of forests resulting from the removal of wood for fuel, is also taking place in the humid tropics.

The destruction of forest, which is occurring at an alarmingly high rate, is further aggravated by a steadily growing population, its concentration into urban centres, and the increasing activities of commercialization. All these and other factors have prompted the UNU to focus their effort and funding into investigations of fuelwood production and consumption in the more forested regions of the Third World. Consequently, one target area chosen for this kind of research concentrated upon the mosaic of dense tropical rainforest and savanna regions of south-western Nigeria.

The establishment of a rural energy systems project at Obafemi Awolowo University (formerly, the University of Ife) in Nigeria - the first institution in Africa to enter into an Agreement of Association with the UNU - began at the University of Freiburg, West Germany, in 1977. It was continued at the UNU headquarters in Tokyo, Japan, where the Rural Energy Production and Supply Project, [presently referred to as the Rural Energy Systems in South-western Nigeria], was presented as a part of a resource systems research package under the UNU Programme on the Use and Management of Natural Resources (Figure 5-8).

Professors G. Afolabi Ojo of the Department of Geography at Obafemi Awolow University, and W. B. Morgan from the Department of Geography at the University of London and a former Consultant to the UNU, helped steer the project through the Tokyo meeting. Professor Ojo eventually became the first Programme Director (Co-ordinator) of the research team, later succeeded by J. Oladipo Adejuwon, also from the Department of Geography at Obafemi.

3.1.1 Workshops of the UNU - Obafemi Awolow University Rural Energy Systems Project

In August of 1978, Professor Walter Manshard, then Vice-Rector of the United Nations University, invited scholars with backgrounds and interests in the ecology and economics of Africa to a workshop held at Obafemi Awolowo University. They were to exchange views on the energy crisis facing the poor in the Third World, and to consider measures to help control the degradation of forest and woodland that results from excessive felling and gathering of wood.

Participants at the meeting included representatives from Nigeria, the United States, Sudan, Britain, West Germany and Norway. Papers were presented, and the discussions which followed covered the objectives, the methodology, and time frame of the study.

The State of Oyo, in south-western Nigeria, was chosen for this research for several reasons. The main ones being that the existing network of roads used for the transport of fuelwood, and the proximity of the towns to major sources of fuelwood appeared to satisfy a major hypothesis of the investigation - stating that the destruction of forest for fuelwood takes place most often, close to locations of development and commercial activities, i.e., populations centres and roads. Other reasons considered the ideal, natural conditions of Oyo State. Since the natural of the region vegetation ranges from savanna to rainforest, and since it is the most heavily urbanized and densely populated in Africa, it is ideal for comparative studies of population pressures on fuelwood supply, production, and consumption, and the effects these pressures exert on the physical environment.

A Second Workshop of the Rural Energy Systems in western Nigeria took place in mid-September, 1979, thirteen months after the First Workshop. This was the period during which the foundations of the research programme were laid - out of which the present investigation was formulated.

The project was originally planned as an inventory study of fuelwood-related problems as outlined in the objectives that Professor Morgan (cited in Hammer, 1980, p. ix) presented at the First Workshop. These objectives were:

a. to identify the main problems of fuelwood use, production, and supply, and to relate these to current costs and the use of alternative fuels;

b. to map the energy production and distribution systems in selected areas of western Nigeria;

c. to examine the agricultural, ecological, and socio-cultural background of energy production especially from fuelwood;

d. to undertake a study of energy consumption and supply, examining in particular urban market, the transport system, and the system of dealers;

e. to seek (where possible) more efficient means of fuelwood production and use, and to examine the possibilities of using alternative fuels and technologies.

In the course of implementing the Project, however, the scope of the study was enlarged to accommodate new forms of energy, such as kerosene, gas, wind, electricity and solar energy - the use of which can be integrated with the more traditional and 'reliable' fuelwood. Professor Ojo (cited in Aubert and Benneh, 1982, p. 6) gave the direction of the Project in the following objectives:

a. to appraise the changing socio-economic behavioural attitudes of the users (including potential users) of alternative energy sources and technology;

b. to determine the effect of urban demands on rural energy production and supply, and to estimate the fuelwood productivity of tropical ecological systems with a view to predicting the wood production;

c. to examine the ecological implications of providing and possibly increasing the supply of fuelwood in the various vegetal zones;

d. to measure energy use and conservation in different types of buildings with a view to relating the design of buildings to constructional materials and the prevailing physical environments for maximum efficiency;

e. to fabricate appropriate technological devices, and to improve on existing ones for the use of alternative energy resources; [and],

f. to determine through experimental methods the biogas yield of some local weeds and agricultural wastes.

This new direction reflected changes in Project emphasis which continue to the present.

Researchers working on the project were organized into groups to investigate each of the above objectives. The information for most of the above objectives was to be chiefly obtained from two survey questionnaires; an urban household consumption survey ("Urban Questionnaire"), and a survey of fuel preferences on household basis ("Rural Questionnaire") (see Chapter Three for further details).

3.1.2 Present Status of the Project

There has been very little analysis completed so far on the results of the questionnaires - apparently because of the high turnover in the group studying this aspect of the Project. The author was invited, at this stage of research, by Obafemi Awolowo University and the UNU to act as Consultant in the data analysis.

Insight into factors of the energy crisis in general, and the fuelwood problem in particular in the State of Oyo, was solicited from the preliminary findings completed at the expiration of the author's contract, in August, 1984.

The present thesis, therefore, arose, in part, from the need to thoroughly analyse the collected data to elicit a more realistic understanding of the rural energy situation in south-western Nigeria, and in part, to contribute to the overall understanding of the energy crisis facing other similar regions in the world.

3.2 *Thesis Objectives*

This investigation is undertaken to fulfill the following primary objective: the identification and understanding of rural energy issues involved at the village level, in two ecologically distinct vegetation zones in south-western Nigeria. This will be accomplished by:

(i) describing the social and economic characteristics and environmental context of energy use;

(ii) examining rural household energy use patterns, i.e. production, gathering, distribution, and consumption of different fuel types;

(iii) evaluating fuel preferences of the poor in rural households settings so as to gain information that might prove useful in guiding energy policies.

The implications of vegetation types of contrasting ecological zones in determining patterns of fuelwood production and consumption also constitute a major part of concern in this study.

The future thrust of this investigation concerns the issues that might be considered in arriving at an effective policy on rural energy development for south-western Nigeria in particular, and the whole country in general.

3.3 *The Research Hypotheses*

Difficulties in securing the necessary energy requirements in many of the rural areas in the Third World have resulted in environmental and developmental consequences. This investigation analyzes vital components (economic, social, cultural, ecological, etc.) of rural energy production and consumption in order to identify and assess issues guiding energy policy formulation. To accomplish this goal, the following hypotheses were set to guide research, data collection and analysis:

(1) The most common response to the energy crisis has been to implement conservation measures such as afforestation and appropriate technology (fuel efficient wood and charcoal stoves), to lessen the impact of the crisis and keep its growth in check. These measures - erected hastily as a 'treatment' response to the chronic problem of the energy crisis - often pay little attention to the social, economic, cultural and ecological processes which necessitated their creation and, therefore, they usually end in failure. In order to establish effective conservation measures, i.e., geared towards preventing the crisis from happening, it is necessary to have a priori knowledge of these processes in their relation to patterns of energy production and consumption. Patterns of user-fuel needs, fuel end-use, actual energy use, and preferred energy use must be determined beforehand. Particular attention must also be directed towards energy production, energy procurement and energy consumption.

(2) It is assumed that the rainforest has a wider energy resource base than the savanna. Therefore, inhabitants of the rainforest are provided with more alternative fuels for substitution than people living in the savanna or savanna-rainforest boundary. Given similar economic, social and cultural characteristics between the two environments, it is the ecology of the regions that will largely determine patterns of fuel consumption.

(3) It is often taken for granted that woodfuel use causes deforestation. However, a correlation between the continual use of woodfuel and deforestation does not establish causation. Causation can only be substantiated by a careful study of social and economic processes in which both woodfuel use and deforestation are taking place.

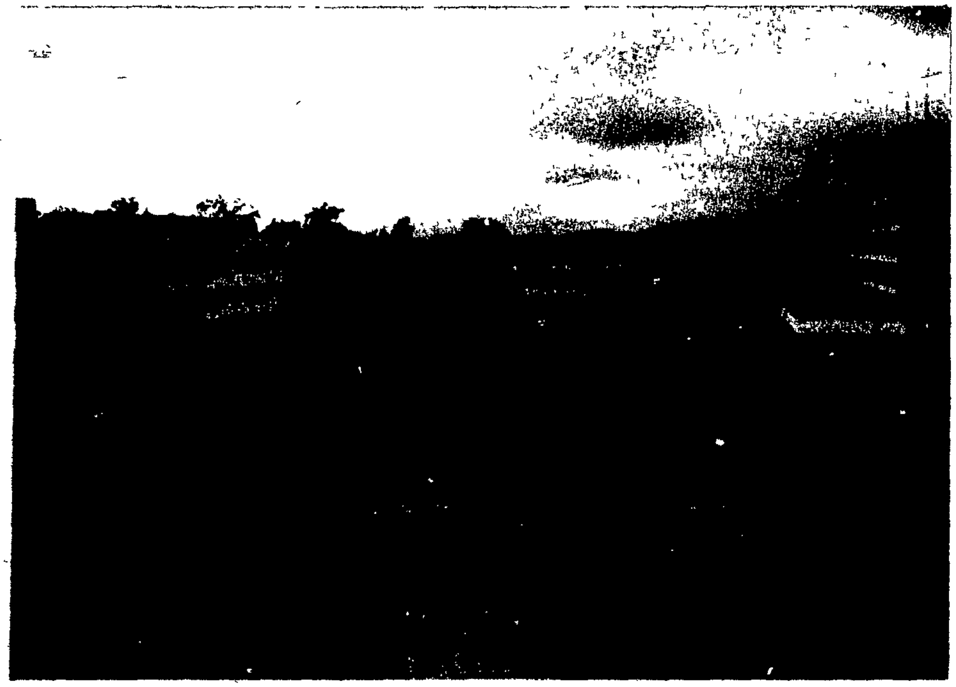

Figure 5 (above) and Figure 6 (below): Obafemi Awolowo University, Ile-Ife, Oyo State.

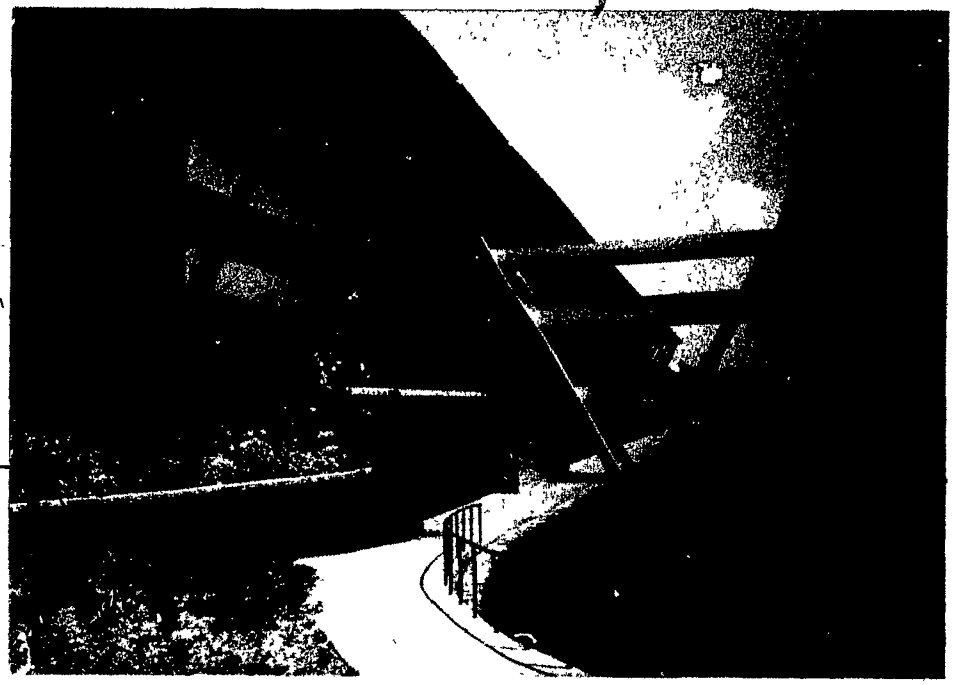

Figure 7 (above) and Figure 8 (below): Obafemi Awolowo University, Ile-Ife, Oyo State.

Chapter Four

THE STUDY AREA

This chapter, divided into two sections, provides a description of the location of the study area along with characteristics of its physical landscape (geology, soils, vegetation and climate). It also highlights the landscape under human settlement.

The first section is a profile of the country (Nigeria) followed by more specific information on the area of study (the state of Oyo, south-west Nigeria).

The material presented draws upon published and unpublished sources as well as field observations.

4.1 *General Background Information*

The territory of modern Nigeria, i.e., the Federal Republic of Nigeria, is made up of the former British colony, Nigeria, together with the northerly parts of the British Cameroon Protectorate. The country gained independence from Britain on 1 October, 1960, at which time it elected to remain a member of the Commonwealth.

Nigeria is located between four and fourteen degrees north latitude and three and fourteen degrees east longitude. Its estimated area of 923,773 square kilometers makes it the 13th largest country on the African continent and the largest of the West African coastal states. Nigeria's population in 1978 was estimated at 68.4 million - higher than any other African nation (cited in New African Yearbook, 1979, p.240). Current estimates, place the population at over 80 million (Nwafor, 1982).

Nigeria is bordered on the south by the Gulf of Guinea, on the west by Benin, on the north by Niger and on the east by Chad and Cameroon - all former French colonies. Moreover, the fact that trade and cultural contacts with the more distant English speaking countries of Ghana and Sierra Leone remain stronger than with those of its neighbouring countries reflects the economic and social ties inherited by Nigeria from its former British administrators.

4.1.1 The Physical Landscape

Geologically, Nigeria sits on the lower part of the great African continental plateau, with a gradient ascending from the north-west to the south-east. A long coastline with sandy bays, lagoons and mangrove swamps characterize the southern landscape of Nigeria. Slightly further to the north, tropical rainforest and swamps of the middle belt merge with woodland and savanna of the extreme northern region. The landscape is interrupted by a central plateau that reaches a height of 2,000 metres.

Numerous rivers traverse the Nigerian landscape. The principal rivers are the Niger - after which the country is named - and the Benue - its largest tributary. Both rivers have their sources outside Nigeria. The rivers systems empty into three major drainage areas; the Niger-Benue Basin in the middle and southern belts; the Lake Chad Basin in the north-eastern sector and; the coastal or Gulf of Guinea Basin to the south.

There are four dominant soil groups in Nigeria. Their distinct composition and structural characteristics correspond closely with the climatic and the vegetation zones of the country as well as with the topography and lithology (Barbour et al., 1982).

Soils found along the coast are either sandy or swampy and heavily leached of nutrients. Soils in the rainforest belt, derived from the weathering of old complex rocks predating the sedimentary rocks found elsewhere in the rainforest, support cacao trees. In contrast, soils derived from sandstone, do not. Forest soils under cultivation are characterized by a thin and fertile top layer - since a high percentage of the nutrient content is locked in the vegetation complex above-ground. Also, lateritic soils are found in areas which experience a markedly dry season. Unfortunately, the rich iron content of these soils and their hard texture make these areas less conducive for cultivation.

Nigeria enjoys a tropical climate with distinct wet and dry seasons. The duration and intensity of the seasons depend largely on the relation of the region to the sea along the southern shores, and to the Sahara along the northern borders. There are three distinguishing climatic patterns in Nigeria; in the south-east, a tropical wet climate with high uniform temperatures and heavy rainfall throughout the year; in the north and west, a tropical wet and dry or savanna climate; and, finally, in the far north, a dry or steppe climate (New African Yearbook, 1979, Barbour et al., 1982).

The two air masses that dominate the climate are the equatorial maritime and the tropical continental. The former is associated with the moist, rain-bearing south-west monsoon which blows from the Atlantic ocean, and the latter with the dry, dusty continental northeasterly Harmattan that blows from the Sahara desert. The fluctuating boundary zone between these two masses, often referred to as the Inter-tropical

Convergence Zone (ITCZ), largely determines the type of weather experienced at any given place in Nigeria during the course of the year.

The vegetation in Nigeria can be broadly classified into two types: forest and savanna. The differences in each of these categories is strongly reflected by the diversity of the existing flora and the structure of plant communities. The vegetation of a specific region is chiefly governed by the amount of rain that falls over that area. The decrease of rainfall from south to north, therefore, dictates the pattern of vegetation. The southern region is dominated by a rainforest complex. This gives way, further to the north, to a forest-savanna mosaic and in the more northerly areas to derived or Guinea savanna. In addition to rainfall, soil characteristics, drainage features and topography were also found to influence the variations in floristic composition of local environments (Barbour et al., 1982, Ojo, 1984).

4.1.2 The Landscape Under Human Settlement

Notable differences, in not only the physical landscape but also in social organization, religion, education and agricultural practices, exist between the northern and southern parts of Nigeria. These differences can be explained by a number of interacting factors. They could be attributed to the geography of the areas - in that the north is landlocked and the south is not. There are also cultural and traditional customs unique to each group. It is believed that these and other related causes have formed the basis of division of Nigeria into three principal regions that can be identified along physical and non-physical features - the southern belt or Guinea coastland, the middle belt and the northern belt - the Nigerian

Sudan.

The south is the most economically developed sector of Nigeria. Its forest resources are intensively exploited for commercial and private use by farmers and commercial plantations. The concentration in this region of major industrial centres, oil fields and sea ports is the highest in all of Nigeria. The southern belt is also characterized by three geographically distinct and dominant cultures; the Yoruba in the west; the Benin in the central part; and, the Ibo and Ibibio in the east.

In contrast to the northern and southern belts, the middle region is the least economically developed and the most sparsely populated part of Nigeria. It occupies two fifths of the total land area in Nigeria, yet it supports only one fifth of the total population. Its inhabitants are a mixture of about 180 linguistic groups (New African Yearbook, 1979). Few industries can be found in the principal towns of Jos and Kaduna. The region, however, gained new importance shortly after the national administrative re-organization of 1975, with the location there of seven out of nineteen state capitals. As well, plans to transform Abuja, a geographically centralized 7,300 square kilometers of territory, into the new Federal capital were to add to the administrative significance of the region. The project was, however, suspended in 1984 by the-then ruling military government of General Muhammed Buhari.

In the far north, the Nigerian Sudan owes much of its present economic pattern, namely agricultural trade with the south, to the construction of a railroad in the early part of the twentieth century which linked it to the southern coastal ports. The dominant inhabitants are a mix of Hausa (settled cultivators) and Fulani (cattle growing nomads) cultures, except for the State of Borno, which is overwhelmingly settled by the Kanuri people of the Lake Chad Basin. The region, prior to the coming of the railroad, maintained close trans-Saharan contacts with the Mediterranean and the Middle East - and with the Muslim Arabs. Islam was, therefore, adopted by the majority of the people as their religion. It is presently the dominant faith in the region.

Slightly more than eighty percent of the population in Nigeria live in rural areas (Abumere, 1982, Okafor, 1982). The variations in the types and structure of rural settlements to be found in any area reflect the intrinsic features of the culture and the physical environments. As these features themselves vary between the southern and northern zones, the types of rural settlements found there vary accordingly (Okpala, 1982).

Closely nucleated villages, for example, are found along the coastal areas of the Gulf of Guinea, in the Yoruba regions in the south-west and in the Hausa-Kanuri penetration in the far north. Settlements in parts of the south-east in the Ibo-Ibibio and Anang areas and in the Tiv areas of the middle belt, consist of dispersed homesteads called compounds. Each compound houses the immediate nuclear family and some relatives. A small garden which is cropped every year with maize, vegetables and yams encircles the compound. A number of congregated compounds make up the 'hamlet' or the village, which is usually inhabited by people who lay claim to a common ancestor, often the founder of the village for whom it may be named. The dominant features of the rural landscape, in the northern Sudan-savanna region, especially in the Hausa areas, are old nucleated villages with dispersed compounds (Okafor, 1982).

A vast majority of people living in rural areas continues to depend on whatever materials are available for constructing their homesteads. Housetypes, therefore, change as one travels inland. Along the coast, houses are constructed from bamboo stakes tied together with a rope and a roof consisting of bamboo leaf mats - materials taken from the indigenous raffia palm tree. Houses in the forest belt are made from mud, and the roofs are matted, but those who are more fortunate than others use corrugated iron sheets as roofing material (an excellent shield from the heavy rains). Houses in the savanna areas of the middle belt consist of round buildings made from mud roofed with sloping grass thatch. Further to the north, especially in the extremely dry areas, flat mud roofs are preferred.

A cultural feature common to all rural settlements in Nigeria is the presence of a village chief or a headman. He is often likely to be the oldest member of the community and rules by the consent of the people. In the Yoruba areas in the south-west and in most parts of the northern states, the village chief, a powerful man held in high esteem, can be chosen by or with the consent of the region's traditional ruler (New African Yearbook, 1975). Another common feature to village life is a system of organization by which people of approximately the same age are grouped and allocated community work.

Prior to this century, Nigerians with the exception of the Hausa, Yoruba, Kanuri and the coastal people of the Gulf of Guinea, were not, generally, town dwellers. The patterns and variations of the urban landscape are a direct result of a variety of interacting factors. These factors include traditional foundations based on cultural beliefs (Oguntoyinbo, 1982), the administrative and economic priorities of the former colonial administration (Ayeni, 1982), and distinct geographical conditions (Nwafor, 1982).

Although many of Nigeria's traditional towns are Yoruba in origin (the most urbanized people in tropical Africa), there are others that are not. Some traditional Yoruba towns include Ile-Ife (one of the three study zones in this investigation, and with a population estimated in 1980 at 175,000) and Oyo (150,000) - both located in the south-western state of Oyo. Nearby towns include Abeokuta (250,000) in Ogun State, Ogbomoso (also a study zone in this investigation with a population estimated at 430,000) - whose characteristics typify Yoruba towns in the forest-savanna boundary - and, Badagri (10,000) in Lagos state. Other traditional Nigerian towns include Maiduguri (the Kanuri capital of the north-eastern state of Borno with a population of 150,000), Sokoto (the Hausa-Fulani dominated capital of the north-western state of the same name with a population of 100,000). Almost all of the towns are several hundred years old, and their original functions as administrative and trading centres have been retained to the present.

Modern cities formed in direct response to the administrative and economic priorities of the British rule include Kaduna in the north, Jos in the middle belt, Enugu and Makurdi in the south-east and Port Harcourt in the far south. The impact of the colonial rule on the more traditional centres gave rise over the years of 'twin cities', one traditional and one modern (Nwafor, 1982). Their original purpose, as administrative centres, presently incorporates some aspects of industrialization. Examples of such cities include Ibadan and Benin in the south-west and Kano and Zaria in the north.

Lagos, the Federal capital, is regarded by many Nigerians as an exceptional urban centre. It was founded some 300 years ago as a small fishing and trading settlement on Lagos Island. It has now become the most industrialized city in black Africa. It boasts the greatest concentration of manufacturing industries, as well as a principal seaport, and an international airport. Lagos is also the location of the head offices of many leading business firms, banks, foreign embassies and international organizations.

Almost all Nigerians can be traced to more than 200 ethnic groups - each of which has its own customs, traditions and dialect. The four largest groups, making up about fifty percent of the total population, include the Yoruba (approximately 15,200,000 in 1982), the Fulani (8,000,000), the Hausa (15,000,000) and the Ibo (13,3000,000). Other prominent but less numerous groups are the Edo of Benin city, the Ibibio in the forest belt, the Tiv and Nupe in the middle belt and the Kanuri in the Chad Basin. The remaining smaller ethnic groups are highly concentrated in the middle belt.

English is the lingua franca of Nigeria. It is the language used by the government, business, the armed forces, academic institutions and the police. Although there are many local dialects, three African languages are more frequently spoken by the majority of Nigerians. Across the Nigerian-Sudan belt in the north, the prevailing language is Hausa, spoken by about 30 million people including the Fulani. It is also spoken in neighbouring countries across the border. In the south-west, the Yoruba people speak their own ancient tongue, a tonal language. In the south-east, Ibo is widely used by its own native people.

Patterns of population distribution and concentration in Nigeria are affected by a variety of factors that are physical, historical, cultural and commercial in character. Afolayan and Barbour (1982) identify three patterns of population density typical to Nigeria. They vary from areas of heavy concentration (about 300 persons per square kilometer), to areas of medium (150 persons per sq. km.) and low concentration (50-60 persons per sq. km.).

The areas of heavy concentration are markedly found in the south-eastern sector of the forest belt, particularly among the Ibo-Ibibio people, and towards the more easterly parts of the Yoruba sphere of influence. The population density in these parts has been observed to exceed 250 persons per square kilometer. In centres such as Orlu, Owigar and Ikeja, figures exceeding 400 persons per square kilometer were also recorded (Afolayan, 1982).

The areas of medium concentration are found in close proximity to the high density areas of the south, especially in the cacao growing areas of the Yoruba, where seasonal labourers from the congested zones of the Ibo-Ibibio migrate to seek employment. Comparable densities are also found in Jos, Kano, Katsina and in the vicinity of Sokoto.

The remainder of Nigeria, that is the northern parts dominated by the Hausa-Fulani and Kanuri communities and the middle belt of extremely mixed ethnicity, fall within the classification of low concentration. The causes for this low density are diverse and debatable. Explanation attributed to physical conditions characteristic to these regions include soil fertility, rainfall frequency and intensity, and the occurrence of diseases. Explanations often attributed to human factors, such as the slave raiding from the south and the Hausa-Fulani conquests from the north, have also been used to account for the sparse settlement of the area.

Census surveys, usually carried out once every ten years since the country gained its independence, have always been unreliable. Even so, sufficient evidence extracted from sample surveys shows that demographic trends in Nigeria do not differ much from those in neighbouring African countries. High birth and mortality rates are the characteristic features although, since about 1950, a considerable decline in the rate of infant mortality has been observed. Consequently a rapid growth in the population was reported to be nearly 55,700,000 in the 1963 census. Using a conservative growth rate of 2.5 percent per annum for all of the country, with the exception of Lagos for which the rate is estimated to be about 4 percent as a result of migration from the hinterland, it is inferred that the population of Nigeria, in 1980, was some 84,730,000 (New African Yearbook, 1979, Nwafor, 1982).

4.2 *Specific Background Information: The State of Oyo, South-western Nigeria*

The specific area of investigation is the state of Oyo - a dominantly Yoruba speaking region in south-western Nigeria. In particular, the study concentrates on the villages and the farmland in the vicinity of the three major towns of Ile-Ife, Ibadan, and Ogbomoso (Figure 2). Although the main focus of the study places much emphasis on the rural areas, where the majority of the people live, it is assumed that these rural areas interact with the neighbouring urban centres.

Taking into consideration the importance of the towns as dominant urban centres in the state of Oyo, the research areas will, henceforth, be referred to as the Ife, Ibadan and Ogbomoso zones. Furthermore, the definition of each zone was formulated on the basis of convenience in executing the investigation, rather than on geographical features or political factors. The boundaries of the zones, consequently:

> "...do not conform with recognizable geographical phenomena, nor with political boundaries, but mainly with the degree of accessibility from the urban centre determined mainly in terms of the availability and quality of the network of roads and also in terms of the physical distance from the focal metropolitan centres" (Ojo, in press).

4.2.1 Characteristics of the Rainforest Zone

The physical landscape of the forest zone in the area of study consists of an undulating plateau which culminates into low lying hills east of Ile-Ife. The types of rocks and rock formations usually found in this zone include gneiss and acidic granite with various types of quartz and schists. The soils observed in the field are ferralitic (iron rich) with a good structure and an adequate content of organic matter, especially concentrated in the upper layers and on the surface of the soil. The vegetation in this zone is dominated by a dense tree cover in addition to low lying shrubs and geophytes, typical of lowland tropical rainforest communities (Figure 9-12). Some of the more than fifty tree species identified in the rainforest include dominant varieties such as <u>Terminalia superba</u> and <u>Chlorophora excelsa</u>, and, in the less humid environments, <u>Triplochiton sclerroxylon</u>, <u>Albizzia ferruginea</u> and <u>Celtis</u> (Aubert and Benneh, 1982, Adejuwon, in press). In some parts of the study area, especially east of Ibadan and west of Ife, the natural vegetation has been removed and replaced by tree crops such as cacao and kolanut. Ojo (1984, p.8) observes that "as much as 25 percent of the Ibadan area and 27 percent of the Ife area is under tree crops". Over the remainder of the land, secondary forest and the 'rotation' or 'bush fallow' system prevail.

In addition to the above-mentioned species, other tree varieties peculiar to secondary growth include species of Futumia, Ficus, Elaesis, Musanga, Harungania and Magnifera (Aubert & Benneh, 1982). The bush fallow system in this ecological zone is characterized by a relatively shorter period of fallow. Whereas in the past the length of fallow was slightly more than ten years, at present, it does not exceed five to six years alternating with three or four years of cropping (Aubert & Benneh, 1982). The main crops cultivated include staple foods such as yam, manioc (cassava), legumes and maize.

In areas north of Ibadan, the influence of human action on the vegetation is particularly noticeable, where:

> "...persistent clearing and cultivation of the land coupled with annual bush fires during the dry season, has led to the establishment of patches of grassy vegetation within the forest belt" (Ojo, in press).

The prevailing climate of the rainforest zone has uniform mean monthly temperatures of about 27 degrees Celsius, and mean annual rainfall of about 1,500 mm. Humidity in the rainforest is always evident, even in the dry season, due to the presence of the maritime tropical air mass blowing from the coast.

Figure 9 (above) and Figure 10 (below): Tropical rainforest in the Ife and Ibadan zones.

Figure 11 (above) and
Figure 12 (below): Tropical rainforest in the Ife and Ibadan zones.

4.2.2 Characteristics of the Derived or Guinea Savanna Zone

The town of Ogbomoso lies in the derived savanna vegetation zone within the rainforest-savanna boundary. This area is dominated by grassy vegetation and species of fire-tolerant trees (Figures 13-16). The term 'derived' refers to the accepted view that the existing diversity of flora found in the zone owes much of its composition to the rainforest vegetation climax from which it was derived - through the agency of human activities (Ojo, in press). Unlike the soils underlying the rainforest community, those found in this zone are leached iron dominated ferriginous soils. In some valleys, alluvial soils are also present. Various grass species of the savanna woodland, reflecting the characteristics and status of the soil, drainage conditions, and the attributes of topography - all of which affect the frequency of cultivation - dominate the vegetation complex. Dense forest vegetation such as tall Andropogon for example, are endemic to richer and heavier soils, whereas Heteropogon and Aristida flourish on degraded soils (Aubert and Benneh, 1982). Shrubs of different categories, however, intermingle with cultivated species such as Butyros, Parkia, Acacia, Blighia, Chrysophyllum and Manifera, especially when those crops are grown near settled areas (Ojo and Adejuwon, in press).

Rural farmers who often make their living by planting cash crops such as yam, maize, cassava, and tobacco in the areas where soil is degraded, adopt the 'rotational' or 'bush fallow' system of farming Ironically, removing nearly all the trees from large fields west of Ogbomoso, to allow for a mechanized form of farming, exacerbated local soil conditions.

Figure 13 (above) and Figure 14 (below): Rural households in the Guinea or Derived savanna vegetation mosaic.

Figure 15 (above) and Figure 16 (below): Rural Households in the Guinea or Derived savanna vegetation mosaic.

Climatically, the region is a good example of a tropical savanna climate with high temperatures reaching an annual mean of 28 degrees Celsius and mean annual rainfall of about 1300 mm. However, the dry season in Ogbomoso, compared to the Ife and Ibadan zones, tends to be longer since the incursion of the continental tropical or the dry Saharan air mass, over the Ogbomoso zone, is of a longer duration.

4.2.3 Description of the towns and Settlement Patterns

In order to assess to what degree the three zones under investigation have been performing as centres of rural energy production, distribution and consumption, a brief description of their origin, size and location characteristics is outlined below.

The Ife Zone

The town of Ile-Ife (Ife) is regarded by the Yoruba people as their spiritual centre and ancestral home. With a population of about 130,000 in 1963 and nearly 200,000 in 1980, it is the largest and most dominant urban nucleus within the Ife zone. Other large settlements such as Asipa, Edunabon, Olode and Ifetedo in addition to villages (compounds) of relatively smaller size, also dot the landscape (Fig. 17). A characteristic feature of the settlements, especially the smaller villages, is their location near tarred, secondary roads or to primary trails or footpaths that link up to the main arteries.

The pattern of settlement distribution in the zone reflects the prevailing economic activity of the area; cocoa farming (Barbour et al., 1982, Aubert & Benneh, 1982, Ojo, in press). Other mainstay economic activities include the widespread trading of consumer goods and agricultural products. Recently introduced small-scale modern industries, such as baking, brick-making, printing, carpentry and blacksmithing also prevail in and at the perimeter of the town of Ile-Ife. In addition, medium sized settlements such as Asipa and Olode are also the locations of saw-milling activities - usually restricted to the main roads leading to these centres.

The Ibadan Zone

Ibadan, the principal city in the zone and the largest indigenous settlement in tropical Africa, was founded in the early part of the nineteenth century near the southern edge of the rainforest-savanna belt. Its original status as a city state was later changed to that of a fortress as a result of Yoruba migration fleeing from wars that eventually brought the collapse of the old Yoruba empire (New African Yearbook,1979, Ojo, in press). Ibadan, over the years, has been attracting and retaining migrant workers - who swelled its population to over 1,000,000 inhabitants. Other towns of considerable size found in the zone include, Lalupon, Ejoku and Ojou.

The pattern of settlement in this zone is similar to that of Ife but with one exception, the presence of a more developed network of tarred roads that closely link the surrounding villages to nearby urban nuclei (Figure 18).

Preferences for cash crops differ between the northern and southern sectors of this zone. People living in the north are more likely to engage in activities producing cassava, plantain, yam, maize and vegetables to sell in the town market. Conversely, the principal agricultural products of the southern sector are basically tree crops such as citrus, kolanut, coffee and cacao - the most profitable of cash crops.

In contrast to the other urban centres in the zone, Ibadan has a broad, established industrial base. In 1963, there were slightly over forty such industries, and since 1973 the figure rose to over eighty establishments. Small-scale commercial retailing and industrial activities, especially saw-milling, also dominate the medium-sized towns in the zone.

The Ogbomoso Zone

As a principal urban centre, the town of Ogbomoso owes much of its present character to the customs and traditions it inherited from the Islamic Fulani Jihad (holy wars) of the early 1800's. The pattern of settlement in this zone is slightly different from the other two zones in that there is a more even scattering of the villages - with the exception of some clustering in the eastern and south-western areas of the zone. Settlements on the whole are located near to each other along the principal Oyo-Ogbomoso road (Figure 19).

The main occupation in the rural areas is farming. Food crops such as yam, cassava, beans, maize, guinea corn, cotton, citrus fruits, pepper, mango and tobacco are grown for trading and selling. Small, local industries are also found in nearby towns. The location of Ogbomoso in the forest-savanna boundary makes it an ideal trading centre linking northern Nigeria to the south.

The cultural identification of its Fulani inhabitants with the people in the far north has evolved over the years into a system of commercial ties. Goods from the south and south-west pass through Ogbomoso and are transported to the northern parts of the country. A widely sought southern crop by the northerners is the kolanut, a fruit revered for its stimulant properties.

4.3 *Summary*

This chapter briefly highlights the more important features of Nigeria in general, and the state of Oyo in particular. It places the rural energy situation of south-western Nigeria in the context with which it occurs with respect to other parts of the country.

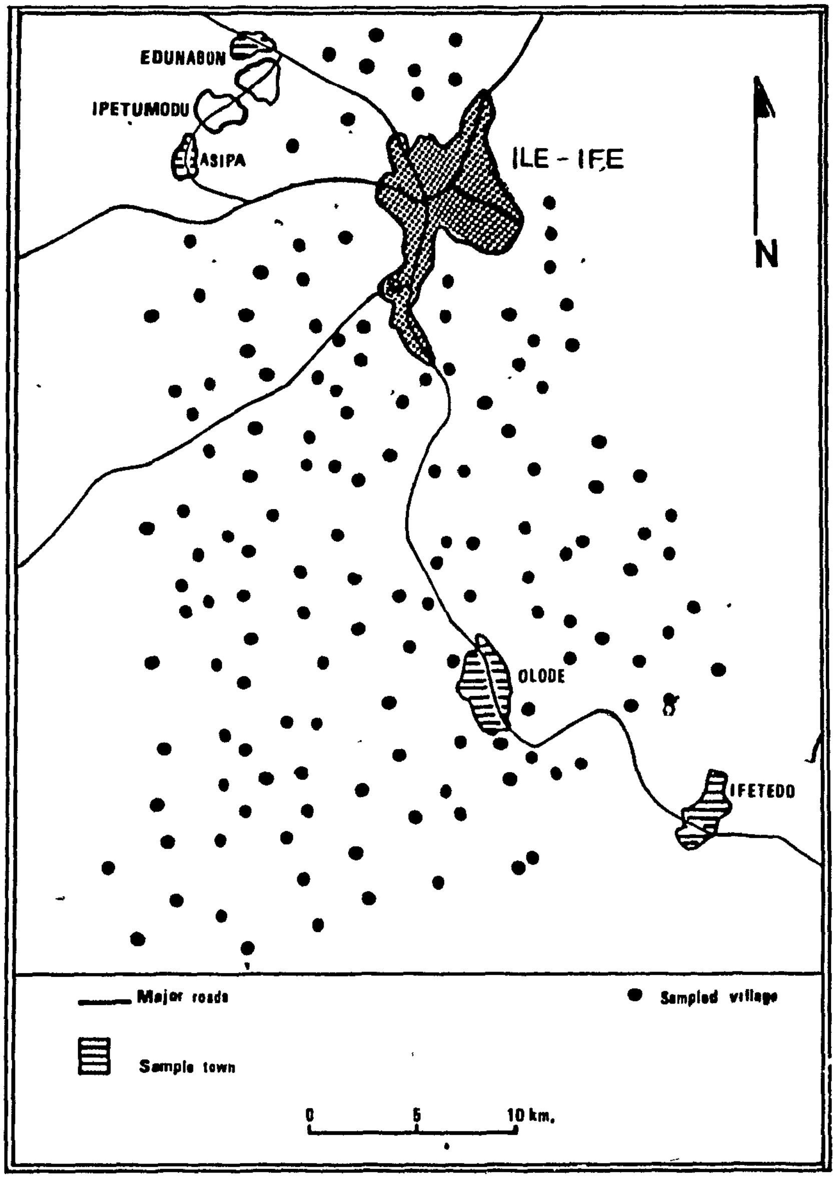

Figure 17: The Ife Zone (Adapted from Ojo and Adejuwon, in press).

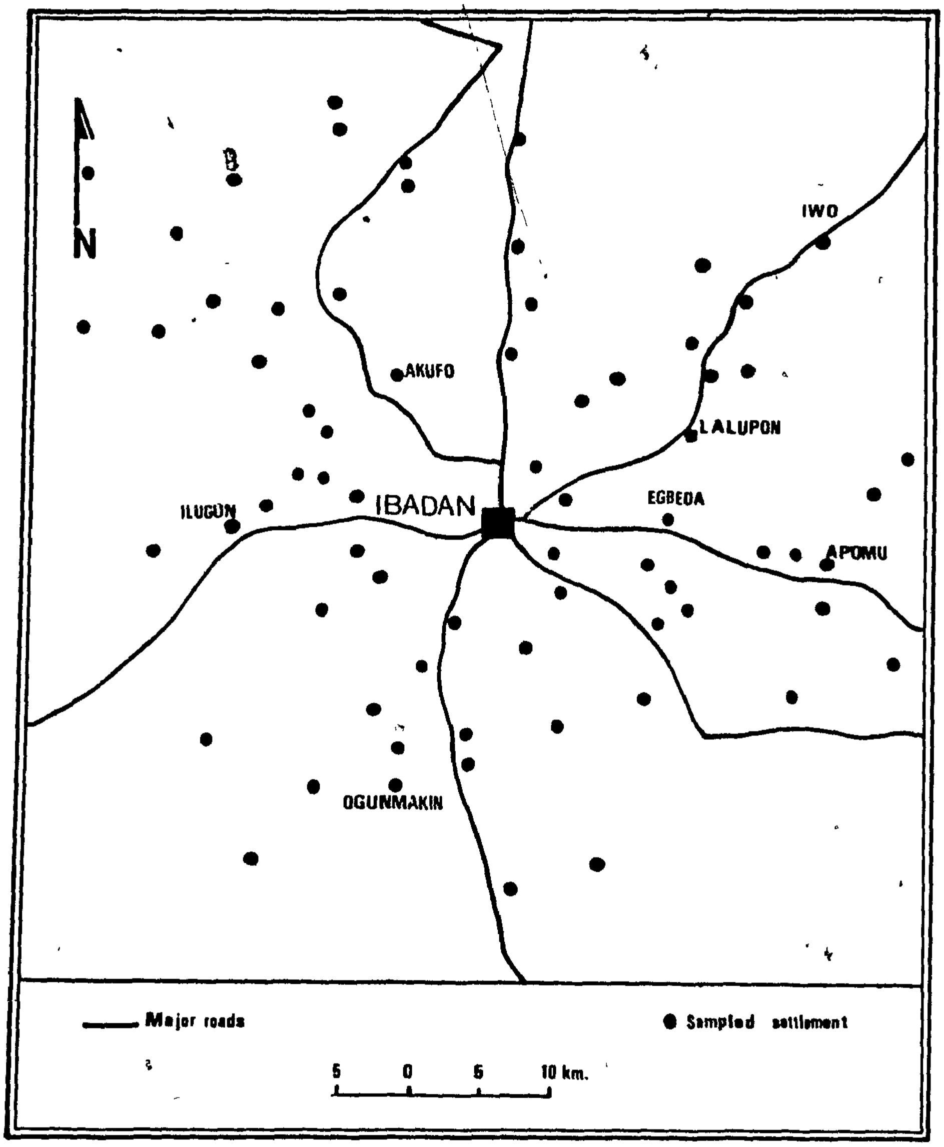

Figure 18: The Ibadan Zone (Adapted from Ojo and Adejuwon, in press).

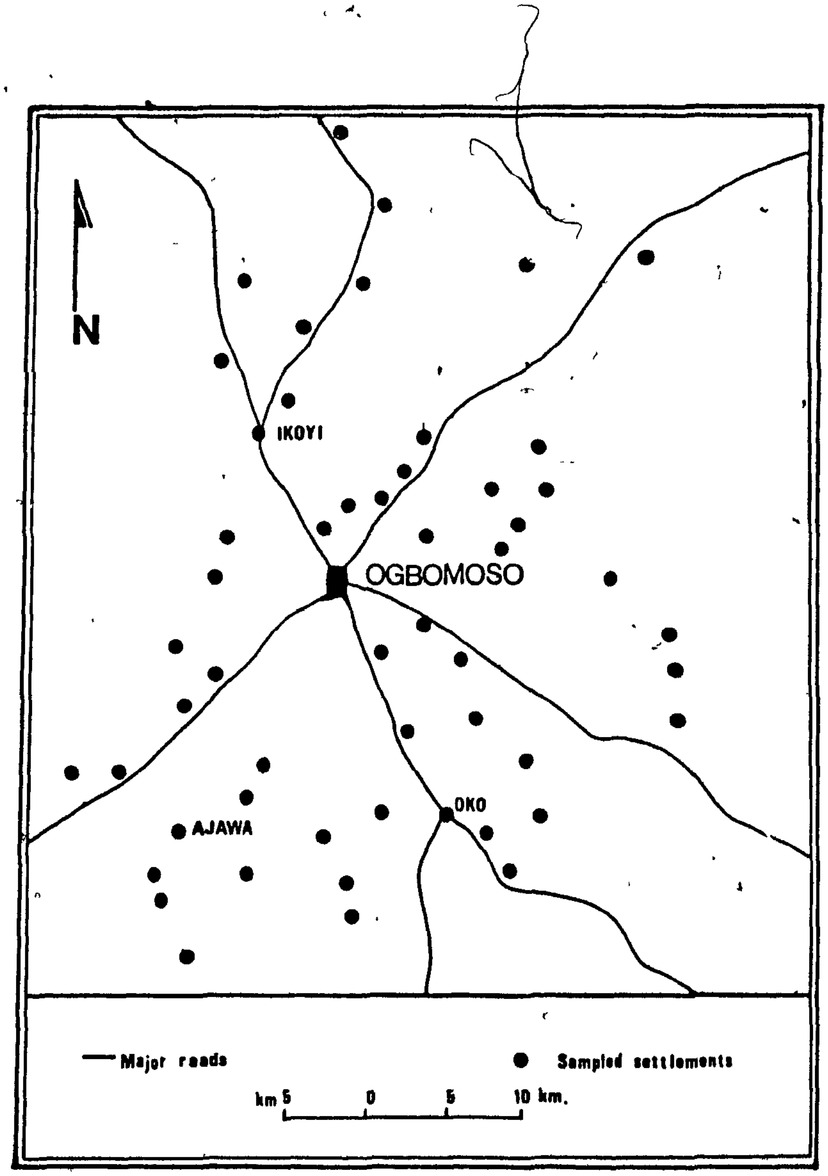

Figure 19: The Ogbomoso Zone (Adapted from Ojo and Adejuwon, in press).

Chapter Five

METHODOLOGY AND FIELDWORK

The collection of data on energy consumption and fuel preferences by the rural poor in the State of Oyo, south-western Nigeria was undertaken in early January 1979 by one of the five groups of the Rural Energy Systems team based at Obafemi Awolowo University. The information was gathered through a survey questionnaire (see App. A). The survey addressed issues pertaining to rural energy uses and preferences by households in villages encircling the towns of Ile-Ife, Ogbomoso and Ibadan. originally headed by Professor Ojo began the task of collecting the data following satisfactory pre-testing of the questionnaire.

5.1 *The Rural Survey Questionnaire*

The rural survey began in the Ife zone with a sample size of about 25 percent of the total number of villages in this zone, and with nearly 33 percent of the households per village (or 8 percent of the total number of households in the zone). Households for the investigation were randomly selected from a census list compiled around 1978 during the registration for national elections.

Statistically, the large sample size chosen for this study is justified if one takes into consideration the number of questionnaires that may have to be omitted from the analysis because of the possibility of not having all the questions completely answered, and the desire to definitively document all aspects of the energy situation in the area. Upon completion of sampling in the Ife zone, it was decided by the survey group that relatively smaller samples, two percent of the total number of households for the Ibadan and Ogbomoso zones, would be just as effective in gathering information and would be unlikely to affect the validity of the results (see also Chapter Six).

5.1.1 Rural Survey: Criteria for Sampling

The sampling techniques employed in the selection of villages in the Ife, Ibadan and Ogbomoso zones were not rigid, but rather reflected the particular characteristics of each zone. In the Ife zone, for example, an initial sample size of one in four villages was set - based on a settlement map of the zone documenting a total of 545 villages (Ojo, in press). It was learned, however, from pilot-surveys, that some villages isolated from primary and secondary roads became inaccessible during the rainy period. Therefore, a decision was made to select:

> "about one third of all the villages, subject to certain constraints ... to be able to obtain successful interviews from about a quarter of the total number of villages" (Ojo, in press).

The constraints imposed are as follows:

i. a systematic sampling consisting of every fifth village located along the forty six roads forming the network of roads in the study area;

ii. in order to nullify any bias that may result from the systematic sampling procedure vis-a-vis the variation along the roads, every village along two randomly selected roads was also to be included in the survey,

iii. taking into consideration the possible irregularities in the spatial variation of the spread of villages along the roads, a map of the area was overlaid with a grid system consisting of forty five equal squares where a village (not already represented) was randomly selected from each square. This was to further offset any inherent bias ascribed to the sampling technique, as well as to provide a sample of villages representative of the true situation in the zone.

The road network, as can be observed from the constraints listed above, was given some relevance in the selection of villages. This was in accordance with empirical evidence which suggested that the villages located near roads actively participated in firewood procuring practices to supplement their requirements for fuel from nearby towns.

Using the above criteria, therefore, a total of 172 villages was selected from the settlement map, of which 143 were surveyed via the rural questionnaire.

The selection of settlements in the Ibadan zone employed similar sampling procedure and constraints as those in Ife. However, the large spatial extent of the settlements comprising the villages and hamlets found in this zone, made it necessary to consider an additional framework for the sampling technique. Since villages located within a forty kilometer radius from the city of Ibadan interacted very heavily with it, and villages beyond the forty kilometer radius gravitated toward other fairly large urban centres, it was decided "to restrict the selection of settlements to an outer limit not exceeding forty kilometer radius from the centre of the city [Ibadan]" (Ojo, in press).

Applying the above additional framework, and systematically selecting every third village along the ten main roads radiating from the city of Ibadan, as many as 114 villages fell within the sample. Also, in order to ensure a representation in the sample of settlements found elsewhere other than near roads, an additional framework was inserted in the sampling procedure (Ojo, in press). It consisted of:

i. a series of concentric circles, equivalent to 10, 20, 30 and 40 km radius from the city centre which were drawn over a settlement map of the zone,

ii. measuring angles 36 degrees apart, ten equal divisions were obtained. Each division contained four sub-divisions with their area increasing outward. Thus, the outer sectors were much larger than the inner ones,

iii. thirty new settlements, one from each of the thirty inner sectors, and twenty settlements, two from each of the ten outer sectors which were randomly selected (to reduce any bias in the sample that could have arisen as a result of the relatively larger size of these sectors and their greater distance from the city centre).

Therefore, with the 114 villages selected using systematic sampling and the 50 additional settlements chosen by the above stratified procedure, a total of 164 villages was surveyed in this zone.

The sampling procedure and methodology employed in the selection of settlements in the Ogbomoso zone paralleled those employed in the two other zones. A total of 573 villages was selected, of which 57 settlements were surveyed. In addition, 48 villages were chosen from the ten major roads (up to a limit of 30 km radius) from the town periphery, and nine new ones were obtained by sampling in sectors between the roads - which have not been previously represented.

The principal manner by which information was collected was through private interviews of the heads of households by carefully selected and trained personnel. Members of the research team took into consideration the various methodological difficulties that were likely to be encountered in the carrying out of such surveys. They also made every effort possible to avoid falling into pitfalls that were only too easy to underestimate. For example, in conducting the survey, interviewers were often unable to locate the respondents when they went to question them, even though appointments were made earlier. By the time the interviewers had reached the villages early in the morning, most of the male inhabitants had already left for the fields, and their spouses who had remained behind hardly ever cooperated in the absence of their husbands.

Accessibility to the villages in the wet season (May - October) also posed a problem, especially in the scheduling of the interviews. Poor road conditions and old; decayed bridges weakened by the heavy rains made it virtually impossible to reach some villages, except perhaps on foot. Other problems, usually associated with data collection of this kind, include; fear of taxation (a number of respondents believed that the surveys were actually a way by which the government obtains information for taxation purposes); general reluctance by local inhabitants to cooperate; and, inability to locate some villages because their names had changed since the time the maps employed in the survey, were compiled. Nonetheless, depending on the time of the interviews and the financial resources available to the interviewers, most of the difficulties encountered were surmountable.

5.1.2 Particulars of the Rural Questionnaire

The rural questionnaire consists of three sections. Section A sought information on household characteristics. Since familial ties are strong among the Yoruba people, it was essential to use 'household' (or house) as a suitable unit of social organization through which information on fuelwood and other traditional sources of energy can be extracted. For the purpose of this investigation, the term household has been defined by Ojo et al. (1981, p. 87) as:

> a relatively standard feature of social organization which may consist of one or more nuclear families [living together in the same dwelling], but at the same time under only one recognized head, the landlord, or in a few cases, the landlady.

The study further places a single residential building in the category as a household.

Section B asked questions pertaining to the social and economic characteristics of the respondent such as age, sex, level of education, occupation, income level, marital status, etc. Furthermore, it was resolved that respondents should be in a position in which they could provide information and speak with knowledge on behalf of their dependents.

Section C, the remaining items of the questionnaire, sought information on energy consumption and fuel preferences by household members and elicited their opinions on fuelwood issues. Particular attention was accorded to existing and future positions of fuelwood in relation to other sources of energy use.

In essence, the questionnaire was deliberately simplified so as to maximize the number of returns with as little unbiased information as possible. Attention was given to the different income levels of respondents in rural areas, including those of relatively low to non-existent institutional educational background.

Criticism of the rural survey with regard to the techniques used in the collection of data mainly focused on the characteristics of the interviewers and their behaviour during the interview. In total, over thirty assistants with a university education underwent a training session where the objectives of this project were outlined and their tasks as interviewers specified. Special care also went into elaborating and discussing each question and how to place it to the respondents. There were as well, excursions to the villages beforehand to introduce the interviewers to the village chiefs.

The statistical lessons learned from the survey were tacitly incorporated into the criteria and formulation of a latter questionnaire on urban patterns of fuel consumption. The results of that questionnaire still awaits analysis. The findings of the analysis will further the understanding of rural energy systems in south-western Nigeria significantly.

5.2 *Data Base Limitations*

> "The importance of statistics in the research process is sometimes exaggerated by the emphasis given to it in graduate curricula. Statistics proper does not include measurement problems such as the construction of indices or the scoring of items on a questionnaire. Rather, statistics involves a manipulation of numbers under the assumption that certain requirements have been met in the measurement procedure .... Statistical considerations enter only into the analysis stage of the research process .... Obviously, problems that will be encountered in analysis have to be anticipated in every stage of the research process, and in this sense statistical considerations may be involved throughout" (Blalock, 1979, p. 7).

Prior to conducting the survey, no other parallel study of similar depth and extent had ever been undertaken. Undoubtedly, pilot surveys are an excellent source of a priori information of the difficulties that will likely be encountered during the actual larger surveys. They enable the investigator to coordinate available research resources and integrate the proper statistical techniques into the research methodology with minimal difficulties, before carrying out the investigation. Unfortunately, the degree of effectiveness of pilot surveys is more readily discernable after the results of the main survey have been gathered and prepared for analysis.

5.3 *The Coding Scheme of the Questionnaires*

The procedural stage that followed the collection of the survey questionnaire focused on weeding out and discarding 'doubtful' material attributed to bias from questions that could have been interpreted in several ways. The source of the questionnaires' shortcomings include; questions whose meanings may be misconstrued so as to invite social discomfort between the interviewer and the respondent; questions of a hypothetical nature; and, language problems arising from uncertainty in the interpretation from English to Yoruba and vice versa.

This process of carefully collating the returns to represent as much unbiased information as possible, and adopting a scheme to code the data was undertaken by the principal research investigators. At a later stage, and working in the capacity of Consultant for the United Nations University, the author assisted in further preparation of the data for computer analysis, and carried out preliminary testing of the results.

The coding scheme of the information collected was chosen to conform to the requirements of the statistical computer programme selected to aid in the analysis - the Statistical Package for Social Science (SPSS). The response to the questions were mainly alphanumerically coded. For example, a 'yes' or 'no' question was accordingly coded a '1' or '0'.

Employing punched computer cards of 80 columns as the medium of initially inputing the data (they were later transferred onto a magnetic computer tape), each rural questionnaire was coded on three cards (see Chapter Six for further details).

5.4 *Summary*

An understanding of the complex web of relationships between the social, physical, and cultural dimensions of rural energy, and how these relationships are 'measured' in the Third World, is imperative to the understanding of the energy crisis facing these less fortunate regions. Hence, an overview of the current issues and methodologies of conducting rural energy surveys in the Third World was briefly outlined in Chapter Two. The methodology and fieldwork undertaken in this investigation were also described.

Chapter Six

RESULTS, ANALYSIS AND DISCUSSION - RURAL HOUSEHOLD FUEL PREFERENCES AND ENERGY CONSUMPTION SURVEY

This chapter documents the findings of the Rural Household and Energy Consumption Survey (App. A), which is the basis for the analysis of the research hypotheses (see section 3.3).

Sampling is an integral component of modern research methodology. A properly designed and selected sample is crucial to the success of most research. The 6293 questionnaires administered in the rural surroundings of Ile-Ife, Ibadan and Ogbomoso, along with their coding scheme, resulted in a large data set (18879 records by 80 columns per record), which required substantial and costly computing. The size of the data set also presented problems of computer space in that it conflicted with the limits placed on it by most statistical packages.

Although the above restrictions could have been overcome, a decision was made by the author to obtain a smaller sub-sample - about 5 percent. The conditions imposed on the smaller sample were twofold; it should conform to computing and statistical package restrictions, and yield results that are as statistically sound as those obtained from the larger, original data set. After all, statistical packages tend to emphasize analytical rather than sampling functions, and, therefore, regardless of the sample size and provided that analytical procedural restrictions are met, the results are often similar.

After consultations with the author's supervisor and computer programmers at McGill University, it was agreed that a sample size of 100 questionnaires for each of the rural zones would be sufficient to carry out the analysis. The Exact-size Random Sample procedure, a sub-programme in the Statistical Analysis System (SAS) package, was employed to process the large data set and randomly draw the 300 (total) questionnaires (1).

The following sections represent the findings of the survey in the three zones. These findings comprise of zones analyzed individually and in combination (i.e. all the three zones yield a single value). Discussions of the primary and subsequent analysis are also presented and accompanied by the author's commentaries on the findings.

6.1 *Survey Results: Trends and Indicators*

Conventionally, the first task of data analysis is to determine the basic distributional characteristics of each of the variables to be used in subsequent statistical analysis. Information on the distribution, variability, and central tendencies of the variables provides the researcher with crucial information required for selection of subsequent statistical techniques.

The Statistical Package for the Social Sciences (SPSS) provides a sub-programme by which information on the distributional characteristics of the variables - largely dependent upon their measurement level - may be obtained (2). This sub-programme - FREQUENCIES - computes and presents one-way frequency distribution tables for discrete or categorical variables, which is in agreement with the coding - scheme of the variables adopted in this research.

The findings that follow present descriptive statistics of the variables in the Rural Household Fuel Preference and Energy Consumption survey questionnaire.

Particulars of the Household

Findings of some variables, such as the names of the settlement, local government area, and ward or compound are not examined - as they do not provide information pertinent to further statistical analysis. However, information on almost all of the remaining questions in the survey, necessary for subsequent analysis, is outlined.

The prevailing form of house architecture in the study areas consists largely of low-lying, single-story structures. The values presented in Table 6.1 (App. B), indicate that as much as 95 percent of total respondents live in single-storied detached and joined bungalows. Whether they live in these accommodations as a single family unit or share it with others is mainly reflected at the zonal level of analysis. For example, in the tropical rainforest zones of Ile-Ife and Ibadan almost equal weight of about 50 to 50 percent is observed between detached, single-storied, single-household bungalows and joined, single-storied with more than one-household. In contrast, a decisive majority of 74 percent of respondents in the Ogbomoso zone live in joined houses in multi-family units.

An explanation for this difference can be found by observing the maps of the study zones (Fig. 4.3). Relative to the other zones, most of the households sampled in the Ogbomoso zone are located on the higher value land adjacent to the major roads. It is, therefore, less costly for families to live together in that they can share in the household expenses incurred.

Of importance to the energy requirements in domestic food preparation, cooking for several households at the same time is more fuel-efficient than cooking for a single family (see also Ayoub, 1986). It was observed that a single family unit is, on average, made up of three adults and five children (Table 6.2, App. B).

Regardless of zonal differences in housetype, more than 75 percent of the houses consist of four to six rooms, individually occupied - although children are more likely to share the rooms (see Tables 6.3 and 6.4, App. B). This particular room arrangement contributes significantly to higher heating costs during the chilly nights in the Harmattan period in that the benefits that could be derived from the proximity of these rooms to the occasional fires in the kitchen are diminished - as over 55 percent of the kitchens are housed in separate buildings detached from the main house (Tables 6.5 and 6.6, App. B). Unfortunately, cooking inside the main house also has some disadvantages in that it imparts heat as well as smoke to the house environment during the stifling hot and dry Harmattan days.

A closer examination of Table 6.5, however, reveals that the kitchen arrangement in the Ogbomoso zone is equally divided - at 45 percent - between those housed separately outside, and those located inside, as part of the main house. The small difference in these values between Ogbomoso and the other two zones benefits the people living in the former zone as ranges in daily temperatures throughout the year are greater in the 'savanna-type' environment, and, therefore, kitchens inside the house contribute more to space heating.

Space-heating in the cooler periods of the day is further enhanced by the material used in constructing the house. Mud layers, with and without cement plaster, are the almost exclusive house-wall material used by nearly 85 percent of the respondents (Tables 6.7, App. B). Dry mud, with cement plaster as a cover, is a good retainer of heat and, therefore, an added advantage in preventing heat generated within the house from escaping.

Although a kitchen inside the house has its disadvantages as outlined above, its advantages, relating to fuel efficiency, are more significant in that fuel requirements for cooking and space heating - two basic domestic energy needs - are met simultaneously during cooking inside the house. This form of fuel application maximizes fuel efficiency and lowers the overall demand for fuel supplies.

Rural supply of electricity in Nigeria in general, and in the three study zones in particular, is lacking. Of the 300 households sampled, 262 or 87 percent are without electricity (Table 6.9, App. B). The findings are more prominent in the Ogbomoso zone where nearly all rural households are without supplies. These low values reflect the ineffective state of rural electrification projects in Nigeria (4).

Likewise, a comprehensive scheme for rural supply of water is not presently under consideration. Nearly 80 percent of total respondents fetch their water from nearby streams and rivers (see Table 6.10, App. B). A closer examination based on zonal differentiation reveals as many as 32 percent of inhabitants in the Ibadan zone - eight times more than the combined total of the other two zones - also depend on groundwater pumped from wells as an additional source of supply. The large difference observed here may be correlated to the proximity and adherence of the rural environment in the Ibadan zone to its sprawling urban centre, in that the town of Ibadan is able to provide its rural surroundings with a wider base of information and material supplies to build wells than the smaller towns of Ogbomoso and Ile-Ife. These values also indicate that although rainwater is an important source for both drinking and washing, it is linked to the frequency of rains and synoptic weather conditions, unlike the dependent supplies fetched from streams and rivers.

Rural Energy and Socio-economic Characteristics

Section B of the questionnaire elicited information on respondents' social and economic characteristics such as gender, age, education level and income bracket. Earlier surveys in rural energy-related studies have demonstrated the significance of these variables in energy systems analysis in the Third World (for more information see Chapter One). Income level in Kenya, for example, has no demonstrable effect on firewood consumption but was found positively related to paraffin or kerosene consumption (O'Keefe and Raskin, 1985). It is, therefore, crucial in documenting energy consumption patterns that similar information is obtained on respondents in the three zones being investigated.

Regardless of zonal differentiation, nearly 90 percent of respondents are married men between 40 to 60 years of age (Tables 6.11-6.13, App. B) (5). Many of them, about 85 percent, are landlords (or landladies) without any formal education. There are some (10 percent), however, that have some primary level of schooling (Tables 6.14 and 6.15, App. B).

A closer examination of Table 6.15 also reveals demonstrable differences in education levels of the respondents in the Ibadan zone compared to those in the other zones. As many as 10 percent of people in the former zone have at least graduated from primary school. This may be, again, a possible influence of the proximity of the surrounding villages to Ibadan - a relatively large urban conurbation.

Results of respondents' occupation (Table 6.16, App. B) deviate between the Ibadan zone and the other areas. The major occupation of rural people is farming (73 percent) followed by small-scale business and trading (15 percent). In the environs surrounding Ibadan, however, only 60 percent are farmers and nearly 34 percent are either artisans and small-scale traders. Conversely, as many as 80 percent and 14 percent respectively in the Ife and Ogbomoso zones are farmers, artists and traders. The differences in occupation between these zones reflect the response for a diversified labour force created by large urban centres. There are more opportunities for different occupations in the Ibadan zone because of the proximity of the villages to the densely-populated city of Ibadan. Irrespective of occupation, however, the annual income level of over 94 percent of respondents is below 2,500 Naira (Table 6.17, App. B) (6)(7).

In the politically and economically volatile Nigerian society, the 'purchasing power' of 2,500 Naira will vary according to political and economical trends. For example, following the Buhari military coup in early January, 1984, prices of rice, detergent, bottled gas, kerosene and other basic foodstuff and essential items were increased threefold (8).

Rural Energy Use, Ranking and Preference

Cooking and lighting are the main domestic activities that consume energy. In the industrialized countries these activities are almost exclusively fuelled by electricity - hydropower and nuclear - whereas in the Third World they are fueled principally by firewood, kerosene and biomass produced methane gas.

In the rural areas investigated in the study, the trends in using firewood for cooking purposes and kerosene for lighting did not vary from those in comparable rural settings elsewhere. Of the 300 combined sample households, 284 or 87 percent always use firewood for cooking compared to only 13 percent using kerosene (Tables 6.18-A,B, App. B) (9). These findings reveal a demonstrable change, from 1970, in actual fuel use - when as many as 95 percent and 3 percent respectively used firewood and kerosene regularly.

Also apparent from Tables 6.18-A,B is the significance of firewood for cooking in all the three zones. That importance has not changed much over the years - as the values of actual use signify. Furthermore, the palm product 'lagidi' - a fire starter used in conjunction with firewood - is also favoured by about 50 percent of the people (Figure 20). Those living under dry conditions in the semi-savanna environment of Ogbomoso, however, do not rely heavily on it. It was used occasionally by at least 35 percent of the respondents.

In 1970, kerosene was the most-used fuel for lighting in rural areas. Of the 300 people sampled, 282 or 94 percent depended on it regularly (Table 6.19-A, App.B). Currently, a slightly smaller portion, 89 percent, still use it frequently - although electricity use has increased from 4 percent to 11 percent in 1970 (Table 6.19 B, App. B). However, a closer inspection of actual fuel use for lighting within the zones indicates the slight benefit that the environs surrounding the Ibadan and Ife zones

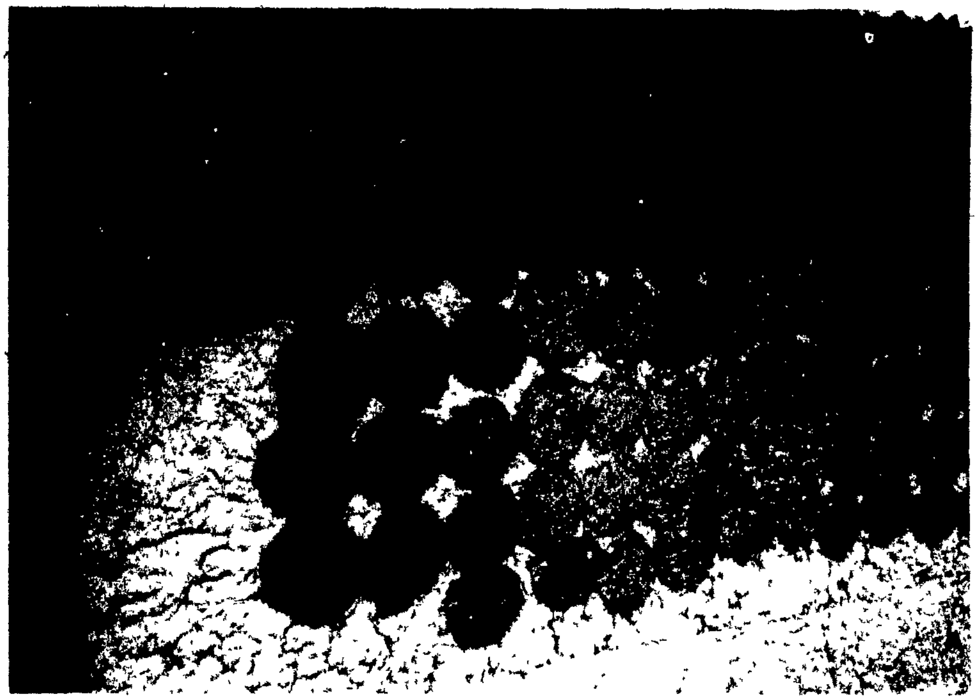

Figure 20: "Lagidi" - palm product - drying on the sidewall of a mudhouse.

received from 'rural electrification' schemes adopted sporadically in 1970. In contrast, the rural areas adhering to the town of Ogbomoso continued to rely heavily on kerosene supplies (10).

Mirroring actual fuel use for cooking and lighting is the ranking of these fuels by respondents in the survey, from the most important to the least. Firewood is ranked by 97 percent of users as the overall most important fuel for cooking (Table 6.20-A, App.B). This percentage is comparable with the percentage who regularly use firewood to cook with. Kerosene, at 24 percent, follows firewood in the ranking as the second most important cooking fuel whereas electricity and bottled gas are ranked the least important by 5 percent of the people interviewed (Table 6.20-A). Likewise, 'lagidi' is important to about 50 percent of the sampled population in the Ibadan and Ife zones. These percentages, not surprisingly, are comparable with those outlined above representing the regular users.

Moreover, the pattern of fuel ranking for lighting follows that of firewood for cooking; namely, fuel ranking is directly proportional to frequency of fuel use. Kerosene, for example, was ranked the most important fuel for domestic lighting by 97 percent of total respondents. It is important because 89 percent who actually use it for the same activity (Table 6.20-B, App. B). Only in the rural areas of the Ife and Ibadan zones do a small percentage of people, about 11 percent, rank electricity very highly.

A measure of users' perception of available fuel supplies and in their ability to obtain them, is reflected by their choice or preference for these fuels. In total, 204 or 68 percent prefer bottled gas the most for cooking (Table 6.21-A, App.B). Electricity and kerosene follow at 61 percent and at 48 percent respectively, whereas firewood, the most important and most widely used, is the least preferred. Further examination of Table 6.21-A reveals zonal differences in cooking fuel preferences. Gas for domestic cooking is highly favoured in the Ibadan and Ogbomoso zones by as much as 75 percent of the people, but it is only second to electricity in preference in the Ife zone. Residents in the Ogbomoso zone also preferred electricity - more than Ibadan residents but not as much as Ife's (Table 6.21-A, App. B).

These indicators reveal zonal differences in respondents perceptions of the various forms of fuel available. Experientially, these perceptions appear to be influenced by the proximity of rural households to large urban centres in their ability to project to rural areas urban patterns of energy consumption. The larger the urban centre, to which surrounding villages adhere, the higher the likelihood villagers will be exposed to a comprehensive energy information base - upon which they base their preference. For example, one would expect rural residents near the town of Ibadan, the largest and most economically developed of three centres in the study area, to prefer electricity for cooking over other fuels - since Ibadan is likely to benefit the most from electrification schemes (11). Yet, they prefer bottled gas to electricity. In contrast, the smaller towns of Ife and Ogbomoso are more in favour of electric power for cooking (Table 6.21-A).

Residents in the latter zones are, in all probability, not as exposed to rural electrification schemes as those in Ibadan and, therefore, are less informed about some of the problems often encountered - limited and interrupted supplies of electricity. Their preference for electricity as cooking fuel is likely to be based on what they perceive the situation of rural electric power supplies to be rather than on what it actually is - unreliable. Furthermore, the people in the Ibadan zone are more aware about the costs associated with electricity (appliances, rates) which might influence their choice of fuel preference.

Electricity, nonetheless, is the most preferred energy form for lighting in the three zones. As much as 289 respondents or 97 percent prefer to use it over other sources (Table 6.21-B, App. B). Kerosene is also preferred, but by a lower percentage (78 percent). These results support consistent experiential observations; domestic lighting, an infrequent activity usually limited to after sunset, conforms to the interrupted and limited supply of electric power (12); and cooking - a more frequent domestic activity averaging thrice daily - requires dependable and clean fuel supplies such as bottled gas.

A closer examination of fuel preferences in Tables 6.21-A,B reveals, moreover, a significant, albeit hidden, facet of fuel choice. Kerosene, at 48 percent, came in third for the most preferred cooking fuel, and, at 78 percent, came in second for the most preferred lighting fuel - in all three zones. In addition, kerosene supplies are reliable and reasonably inexpensive. People, therefore, are more inclined to depend on kerosene as a secondary source should supplies of their favourite and preferred forms - bottled gas for cooking and electricity for lighting - become less available.

Findings of fuel preferences for lighting and cooking were further supported in Tables 6.21-C and 6.21-D (App. B). When respondents were questioned as to their favourite cooking fuel if they were to live in towns, 38 percent chose bottled gas, 26 percent preferred kerosene and 22 percent favoured electricity. Firewood, at 13 percent, is the least preferred cooking fuel in urban centres (Table 6.21-C).

Between zones, however, values for the most-preferred cooking fuel if they were to live in towns, vary slightly. More people in the Ibadan and Ogbomoso zones favour using gas over kerosene, whereas in the Ife zone, twice as many people preferred kerosene over gas. The difference in these results could be explained, in large part, by market forces operating within the three zones. For example, in the Ife zone, supply might not meet demand, or the cost of gas might exceed the maximum price Ife respondents are willing to pay. Also, firewood supplies might be available in larger quantities in the town of Ile-Ife, and,therefore, with their relatively lower cost, might be favoured by the local population. Nevertheless, kerosene figures significantly in the choice for fuel preference in all the three zones.

Likewise, electricity is the prominent choice for lighting in the towns. As many as 85 percent prefer to use it over other sources - there was an insignificant variation between the zones (Table 6.21-C). Kerosene is again the only significant alternative preferred by not more than 12 percent.

When the same people were questioned for their fuel preferences for cooking and lighting if they were to live in rural settings - which is precisely where they are - they chose firewood over kerosene for cooking (68 to 32 percent) and kerosene over electricity for lighting (91 to 7 percent). These findings reveal a pattern of fuel preference that is, partly, based on respondents perception of fuel supplies, fuel costs and fuel availability within their immediate habitat, and, partly, on the frequency and type of fuel consumed by the respondents. Some people suggested that firewood imparts flavour to their cooking - a quality they prefer.

In the rural areas, in general, the preference is between firewood and kerosene for cooking with firewood the favourite, and between kerosene and electricity for lighting with the former chosen first. Conversely, in urban centres, respondents would rather use gas than kerosene for cooking and electricity over kerosene for lighting. These preferences correlate positively with the fuels presently being consumed (13).

Rural Energy Production and Supply

Throughout the study area, 84 percent of respondents collect their fuelwood supplies compared with 11 percent who buy it. Almost 5 percent combine both sources. The collection of fuelwood is done directly from their own farms or from their relatives' plots, whereas buying is usually from the market or wood sellers (Tables 6.22-A,B, App. B). The pattern between the zones, however, varies. There are more people in the Ibadan zone - about 20 percent compared to 6 percent in the other zones - that purchase their supplies entirely from the market.

These values support Ay's (1980) findings in that there ia a more organized wood selling market in The Ibadan zone compared to the other zones. This is probably because the demand for firewood in the larger town of Ibadan necessitates the establishment there of an organized market. Therefore, the likelihood that people in the rural areas will buy it -

provided the prices are reasonable - is higher in this zone.

The distance respondents travel to collect firewood differs between zones. In the Ife and Ibadan zones, about 55 percent of respondents travel from one to two kilometers and about 20 percent one kilometer (Table 6.22-C, App. B). However, some people in the Ogbomoso zone travel much further. Nearly 30 percent of respondents in that zone travel twice the distance - two to four kilometers - compared to 15 percent in the Ife zone and 11 percent in Ibadan (Table 6.22-C). This difference is understandable since the sampled area of Ogbomoso lies within the rainforest-savanna ecological boundary (14).

Firewood collection and gathering in the study area - as in other Third World nations - is an activity dominated by women and children. The survey reveals, irrespective of zone, as many as 53 percent of females and 24 percent of children do the actual gathering, compared to only 20 percent for men - who are likely to sell it in the town markets (Table 6.22-D, App. B). However, transporting it home rests heavily on females and children (15).

The dominant tree species collected or bought vary between ecological zones. Results outlined on Table 6.23 (App. B) summarize the most important species from a list of over one hundred species named - as some farmers seem to have named almost any tree species that occurred to them, and others have refused to answer altogether. However, many responses appear reasonable and consistent. Despite variation due to error, there is a discernable spatial pattern observed.

On one level of observation, between ecosystem variation, species found to be of importance in the rainforest environment of Ife and Ibadan lose their significance in the rainforest-savanna mosaic of Ogbomoso. For example, species such as Celtis, Cacao, Ficus, Ire, and Albizia found in the rainforest give way to Hymencoardia, Acacia and Butyrosperm in the Ogbomoso mosaic.

On another level of observation, within ecosystem variation, Celtis, Cacao and Albizia, in decreasing order, appear to be the most important in Ife and Ibadan, whereas, Hymencoardia and Butyrospermum are important in Ogbomoso (16).

Respondent Opinions on Firewood-Related Issues

Many of the opinions sought in this section are basically second-hand and seem to have significance mainly in the context of a nation-wide general rural energy perception survey. Interviewers reported that respondents in many cases were unhappy with this section, especially with the questions where they were asked to give their opinions on energy use versus education levels or income levels. They felt uncomfortable giving their opinions on issues they don't relate to. Responses to this question were given grudgingly. Therefore, they are taken with lesser value than that placed on information taken from first-hand knowledge questions - such as the value of firewood, its accessibility and reliability. The results are summarized in Table 6.24 (App. B).

Many people throughout the study area believe firewood is a cheap and accessible fuel. In the Ife and Ibadan zones, as many as 80 percent hold this opinion to be at least partly true. Ogbomoso residents, however, differ slightly in their opinions, in that there is a lower number of people - about 65 percent -that believe firewood is cheap and accessible.

Nonetheless, 90 percent of respondents, in general, indicated that firewood supplies are, at least, partly reliable. Furthermore, over 85 percent in the Ife and Ibadan zones believe firewood is more readily available in the dry Harmattan season, whereas 65 percent in Ogbomoso are of the same opinion. It appears that firewood is more available in the more dense rainforest systems than in the savanna environment.

Opinion on the 'ease of firewood use' was equally divided between 'true', 'partly true' and 'untrue'. Nearly 66 percent of the respondents indicated that firewood is almost easy to use and 33 percent indicated the contrary. Response on whether firewood is mainly used by the poor of the society and illiterates was also equally divided, irrespective of zones - a reflection of respondents ambivalence to commit an opinion.

Almost overwhelmingly, respondents are in agreement that firewood is suitable for traditional cooking and for use in institutions such as hostels, hospitals and prisons. They also agree to its suitability in commercial activities such as cooked food selling, and in small-scale businesses and factories such as bakeries and brick-making.

Nearly 35 percent, however, do not believe firewood can be used in modern-type houses, although 60 percent - mostly in the Ogbomoso zone - believe it is partly conceivable.

Of particular interest to future firewood supplies, 93 percent of the rural population in the sampled area realize that firewood, though reliable and accessible, is now scarcer in quantity than it was ten years ago. This could be interpreted as early signs of exhaustion of firewood supply areas that might lead to deforestation in the future - more specific investigations of fuelwood supply areas are, however, needed to corroborate patterns of deforestation (17).

Miscellaneous Results

A seemingly fair question asking whether respondents sell firewood was misinterpreted as "do you want me to sell firewood to you, the questionnaire?", "am I a dealer in firewood?", and "am I being accused of engaging in the lowest of all, occupation", i.e., selling firewood? (Morgan and Moss, 1979, App. 1, p. 2).

Men would not generally admit to selling firewood even if they were engaging in that activity. The findings reveal that about eight in 300 respondents admitted to selling firewood - mostly "occasionally".

Many of them, however, admitted that they were not entirely satisfied with their existing cooking and lighting facilities. Out of 300 respondents, 228 or 75 percent need new facilities compared to 23 percent who were satisfied with current conditions (Table 6.25, App. B). In fact almost everyone (98 percent) seem to want this mysterious gift of science - the solar cooker - although many have not even seen it (Table 6.25, App. B).

. For those who desire new cooking and lighting facilities, the lack of money is the main difficulty standing in their way. Almost 60 percent said money is the problem compared to 15 percent who replied that the facilities were unknown to them, and another 15 percent who new about the existence of the facilities but were not available to them (Table 6.26, App. B).

Summary of Findings

The rural energy survey questionnaire yielded extensive information on social, economic and environmental factors which form the patterns of production and consumption of traditional fuels. Firewood is found to be the most frequently used fuel for domestic cooking and, in the cooler nights during the Harmattan period, in household space heating. Kerosene is extensively used in rural areas to meet the demand for lighting - and to a lesser degree, cooking.

The frequency of firewood and kerosene consumption across income groups shows little variation among the households. This is also true for the relative ranking of importance of these fuels. In contrast, the degree of preference for gas and kerosene for cooking, and electricity and kerosene for lighting vary according to the size of the urban center in the sampled zones. Responses of fuel preferences and use from the inhabitants of the larger Ibadan zone, in general, reflect a heightened awareness of the availability of alternative energy forms and their position in the market place.

Firewood and kerosene are preferred fuels in rural areas, whereas bottled gas and electricity use are favoured in urban environments. Many respondents' wives and children fetch firewood directly from their own farms or their relatives' plots by travelling, on average, two and one half kilometres. Kerosene and bottled gas are bought at the local markets in towns; their availability and cost, therefore, become crucial in determining the frequency of their use.

There appears to be very little variation in the patterns of energy consumption and preferences between the two contrasting ecological systems

- the rainforest and the forest-savanna complex. Ecological differences are, however, markedly revealed in the choice of tree species preferred by respondents. In the rainforest zones of Ife and Ibadan, Celtis and Ficus and Ire species are preferred, and in the forest-savanna complex of Ogbomoso Butyrospermum, Acacia and Hymencoardia are favoured. Opinions on fuelwood's 'relatively cheap cost', 'ease of accessibility' and its readily available supplies in the dry season vary between zones. In the Ogbomoso zone, it is not as accessible and cheap as in the other zones. It is also scarcer in quantity there than it was ten years ago. Firewood is suitable for use in brick-making factories, bakeries and health institutions.

- Many respondents are not satisfied with their existing cooking and lighting facilities, and attributed the difficulties of not adopting modern facilities on the lack of money. They were also very much in agreement on the use solar cookers - the wonders of 'modern science'.

6.2 *Analysis of Results and Discussion*

The succeeding step in the data analysis, after having examined the distribution of each of the variables, is to investigate sets of relationships among two or more of these variables in order to further our understanding of the factors and patterns related to rural energy studies. It is apparent that these variables exhibit very little variation through space and time.

The frequency distributions of fuel consumption, fuel preference, fuel end-use, respondents income level, occupation and educational background, in addition to the distribution of the other variables in the questionnaire, congregated around singular values. For example, energy consumption for cooking, in which firewood dominates, does not vary significantly between zones, ecological systems, or over time.

The agreement in fuel consumption, therefore, does not lend itself to rigorous statistical testing, such as regression, as much as it does to experiential analysis (18). It does, nonetheless, comply with the statistical conditions and limitations of cross-tabulation (19).

Socio-Economic Characteristics

Education level, income and occupation are parameters relevant to our understanding of patterns of energy consumption and fuel preferences. Therefore, a closer examination of the relationships between these variables, within the context of rural energy systems in south-western Nigeria, is necessary.

The joint frequency distribution of education level and occupation group in the study zones reveal a significant degree of dependence between these variables (20). This is proven by the relatively high chi-square value achieved for this relationship (Table 1, below) (21).

Table 1. Cross-tabulation of Socio-Economic Characteristics.

VARIABLES	CRAMER'S V	CHI-SQUARE	DF*	SIG**
EDUCATION vs INCOME	0.1323	10.5018	8	0.2316
EDUCATION vs OCCUPATION	0.4970	296.3828	20	0.0100
OCCUPATION vs INCOME	0.1737	18.0942	10	0.0534

* DF or 'degrees of freedom' is the number of linearly independent items in the sum of squares. It is a number which represents in some way the size of the sample, or samples in the test. In some cases it simply the sample

size, in others it is a value which has to be calculated. Just how this is done and the logic behind the calculation differs between tests. The shape of the sampling distribution of chi-square is dependent upon the degrees of freedom.

** SIG or 'significance' is the risk the researcher is prepared to tolerate of wrongly rejecting the null or research hypothesis. If SIG is less than 0.05, i.e., 5% level of significance, than the research hypothesis for the joint distribution under study will be rejected. The hypothesis is usually framed to show no relationship and, therefore, rejected in favour of the alternative hypothesis that indicates a relationship.

The chi-square of 296.38 for the frequency distribution essentially indicates that the observed frequencies, occurring in each cell of the cross-table, deviate so much from what we would expect to find there under the conditions of statistical independence that a systematic relationship between the cross-tabulated variables - education and occupation - exists. Furthermore, the distribution reveals that the chi-square obtained is significant at the 0.01 (or 1 percent) probability level, i.e., the probability of obtaining a chi-square value this large or larger, by chance, with 20 degrees of freedom is less than 1 in 100.

It should be noted, however, that the chi-square is only used in deciding whether or not the variables are independent. It does not give information on the strength of the relationship. The measure that does reveal the strength is Cramrer's V measure of association (22). The higher the 'V' (maximum is 1.0) the stronger the relationship.

The distribution of education and occupation achieved a 'V' value of 0.4970 - indicating a relatively moderate degree of association. It appears that a significant relationship in the study area does exist, although it is not substantively important. The relationship essentially shows that a large number of farmers have, at most, a primary level of education. These results lend support to a widely observed migratory pattern in the Third World - in which the more educated the people are the higher the likelihood they will leave their villages for better job opportunities in the cities.

When education was cross-tabulated with income - to show whether they are related - the results revealed no statistical significance whatsoever (Table 1). The chi-square value of 10.5018 (significant at the 0.2316 probability level) implies that the cell frequencies do not deviate so much from what can be expected there under the conditions of statistical independence. Therefore, based on the questionnaire results, a systematic relationship does not exist between education and annual earnings in the sampled zones of Ife, Ibadan and Ogbomoso - a view supported by a low Cramer's V of 0.1323 (23).

Nonetheless, the author and the reader can assume from these results, with reasonable statistical support, that education - secondary level and below - does not lead to a pronounced increase in income. Its significance in the rural areas lies in its quality to provide people with different work opportunities which are not available to those without any education. These opportunities, however, do not, necessarily, translate into higher income.

Education, Energy Consumption and Fuel Preferences

The type of fuel generally consumed by people depends largely on its availability through space and time. Its use is also influenced by its cost (monetary and social) relative to other existing fuel alternatives.

Formal education, in its capacity to expose people to different jobs and, possibly, more income, could have a decided influence on the choice of fuel consumed.

Results of the cross-tabulation between education and actual energy consumption - specifically firewood for cooking and kerosene for lighting - in the rural areas reveal, at first glance, statistically significant relationships (Table 2).

Table 2. Cross-tabulation of Education Level of User and Actual Fuel Use.

VARIABLES	CRAMER'S V	CHI-SQUARE	DF	SIG
FIREWOOD - cooking	0.3561	76.0757	8	0.0001
KEROSENE "	0.2389	51.3608	12	0.0001
KEROSENE - lighting	0.2230	29.8364	8	0.0002
ELECTRICITY "	0.2249	45.5138	12	0.0001

The table shows, respectively, significant chi-square values of 76.0757 and 29.8364 for the relationships between firewood consumption and education, and kerosene consumption and education. This is not to imply that the relationship is strong. On the contrary, Cramer's V values for these relationships (see Table 2) demonstrate their weakness. People use firewood and kerosene for cooking and lighting regardless of their background in formal education.

Rural households, therefore, consume firewood and kerosene because these are the fuels available to them in their villages - although kerosene is often bought from the market in the towns. The pattern of fuel consumption, therefore, is largely dictated by fuel availability. According to the survey results, the joint frequency distribution of respondents' education level and forms of energy consumed is significant, i.e., it could not have arisen by chance. Firewood and kerosene are consumed by many uneducated rural people. However, according to the analysis, education does not cause people to consume these fuels. Fuel availability is a more determining factor of fuel consumption.

One would expect that the more the formal education people receive, the more they come into contact with information on alternative energy sources, and the higher the likelihood of them preferring clean, higher status fuels such as bottled gas and electricity. But, in fact, the relationship between education and fuel preference is statistically insignificant (see values of chi-square and Cramer's V in Table 3).

The basis of information upon which respondents preferences are decided does not include their levels of education. Education does not inherently imply knowledge nor the ability to think and perceive better than in the absence of it. More pertinent factors form the data base of information. These factors include tradition, social status and proximity of households to large urban centres - which project to the rural areas urban patterns of energy consumption.

Table 3. Cross-tabulation of Education Level of User and Preferred Fuel Form.

VARIABLES	CRAMER'S V	CHI-SQUARE	DF	SIG
ELECTRICITY - cooking	0.1038	12.9392	16	0.6772
FIREWOOD "	0.1619	23.5934	12	0.0231
GAS "	0.1318	15.6415	12	0.2082
KEROSENE "	0.1204	17.3944	24	0.8314
ELECTRICITY -lighting	0.1046	9.8431	12	0.6297
GAS "	0.1527	20.9795	12	0.0507
KEROSENE "	0.1385	23.0045	20	0.2886

Income, Energy Consumption and Fuel Preferences

Income level was then cross-tabulated first with actual energy consumption, and second, with fuel preferences. The results of the analysis are outlined in Table 4 and Table 5 respectively.

Table 4. Cross-tabulation of Income and Actual Energy Use

VARIABLES	CRAMER'S V	CHI-SQUARE	DF	SIG
FIREWOOD- cooking	0.0932	5.2126	4	0.2662
KEROSENE "	0.0733	3.2229	6	0.7804
KEROSENE- lighting	0.1161	8.0837	4	0.0886
ELECTRICITY "	0.1439	12.4316	6	0.0530

The results attest to a similar pattern as that observed between education and energy consumption - income has no direct, significant bearing on the type of fuel consumed in the rural areas. One would assume that the more money people have the higher the likelihood they will switch from low status fuels such as firewood, to higher status fuels such as bottled gas. However, this pattern is not supported by the analysis. It may be prelevant in urban centres - as the inhabitants there are exposed to a wider energy base - but is not as apparent in the rural areas. Fuel availability, tradition and domestic circumstances are more relevant factors shaping energy consumption.

Likewise, what people earn generally had no bearing on the type of fuel they prefer to use (see Table 5). There appears, however, a significant relationship between income and the preference for electricity and kerosene for lighting. The chi-square values in Table 5 show significance of joint frequency occurrence, but the significance is not supported by Cramer's V, i.e., the relationship is irrelevant.

The analysis do not imply that income levels are not related to fuel preferences, but that regardless of what people earn, they still prefer to use these sources the most.

Also, the lack of proper awareness of the problems associated in rural electrification schemes results in many people preferring electricity - kerosene is preferred next to electricity as a stand-by fuel, should supplies are interrupted.

Table 5. Cross-tabulation of Income and Preferred Fuel Form.

VARIABLES	CRAMER'S V	CHI-SQUARE	DF	SIG
ELECTRICITY - cook	0.0819	4.0260	8	0.8548
FIREWOOD "	0.1323	10.5768	6	0.1024
GAS "	0.1029	6.3553	6	0.3846
KEROSENE "	0,0871	4.5493	12	0.9714
ELECTRICITY - light	0.1799	19.4259	6	0.0035
GAS "	0.1166	8.1594	6	0.2267
KEROSENE "	0.2179	28.4939	10	0.0015

Discussion on Firewood-Related Issues

Firewood is the main fuel consumed in rural domestic cooking activities. How the users view it form economic, social and traditional perspectives is crucial in developing guidelines for energy conservation policies. Equally important are users' opinions on the current state of firewood supplies and how it might evolve in the future.

The findings reveal that the majority of firewood collectors in the area of study, when questioned, maintain that firewood, although used by the poor, is not exclusively for the poor. It can be a stand-by fuel for those who can afford it - they are, most often, urban households. Firewood is also a preferred fuel for traditional cooking, an activity usually done on open fires or using traditional woodstoves - regarded as highly inefficient methods of energy conversion.

Furthermore firewood is less accessible in the dry season than at any other time of the year, especially in the lower vegetation density ecosystem in the Ogbomoso zone. Even when electricity or gas supplies are intermittently used in hospitals, prisons, schools, universities, and hotels, firewood is either consumed regularly or stored as a stand-by fuel.

The heavy reliance on firewood does not show signs of abating in the future. The majority of firewood gatherers agree that firewood consumption will continue to be used in the future, in spite of the fact that it has become increasingly scarce since early 1970. Their dependence on it is overwhelming - as there are few other options available to them in the way of cheap and constant supplies. They are, however, more interested in trying alternative sources, e.g., solar cookers.

6.3 Summary

The rural household energy consumption and fuel preference survey questionnaire in selected zones in southwestern Nigeria yielded wide-reaching results relevant to the understanding of the energy situation in the region, especially in rural settings. The study area (the Ife, the Ibadan and the Ogbomoso zones) is not presently facing a fuel crisis to the degree facing areas further to the north in Nigeria, especially the areas bordering the Sahel.

This view is supported by the results of the survey - especially those dealing with firewood availability and accessibility which show that firewood is a reliable and accessible fuel with a future. This does not necessarily imply that a fuel crisis might not materialize in the future. On the contrary, should present dependence on firewood continue, especially with an increasing population, an ensuing fuel crisis is inevitable. It is, therefore, imperative to enact and implement an energy policy to counteract the threat before it occurs.

Results and analysis of the rural energy survey presented in this chapter provide important information which can be used to guide formulation of a comprehensive energy policy. Of particular interest to the investigation, it provides information on the role of different ecological systems in patterning fuel consumption, production and perception. The ecological systems investigated here - the rainforest in the Ibadan and Ife zones and the forest-savanna mosaic in Ogbomoso - provide the opportunity to examine whether such relationships exist.

The results and analysis show that there are no significant differences - between the two ecological systems - in the types of fuel that is consumed and preferred by the villagers. These results are, furthermore, supported by experience.

However, there were apparent differences in the results of fuel preferences between respondents in the Ibadan zone and the other two zones. The variation in response, therefore, is not a function of ecological differences (as the Ibadan and Ife zones are both in the rainforest), but a function of other factors that differentiate the former zone from the Ife and Ogbomoso environments. One major difference is the presence of a large urban centre in the Ibadan zone - the town Ibadan.

Ibadan, the largest and fastest growing urban nucleus of the three zones is the location of many academic, political, banking and business institutions. By virtue of its size, political, social, and economic patterns peculiar to it radiate outward towards surrounding rural areas. Hence, more opportunities for the exchange of information on fuel-related issues - so enhancing rural perception of these possibilities - is offered to rural inhabitants.

Awareness of relevant issues pertaining to alternative energy forms influences the way people respond to energy related questions. For example, the response of the people in the Ibadan zone to the use of electricity for lighting was not as unanimous as the response of the people in the other zones - an indication of a higher level of awareness by respondents in the Ibadan zone to the costs and interrupted supplies of electricity.

Therefore, given similar traditional, cultural and socio-economic characteristics between the zones, increasing people's awareness of issues related to energy and the context in which it is consumed enables them to have a comprehensive under-standing of existing energy systems. Hence, village or communal education geared towards increasing awareness becomes an integral area of rural energy conservation programmes by making it, for example, more possible to introduce to these areas new fuel-efficient stoves.

The different ecosystems in the zones are mainly significant in determining the availability, quantity and species of firewood collected by the villagers. In the savanna-like environments, women and children travel much further to collect firewood than their counterparts in the forested areas. According to the results of the survey, it is essentially in this context that the particular nature of each ecosystem becomes important.

The question of whether continual firewood use causes deforestation can be answered, in part, by examining the degree to which respondents agree about its growing scarcity since 1970. Also, in part, by examining the frequency with which firewood, relative to other sources, is used over time.

The results of the survey reveal that firewood is in fact becoming scarcer - especially in the more sparsely vegetated regions in the savanna environment of Ogbomoso. Furthermore, the dependence on firewood for cooking and heating has not abated over time. Although, currently there are more alternatives in the form of bottled gas and kerosene available to them, firewood continues to be a heavily reliant fuel.

The process of deforestation is not wholly dependent on firewood use. It would be difficult to conceive of the rich, tropioal rainforest zones of Ife and Ibadan, and, to a minor degree, parts of the Ogbomoso zone undergoing deforestation. Yet, it is misleading to assume that these forests provide endless supplies of fuelwood - as much of the vegetation there, namely vines and sprawling herbaceous plants, smokes rather than burns. Also, dry firewood is a pre-requisite for burning. These forests, especially throughout the rainy season, are extremely humid and the firewood is often wet, thus requiring drying before using it. Drying technology is, often, time-consuming and difficult to apply in the rainy period.

Deforestation, however, is more prevalent in the drier and sparsely vegetated areas surrounding Kano, Kaduna and Makurdi in the far northern parts of the country. Thus, removing the plant cover for burning becomes a crucial activity directly exacerbating the rate of deforestation. However, an understanding of why firewood should be removed in the first place, especially in an oil producing country such as Nigeria, requires a careful study of the social, political, cultural and economic processes in which firewood use and deforestation are taking place.

CONCLUSION

Energy is a measure of the potential to produce change. The more energy is consumed by a system, and the higher the efficiency with which it is consumed, the greater is the productivity of the system. In agricultural practices and industrial activities, the results are apparent. Energy inputs such as fertilizer, high yield grains, and irrigation schemes attest to the laboratory success of the 'Green Revolution'.

There is little question but that more useful work - essential to individual, local, and national processes of development - is obtained both from more energy and more efficient use of it. In the Third World, the energy characteristic typical of poverty is not so much low per capita energy use - though that is definitely a part of it - but the relatively small amount of useful work that is obtained from it (Makhijani and Poole, 1975).

Results of the study show that firewood is the dominant fuel consumed in rural domestic cooking and heating, and kerosene the exclusive fuel used in rural household lighting. They also reveal a number of factors that influence patterns of rural energy consumption and fuel preferences. These include; physical availability of fuels; household size; proximity of villages to relatively large urban nuclei; awareness of other fuel alternatives; distance travelled to supply areas; climate; vegetation differences; culture; tradition; socio-economic characteristics; and general awareness of the relative importance of fuels in daily routine activities.

Analysis and discussion of the results are outlined above. What is clear is that the continual removal of wood (especially firewood) to meet local energy needs is a practice leading to environmental vulnerability. In the face of a growing population in Nigeria (about 2.3 percent annual increase) and the ensuing increase in the demand for fuel supplies, the present rural energy system in the study area - which heavily favours the removal of wood - will continue to deteriorate. Moreover, cooking within the sampled zones is often done on open fires - a highly inefficient energy transformation activity. As much as ninety percent of wood energy is lost to the environment as a result of this method of burning.

There is much improvement to be made by introducing efficient wood stoves and, in some cases, upgrading local models to better consume the local energy resources. However, technical efficiency considerations, by themselves, do not determine what is socially desireable and acceptable. Consideration should be given to the traditional, cultural, social, and environmental contexts within which fuel consumption takes place. Moreover, resource base improvement and conservation strategies should be compatible with local user needs - which must be thoroughly investigated.

Plans to satisfy rural household energy needs must take into account importance of firewood to the users. It remains, and will remain, for a long time the major source of cooking fuel. It is by no means the most preferred cooking fuel. The use of bottled gas and kerosene has made some inroads , especially in the town centres. Their sudden price fluctuations, however, and, in the case of gas, inconsistent supplies have led the villagers to rely less on their use.

The exclusive reliance on firewood necessitates the implementation of ecologically sound conservation practices with regard to the resource base. Practices incorporating reforestation and afforestation strategies that may materialize as communal or village woodlots, state or federal government designated reserves, and large plantations. They should be planned and managed on a sustainable multi-purpose basis with general and sound ecological and wood production policies.

Of fundamental importance to rural development programmes is the role of women. Any planning must involve the direct participation of women - for they are the leading agents in the procurement and consumption of energy. Out-reach education programmes by volunteers and animators - to acquaint fuel users with technologically improved and fuel-efficient wood stoves and conservation strategies - must have an element whereby information transfer exceeds material transfer. Self- sufficiency should be fostered and encouraged.

There are, of course, a number of political, cultural, socio-economic, and bureaucratic constraints that need to be understood, studied, and eventually modified before realizing these objectives. Once the committment is shown, finding a way to modify and adapt these constraints should not be insurmountable.

This investigation is by no means an end in itself. It does not profess to provide solutions to the rural energy problems facing rural people in south-western Nigeria. Rather, it documents patterns of energy consumption and fuel preferences, and suggests alternative ways towards finding solutions. The study is a component of the larger and encompassing Rural Energy Systems in Nigeria Project. In particular, it provides material which can be contrasted to urban energy studies to discover whether any relationships between urban and rural energy consumption patterns exist. In this way, a comprehensive analysis of the energy situation in south-western Nigeria can be achieved. It is also a source of information from which local, state, and federal governments can draw their own conclusions as the basis for initiating and implementing implement conservation programmes. The aim of these programmes is, ultimately, to prevent wasteful degradation of tropical forests and reduce the daily struggle of searching for fuel. The time saved from this activity, therefore, can be channelled towards improving the conditions of poverty.

NOTES

Chapter One: Rural Energy - An Overview

(1) BCE is a physical unit of measurement which converts various energy forms according to their caloric value.

(2) Morgan (1980) and Adejuwon (1985) found that the preferred species in the tropical rainforest include Albizia and Funtumia elastica (the "rubber tree") - useful for planks and charcoal; Celtis - noted for quality firewood; and Lecaniodisus and Bridelia - frequently found in villages as shade trees, in addition to being good sources for charcoal and poles. Preferred species of the moist-savanna and savanna-forest mosaic include Ficus and Butyrospermum (the shea nut), which are the dominant sources of firewood and charcoal

Chapter Four: The Study Area

(1) A variety of reasons and conditions formed the basis of selecting the towns and villages used in this study. Firstly, since the University of Ife (currently re-named Abofami Awolowo University) was the operational base of the study, the nearby towns of Ife was selected as one of the major urban centres to which a number of surrounding villages adhered. The location of Ife in the typically high forest, within the tropical rainforest belt, was another reason for choosing it. Conversely, the town of Ogbomnoso, located in the savanna woodland mosaic, within the Derived Guinea or savanna woodland communities, was chosen as an ecologically contrasting zone - so as to compile information on how the dominant sources of rural energy varied between zones. Moreover, Ibadan, one of the most populated urban centres in tropical Africa, was selected to provide a perspective of scale in rural energy dynamics (Ojo, in press).

Chapter Six: Results, Analysis and Discussion - Rural Household Fuel Preference and Energy Consumption Survey

(1) Random selection was used to lower the bias inherent in sampling techniques and, therefore, present findings that are representative of the 'real world'. According to Blalock (1983, p.140), a random sample has the property:

> "... not only of giving each individual [questionnaire] an equal chance of being selected but also of giving each combination of individuals an equal chance of selection."

(2) A note on levels of measurement. When the data are being collected, the process of assigning values or scores to the observed phenomena constitutes the process of measurement. The rules defining the assignment of appropriate values determine the "level of measurement....The traditional classification of levels of measurement...[are] nominal, ordinal, interval, and ratio" (Nie et al., 1970, p. 4). The levels of

measurement adopted in this research are nominal and ordinal (categorical).

(3) Discrete or categorical variables are those variables coded or classified into integer numbers of values or categories.

(4) Plans for rural electrification in Nigeria fall largely under national development schemes. These schemes have been tied to unstable trends in the oil market. In Nigeria, oil brought windfall revenues for the development budget during the energy crisis of the 1970s. It also entailed severe cutbacks in the same budget during the oil glut of the 1980s. Consequently, the development plans for the years post 1980 became unrealistic, and some projects and programmes such as rural electrification had to be cancelled or suspended. Moreover, the sheer number of political, social and economic factors incorporated into the rural electrification schemes at the local, state and federal levels of planning, hinder the effectiveness of development planning in Nigeria (for more information, see Adeniyi et al., 1987).

(5) Although women and young children figure prominently in domestic activities including energy procurement and use and, therefore, are in a better position, than their spouses, to answer the questions in the survey, many were prevented from doing so by their menfolk. This behaviour, especially in semi-secluded settings, conforms with Nigerian cultural norms - which are strongly patriarchal. The respondents, nevertheless, were in a position to provide pertinent information and speak knowledgeably on behalf of their dependents.

(6) One Naira (Nigerian currency) was equivalent to |.60 Dollars Canadian in 1980. The value of it has depreciated since then as result of political and economical instability.

(7) Although income level refers to respondent and not household, it understood that in Yoruba society, the leader of the house has control over all sources of income. Therefore, with a small degree of uncertainty, it is not wrong to accept respondent income as household income. Furthermore, most of the people thought that this question was in some way connected with tax collection, and they were, therefore, initially hesitant to respond until they were reassured to the contrary. Income levels in the questionnaire were too high and failed to differentiate. Therefore, only two levels, above and below 2,500 Naira, were coded.

(8) A common occurrence in Nigerian society, as in any other society experiencing a forced political change in government, is the hording of basic foodstuff and imported items by small retailers thus raising existing prices to unprecedented levels. These price rises are sensitive to sudden political developments and take a longer time to return to their former levels.

(9) In some cases, respondents had two houses; one in the village and the other in the town. Therefore, there was some confusion here over the

'house' referred to in the questionnaire - despite instructions that it referred to village use. Nevertheless, a careful inspection to weed out doubtful interviews by cross-checking was made, and the results obtained reflect the intent of the question.

(10) See n.4.

(11) Ibadan is a major centre for business, academic institutions, banking branches, government agencies and international organizations.

(12) Not surprisingly, bottled gas was the least preferred energy form for lighting. Only 15 percent of the people chose it.

(13) For actual fuel use, see Tables 6.18-A,B and Tables 6.19-A,B in Appendix B. Although the survey concentrated on rural areas and not on urban centres, there were prior studies conducted on fuel consumption in urban centres which showed that gas is the fuel most often used (see Ay, 1980). Also, a second urban energy consumption survey was conducted in the three towns in the study area but the results have yet to be satisfactorily analyzed.

(14) The rainforest-savanna environment has less denser vegetative cover relative to a tropical rainforest ecosystem. Therefore. people will have to travel longer distances and cover wider areas to collect firewood compared to the other zones in the rainforest environment (see also Chapter Four).

(15) Firewood collection is considered a low status occupation, therefore, men, especially in a patriarchal society like Nigeria, often shun the task of collecting, unless of course they are wood-sellers.

(16) For more specific and definitive information, the author recommends a follow-up survey on a small and representative sample of farms in the area of study.

(17) The study by Nkambwe (in Ojo and Adejuwon, in press) on the availability of fuelwood supplies in south-western Nigeria by applying remote sensing techniques, revealed steady losses of standing stock of firewood species surrounding the major towns of Ife, Ibadan and Ogbomoso since 1963. He attributes the causes to human demand for wood (energy needs, building requirements, etc).

(18) Regression is a general statistical technique through which one can analyze the relationship between a dependent or criterion variable and an independent - in the case of simple regression - or set of independent variables - as in multiple regression. The main focus of regression analysis is the evaluation and measurement of overall dependence of a variable on a set of other variables. This evaluation is achieved through analyzing the variances in the measured variables. It seeks to explain the sources of variation in the dependent variable by examining the variation in the independent variable(s). The fuel consumed for cooking is predominantly firewood, therefore, cooking fuel consumption does not meet

the conditions of regression analysis.

(19) Cross-tabulation is a joint frequency distribution of cases according to two or more classificatory variables. The display of the distribution of cases by their position on two or more variables is the main component of contingency table analysis and a commonly used analytic method in the social sciences. These joint frequency distributions can be statistically analyzed by certain tests of significance, e.g., the chi-square statistic, to determine whether or not the joint occurrence of these variables are statistically independent. Moreover, these distributions can be summarized by a number of statistical measures of association, such as the contingency coefficient, phi, tau, gamma. etc., which describe the degree to which the values of one variable predict or vary with those of another (Nie et al., 1970). Measures of association indicate how strongly two variables are related to each other. In essence, they indicate to what extent characteristics of one sort and characteristics of another sort occur together, <u>in the cases</u> that have been studied. Tests of significance tell us the probability that the observed relationship could have happen by chance.

(20) Cross-tabulations presented in the text are based on total sample size, i.e., the 300 questionnaires, and not the zonal sample of 100 questionnaires. This decision was made because conclusions derived from both analysis were very similar and, therefore, the larger sample is more appropriate to use as it deals with the whole study area.

(21) Chi-square is a test of significance, and one of the most versatile in statistical theory. The author does not wish to enter here into the mathematical theories which underlie this test, nor into a description of how chi-square is calculated (for detailed information, consult Nie et al. 1970, p.223-5). Chi-square tests essentially whether the observed frequencies in a joint variable distribution differ significantly from the frequencies which might be expected according to some assumed hypothesis. According to Nie et al. (1970, p.223):

> Chi-square is a test of statistical significance. It helps us to determine whether a systematic relationship exists between two variables. This is done by computing the cell frequencies which would be expected if no relationship is present between the variables given the existing row and column totals (marginals). The expected cell frequencies are then compared to the actual values found in the table....The greater the discrepancies between the expected and actual frequencies, the larger the chi-square and the higher the probability of dependence of variables

(22) Cramer's V is a suitable measure of association, i.e., a measure of strength of relationship. V ranges from 0 to +1 when several nominal categories are involved. A larger value of V merely signifies the existence of a higher degree of association, but without revealing the

manner in which the variables are associated (for indepth information, see Nie et al., 1970, p. 225).

(23) The reader is reminded that results from statistical tests are as pertinent as the data that went into their calculation. The question on income was not adequately answered to the satisfaction of the author - as there were some misconceptions as to purpose of asking such a question. Therefore, there may be some bias incorporated into the chi-square and Cramer's V statistics, thus, rendering them inconclusive. The reader is advised to pay little attention to the significance of the relationship, but to view it as a trend in the overall process of energy consumption.

APPENDIX A - THE RURAL SURVEY QUESTIONNAIRE

RURAL QUESTIONNAIRE: APPENDIX A

RURAL ENERGY SYSTEMS IN NIGERIA

UNIVERSITY OF IFE - UNITED NATIONS UNIVERSITY PROJECT

SURVEY OF FUEL PREFERENCES ON HOUSEHOLD BASIS

Name of Interviewer: ______________________________
Date of Interview: ______________________________

A. Particulars of Household

1. Name of settlement: ______________________

2. Name of local Government area: ______________________

3. Name of Ward or Compound: ______________________

4. Location of House
   (tenement assessment or street number): ______________

5. Name of Landlord or Owner: ______________________

6. Type of House:
   Detached Bungalow with single household: ______________

   Undetached bungalow(s) with more than one household: ______________

   Detached storeyed house with single household: ______________

   Undetached storeyed house with more than one household: ______________

7. Total number of rooms in the house: ______________

8. Arrangement of rooms:
   Separate rooms occupied on individual basis: ______________

   Connected rooms in form of flats: ______________

9. Type of kitchen(s) in the house:
   Room(s) in separate building detached from main house: ______________

   Room(s) inside or part of the main house: ______________

   Open fireplace: ______________

10. Number of kitchen rooms in the house: ____________

11. Material(s) used for the wall of the house:

wooden (poles) ____________
mud layers without plaster ____________
mud layer with cement plaster ____________
mud blocks without plaster ____________
mud blocks with plaster ____________
cement blocks with or without plaster ____________

12. Material(s) used for the roof of the house:

thatch ____________
corrugated 'iron' sheets ____________
ardex sheets ____________

13. Is the house supplied with electricity: Yes ________ No ________

14. Source of water for domestic use in the house:

from streams/rivers ____________
from wells ____________
from pipe-borne water outside the house ____________
from pipe-borne water inside the house ____________

15. Number of current residents in the house:

adult males ____________
adult females ____________
children of secondary school age and below ____________
Total ____________

B. <u>Particulars of Respondent</u> (Landlord/Landlady or substitute)

16. Sex: Male ____________ Female ____________

17. Age: 20-40 ________ 40-60 ________ over 60 years ____________

18. Marital status: Single ____________ Married ____________

19. Position in the family:
(landlord/landlady, etc) ____________________________

20. Formal Education:

Nil ____________
below primary ____________
completed primary ____________
full secondary or teacher training
(modern, grammar, technical) ____________

21. Occupation:

Farming ______
Full time artisan ______
Trading/business ______
Teaching/office and any other white collar work ______
Field workers/labourers ______

22. Income level: (per annum)

below 2,500 ______
2,500 - 5,000 ______
5,000 - 10,000 ______
above 10,000 ______

23. Number of persons fed and maintained by respondent: ______

24. How frequently did you use the following fuel sources for COOKING purposes around 1970 (i.e. about ten years ago?)

	Always	Occasionally	Not at all
Charcoal/coal			
Sawdust			
Timber offcuts			
Palm products			
Electricity			
Firewood			
Gas			
Kerosene			

25. How frequently do you use these sources of fuel for COOKING purposes nowadays (i.e. in 1979)

	Always	Occasionally	Not at all
Charcoal/coal			
Sawdust			
Timber offcuts			
Palm products			
Electricity			
Firewood			
Gas			
Kerosene			

26. How frequently did you use these fuel sources for LIGHTING purposes around 1970?

	Always	Occasionally	Not at all
Charcoal/coal			
Sawdust			
Timber offcuts			
Palm products			
Electricity			
Firewood			
Gas			
Kerosene			

27. How frequently do you use these fuel sources for LIGHTING purposes nowadays (i.e. in 1979)?

	Always	Occasionally	Not at all
Charcoal/coal			
Sawdust			
Timber offcuts			
Palm products			
Electricity			
Firewood			
Gas			
Kerosene			

28. Rank these sources of fuel in order of their present importance to you for COOKING purposes (marke- one-1 for the most important, down to 7 for the least important).

Charcoal/coal ____________
Sawdust ____________
Timber offcuts ____________
Palm products ____________
Electricity ____________
Firewood ____________
Gas ____________
Kerosene ____________

29. Rank the same sources in order of their importance to you for LIGHTING purposes (1 for the most important, down to 7 for the least important).

Charcoal/coal ____________
Sawdust ____________
Timber offcuts ____________
Palm products ____________
Electricity ____________
Firewood ____________
Gas ____________
Kerosene ____________

30. What is the approximate value in Naira and Kobo of each of the fuel types you used for COOKING and also for LIGHTING during last month?

	for COOKING	for LIGHTING	both
Charcoal/coal			
Sawdust			
Timber offcuts			
Palm products			
Firewood			
Gas			
Kerosene			

31. Assuming there is no financial constraint, indicate any THREE of the sources which you will prefer to use for COOKING purposes. (Mark 1 for the most important, down to 3).

Charcoal/coal
Sawdust
Timber offcuts
Palm products
Electricity
Firewood
Gas
Kerosene

32. Assuming there is no financial constraint, indicate any THREE of the sources which you will prefer to use for LIGHTING purposes. (Mark 1 for the most important down to 3).

Charcoal/coal
Sawdust
Timber offcuts
Palm products
Electricity
Firewood
Gas
Kerosene

33. Which of the above mentioned sources of fuel or any other source known to you would you now prefer to use for DOMESTIC purposes if you are living or have to live in an URBAN area.

For COOKING ____________________

For LIGHTING ____________________

34. Which one of the above mentioned sources of fuel or any other source known to you would you now prefer to use for DOMESTIC purposes if you are living or have to live in a RURAL area>

For COOKING ____________________

For LIGHTING ____________________

35. If you use firewood at all, either occasionally or frequently, how have you been obtaining your supply most of the time?

directly by fetching it from the farm	______
entirely by buying it	______
partly by fetching and partly by buying	______

36. From where do you obtain the bulk of your firewood most of the time if you fetch it directly?

from your own farmed plots	______
from relative's farmed plots	______
from non-relative's farmed plots	______
from uncultivated plots	______

37. How far from your settlement is the main place from which you generally obtain firewood?

	less than 1/2ml	1/2-1ml	1-2ml	beyond 2ml
Nearby farm (oko etile)				
Distant farm (oko egan)				

38. Who is primarily responsible for gathering the firewood, if you do not have to buy it?

Adult males within the family	______
adult females within family	______
children within family	______
paid labour	______

39. Who is primarily responsible for conveying the firewood home?

Adult males within the family	______
adult females within family	______
children within family	______
paid labour	______

40. From where do you buy the bulk of your firewood (if you do not fetch it directly)?

from the farm	______
from the roadside distributing points outside the town	______
from special firewood stalls in the town	______
from the market place	______
from firewood vendors	______

41. List FIVE fuelwood types (species) in decreasing order of importance often fetched and/or sold in your locality.

(i) ____________________
(ii) ____________________
(iii) ____________________
(iv) ____________________
(v) ____________________

42. From your personal knowledge, to what extent are the following statements true of firewood especially in comparison with other fuel sources, known to you?

	Untrue	Partly true	Entirely true
Firewood is cheap			
Firewood is accessible			
It has a reliable supply			
It is more readily available in the dry season			
It is easy to use			
It is mainly used by the poor classes of the society			
It is used mainly by illiterates			
It is suitable for traditional cooking			
It is suitable for use in institutions such as hostels, hospitals, prisons.			
It is suitable for use in some factories such as bakeries and brick-burning			
It is the favourite fuel of cooked food sellers			
It is the most preferred fuel source to most people in the locality			

It has an assured future in the energy requirements of rural areas

It can be used in the modern type house

It is now scarcer in quantity than it was ten years ago

43. Do you sell firewood?

Not at all ________ Occasionally ___________ Always ___________

44. If you sell firewood occasionally/always, do you belong to a " selling group/organization "? YES ________ NO ____________

45. What is the numerical size of the organization? _____________

46. To which of the following categories do the bulk of your customers belong?

Individuals who buy firewood for domestic purposes	___________
Firewood retailers in urban areas	___________
Institutions (colleges, hospitals, prisons)	___________
Industries such as bakeries and brick-burning	___________

47. What means of transport is most often used by the majority of those who buy firewood from you?

Personal small cars	_______________
Personal big cars	_______________
Public taxis	_______________
Public lorries	_______________
By head porterage	_______________
By bicycle/motorcycle	_______________

48. Are you satisfied with using the facilities currently available to you for cooking and lighting?

YES _____________ NO _______________

49. Will you like to use a solar cooker or a firewood stove for cooking, if available at a cost not higher than using a gas cooker or electric cooker?

YES _____________ NO _______________

50. What is the most serious difficulty you have in adopting modern up-to-date facilities for cooking and lighting?

No money	__________
Facilities unknown to me	__________
Facilities are known but unavailable	__________
Present accommodation is unsuitable for such facilities	__________

****

APPENDIX B - RESULTS OF THE RURAL SURVEY QUESTIONNAIRE

Please note "0" code implies "No response".

Table 6.1 House type

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	-	1	1	2
1	46	46	23	115
2	51	42	74	167
3	1	5	-	6
4	2	6	2	10
Total	100	100	100	300

Category label

1 - detached Bungalow with single household
2 - undetached Bungalow(s) with more than one household
3 - detached storeyed house with single household
4 - undetached storeyed house with more than one household

Table 6.2 Number of Residents in the House

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
Males Females Children				
0	3: 3: 6	5: 3: 3	2: 3: 3	10: 9: 12
1-2	76: 70: 15	71: 57: 10	81: 63: 22	228:190: 47
3-4	18: 22: 39	15: 30: 35	14: 30: 46	47: 82:121
5-6	2: 4: 22	7: 9: 19	1: 4: 13	10: 17: 54
7+	1: 1: 18	2: 1: 33	2: -: 16	5: 2: 67
Total	100:100:100	100:100:100	100:100:100	300:300:300

Category label

Children - Secondary school age and below

Table 6.3 Number of Rooms in House

Rooms/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	2	1	-	3
1-3	16	4	2	22
4-6	73	72	79	224
7	9	23	19	51
Total	100	100	100	300

Table 6.4 Arrangement of Rooms

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	1	3	-	4
1	87	91	96	274
2	12	6	4	22
Total	100	100	100	300

Category label

1 - Separate rooms occupied on individual basis
2 - Connected rooms in form of stats

Table 6.5 Type of Household Kitchen

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	-	1	-	1
1	54	67	43	164
2	32	21	45	98
3	14	11	12	37
Total	100	100	100	300

Category label

1 - Kitchen is in separate building, detached from main house
2 - Kitchen is inside or part of the main house
3 - open fireplace

Table 6.6 Number of Kitchen Rooms in the House

Rooms/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	15	18	29	62
1	63	64	43	170
2	20	16	26	62
3	-	2	2	4
more than 3	2	-	-	2
Total	100	100	100	300

Table 6.7 Wall Material for the House

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	2	1	-	3
1	1	1	-	2
2	55	36	67	158
3	22	47	29	98
4	11	6	2	19
5	6	5	2	13
6	3	4	-	7
Total	100	100	100	300

Category label

1 - Wooden poles
2 - Mud layers without plaster
3 - Mud layers with cement plaster
4 - Mud block without plaster
5 - Mud blocks with plaster
6 - Cement blocks with or without plaster

Table 6.8 Roof Material for the House

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	2	1	-	3
1	-	5	2	7
2	98	92	98	288
3	-	2	-	2
Total	100	100	100	300

Category label

1 - Thatch
2 - Corrugated 'iron' sheets
3 - Ardex Sheets

Table 6.9 Electricity Supply

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
No response	2	2	-	4
Yes	14	19	1	34
No	84	79	99	262
Total	100	100	100	300

Table 6.10 Source of Water for Domestic Use

Category/Zone	Ile-Ife	Ibadan	Ogbomoso	Combined
0	5	1	-	6
1	81	59	98	238
2	4	32	2	38
3	10	7	-	17
4	-	1	-	1
Total	100	100	100	300

Category label

1 - From streams/rivers
2 - From wells
3 - From pipe-borne water outside the house
4 - From pipe-borne water inside the house

Table 6.11 Respondent Gender

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
Male	93	88	86	267
Female	7	12	14	33
Total	100	100	100	300

Table 6.12 Respondent Age-Group

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	2	-	-	2
20-40	29	34	32	95
41-60	58	50	50	158
over 60	11	16	18	45
Total	100	100	100	300

Table 6.13 Respondent Marital Status

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	-	-	-	-
Married	99	89	97	285
Single	1	11	3	15
Total	100	100	100	300

Table 6.14 Respondent Position in Family

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	-	1	-	1
Landlord	79	74	73	266
Landlady	7	5	9	21
Substitute Landlord etc.	12	16	12	40
Renter	2	4	6	12
Total	100	100	100	300

Table 6.15 Formal Education Level

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	-	1	-	1
1	78	67	80	225
2	13	12	10	35
3	9	14	4	27
4	-	6	6	12
Total	100	100	100	300

Category Label

1 - No formal education
2 - Below primary
3 - Completed primary
4 - Full secondary or teacher training

Table 6.16 Respondent Occupation

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	1	-	-	1
1	81	59	80	220
2	5	13	1	19
3	11	21	12	44
4	1	7	6	14
5	1	-	1	2
Total	100	100	100	300

Category label

1 - Farming
2 - Full-time artisans
3 - Trading/business
4 - Teaching, office (any other white color worker)
5 - Field worker/laborour

Table 6.17 Respondent Income Level

Category/Zone	Ife	Ibadan	Ogbomoso	Combined
0	6	1	-	7
1	86	92	98	276
2	8	7	2	17
Total	100	100	100	300

Category Label

1 - Below 2,500 Naira.
2 - Above 2,500 Naira.

Table 6.18-A Frequency of Fuel Source for Cooking in 1970

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	96	-	-	4	98	1	1	-	100	-	-	-	294	1	1	4
SAWDUST	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
TIMBER OFFCUTS	95	-	1	4	99	-	1	-	98	-	2	-	292	-	4	4
PALM PRODUCTS*	31	53	14	2	39	26	35	-	64	1	35	-	134	80	84	2
ELECTRICITY	96	-	-	4	97	3	-	-	100	-	-	-	293	3	-	4
FIREWOOD	3	97	-	-	5	92	3	-	4	95	1	-	12	284	4	-
GAS	95	1	-	4	98	2	-	-	100	-	-	-	293	3	-	4
KEROSENE	92	2	1	5	93	3	4	-	92	5	3	-	277	10	8	5
TOTALS		100				100				100				300		

*Palm Products such as 'lagidi' is a fire starter.

<u>Category label</u>

1 - Always
2 - Occasionally
3 - Not at all

Table 6.18-B Frequency of Fuel Source for Cooking in 1980

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	98	-	-	4	98	1	1	-	100	-	-	-	294	1	1	4
SAWDUST	95	-	1	4	98	-	2	-	99	-	1	-	292	-	4	4
TIMBER OFFCUTS	100	-	-	-	99	-	1	-	99	-	1	-	298	-	2	-
PALM PRODUCTS*	33	47	18	2	50	21	29	-	67	-	33	-	150	68	80	2
ELECTRICITY	94	1	1	4	98	1	1	-	98	-	2	-	291	2	3	4
FIREWOOD	4	88	8	-	8	85	7	-	9	88	3	-	21	261	18	-
GAS	96	-	-	4	100	-	-	-	98	1	-	1	294	1	-	5
KEROSENE	71	15	11	3	67	14	19	-	83	9	8	-	221	38	38	3
TOTALS		100				100				100				300		

*Palm Products such as 'lagidi' is a fire starter.

<u>Category label</u>

1 - Always
2 - Occasionally
3 - Not at all

Table 6.19 -A Frequency of Fuel Source for Lighting in 1970

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
SAWDUST	95	-	1	4	100	-	-	-	100	-	-	-	295	-	1	4
TIMBER OFFCUTS	95	1	-	4	100	-	-	-	100	-	-	-	295	1	-	4
PALM PRODUCTS	88	4	4	4	94	1	5	-	95	-	5	-	277	5	14	4
ELECTRICITY	92	4	-	4	93	7	-	-	99	1	-	-	284	12	-	4
FIREWOOD	96	-	-	4	98	-	-	-	98	2	-	-	294	2	-	4
GAS	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
KEROSENE	-	94	6	-	4	91	5	-	3	97	-	-	7	282	11	-
TOTALS		100				100				100				300		

<u>Category label</u>

1 – Always
2 – Occasionally
3 – Not at all

Table 6.19 - B Frequency of Fuel Source for Lighting in 1980

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	96	-	-	4	100	-	-	-	99	1	-	-	295	1	-	4
SAWDUST	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
TIMBER OFFCUTS	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
PALM PRODUCTS	93	-	3	4	97	-	3	-	94	-	6	-	284	-	12	4
ELECTRICITY	82	14	-	4	83	17	-	-	98	1	1	-	263	32	1	4
FIREWOOD	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
GAS	96	-	-	4	100	-	-	-	100	-	-	-	296	-	-	4
KEROSENE	2	88	10	-	2	81	17	-	-	99	1	-	4	268	28	-
TOTALS		100				100				100				300		

<u>Category label</u>

1 – Always
2 – Occasionally
3 – Not at all

Table 6.20 -A Fuel Rank According to Present Importance - for Cooking

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	92	-	-	8	98	1	1	-	100	-	-	-	290	1	1	8
SAWDUST	91	-	1	8	99	-	1	-	100	-	-	-	290	-	2	8
TIMBER OFFCUTS	91	-	1	8	98	1	1	-	98	-	2	-	287	1	4	8
PALM PRODUCTS	27	57	12	4	52	43	5	-	69	27	4	-	148	127	21	4
ELECTRICITY	89	3	2	6	98	2	-	-	100	-	-	-	287	5	2	6
FIREWOOD	5	92	1	2	10	88	2	-	5	95	-	-	20	275	3	2
GAS	90	4	-	6	99	1	-	-	100	-	-	-	289	5	-	6
KEROSENE	62	24	12	2	66	28	6	-	81	19	-	-	209	71	18	2
TOTALS			100				100				100			300		

<u>Category label</u>

1 = Most important
2 = --
3 = Least important

Table 6.20 - B Fuel Rank According to Present Importance - for Lighting

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	94	-	-	6	100	-	-	-	100	-	-	-	294	-	-	6
SAWDUST	94	-	-	6	100	-	-	-	100	-	-	-	294	-	-	6
TIMBER OFFCUTS	94	-	-	6	100	-	-	-	100	-	-	-	294	-	-	6
PALM PRODUCTS	83	10	2	5	97	3	-	-	93	7	-	-	273	20	2	5
ELECTRICITY	81	16	-	3	82	18	-	-	100	-	-	-	263	34	-	3
FIREWOOD	89	6	-	5	100	-	-	-	100	-	-	-	289	6	-	5
GAS	92	2	-	6	99	1	-	-	100	-	-	-	291	3	-	6
KEROSENE	-	95	5	-	3	97	-	-	3	100	-	-	3	292	5	-
TOTALS			100				100				100			300		

<u>Category label</u>

1 = Most important
2 = --
3 = Least important

Table 6.21 - A　　　Fuel Source Preference for Cooking

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	100	-	-	-	99	-	1	-	100	-	-	-	299	-	1	-
SAWDUST	100	-	-	-	100	-	-	-	100	-	-	-	300	-	-	-
TIMBER OFFCUTS	99	-	-	-	100	-	-	-	100	-	-	-	299	-	1	-
PALM PRODUCTS	90	7	3	-	92	5	3	-	97	-	3	-	279	12	9	-
ELECTRICITY	29	73	7	-	35	47	17	1	33	62	5	-	88	182	29	1
FIREWOOD	72	16	12	-	59	20	21	-	68	9	23	-	199	45	66	-
GAS	19	52	29	-	17	73	10	-	4	79	17	-	40	204	56	-
KEROSENE	3	50	47	-	6	49	44	1	2	46	52	-	11	145	142	2
TOTALS		100				100				100				300		

Category label

1 - Most preferred
2 - --
3 - Least preferred

Table 6.21 - B　　　Fuel Source Preference for Lighting

FUEL SOURCE	Ife				Ibadan				Ogbomoso				Combined			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
CHARCOAL/COAL	100	-	-	-	99	-	-	1	100	-	-	-	299	-	-	1
SAWDUST	100	-	-	-	99	-	-	1	100	-	-	-	299	-	-	1
TIMBER OFFCUTS	100	-	-	-	98	1	1	-	100	-	-	-	298	1	1	-
PALM PRODUCTS	86	2	12	-	91	-	9	-	83	1	16	-	260	3	37	-
ELECTRICITY	2	96	2	-	3	97	-	-	3	96	1	-	8	289	3	-
FIREWOOD	98	2	-	-	99	1	-	-	100	-	-	-	297	3	-	-
GAS	70	11	19	-	46	18	36	-	42	25	33	-	158	54	88	-
KEROSENE	2	83	15	-	2	79	17	2	3	71	26	-	7	233	58	2
TOTALS		100				100				100				300		

Category label

1 - Most preferred
2 - --
3 - Least preferred

Table 6.21 - C Fuel Preference for Cooking and Lighting in Urban Environment

FUEL SOURCE	Ife		Ibadan		Ogbomoso		Combined	
	Cook	Light	Cook	Light	Cook	Light	Cook	Light
CHARCOAL/COAL	-	-	-	1	-	-	-	1
SAWDUST	-	-	-	-	-	-	-	-
TIMBER OFFCUTS	-	-	-	-	-	-	-	-
PALM PRODUCTS	-	-	-	-	1	-	1	-
ELECTRICITY	19	82	18	85	27	94	65	261
FIREWOOD	22	-	25	1	3	-	40	1
GAS	19	-	37	1	55	-	111	1
KEROSENE	40	18	27	11	11	5	78	34
TOTALS	100	100	100	100	100	100	300	300

Table 6.21 - D Fuel Preference for Cooking and Lighting in Rural Environment

FUEL SOURCE	Ife		Ibadan		Ogbomoso		Combined	
	Cook	Light	Cook	Light	Cook	Light	Cook	Light
CHARCOAL/COAL	-	-	-	1	-	-	-	1
SAWDUST	-	-	-	1	-	-	-	1
TIMBER OFFCUTS	-	-	1	-	-	-	1	-
PALM PRODUCTS	-	-	1	2	-	-	1	2
ELECTRICITY	-	8	1	13	-	-	1	22
FIREWOOD	61	1	59	1	77	-	197	2
GAS	6	-	5	-	1	1	12	-
KEROSENE	33	91	32	81	21	98	86	270
TOTALS	100	100	99	99	99	99	298	298

Table 6.22 - A Firewood Supply Areas

Supply Areas	Ife	Ibadan	Ogbomoso	Combined
0	4	11	4	19
1	86	66	83	235
2	5	17	8	30
3	5	6	5	16
	100	100	100	300

<u>Category label</u>

1 - Directly by fetching it from farm
2 - Entirely by buying it
3 - Partly by fetching and partly by buying

Table 6.22 - B Supply Areas of Directly Fetched Firewood

Supply Areas	Ife	Ibadan	Ogbomoso	Combined
0	9	27	12	48
1	69	52	66	187
2	15	12	13	40
3	-	3	3	6
4	7	6	6	19
	100	100	100	300

<u>Category label</u>

1 - From own farmed plots
2 - From relative's farmed plots
3 - From other's farmed plots
4 - From uncultivated plots

Table 6.22 - C Distance of Firewood Supply Areas (A, B) to Respondent Settlement

Category	Ife A	Ife B	Ibadan A	Ibadan B	Ogbomoso A	Ogbomoso B	Combined A	Combined B
0	12	94	35	83	19	79	76	256
1	15	-	20	5	14	4	49	9
2	53	5	28	7	30	11	111	23
3	16	-	7	1	24	5	47	6
4	4	-	10	4	3	1	17	9
Totals	100		100		100		300	

Category label

1 - Less than ½ mile
2 - ½ to 1 mile
3 - 1 mile to 2 miles
4 - over 2 miles

Supply Areas

A: from 'oko etile' - nearby farm
B: from 'oko egan' - distant farm

Table 6.22 - D Persons Fetching and Conveying Firewood Home

Category	Ife Fetch	Ife Convey	Ibadan Fetch	Ibadan Convey	Ogbomoso Fetch	Ogbomoso Convey	Combined Fetch	Combined Convey
0	10	8	27	22	12	5	49	35
1	20	7	23	8	16	2	59	17
2	59	59	32	34	41	53	132	146
3	11	26	18	34	31	40	60	100
4	-	-	-	3	-	-	-	2
Totals	100		100		100		300	

Category label

1 - Adult males within the family
2 - Adult females within the family
3 - Children within the family
4 - Paid labour

Table 6.23 Firewood Species Fetched or Sold

Spices	Ife					Ibadan					Ogbomoso				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
0	9	9	9	10	9	8	8	11	13	12	1	1	1	2	2
Ire	10	7	8	13	12	6	11	6	11	7	-	-	-	-	-
Cacao	12	6	13	6	10	8	5	-	7	10	-	-	-	-	-
Celtis	15	9	19	7	9	11	10	15	8	6	8	5	5	-	-
Ficus	14	7	-	-	8	16	7	11	8	5	5	-	5	7	-
Albizia	9	-	8	6	-	8	7	14	11	12	-	-	-	8	-
Kola	-	8	9	6	-	-	5	7	7	6	-	-	-	-	-
B.mircantha	-	-	-	9	-	-	8	-	-	-	-	6	5	5	5
Butyrospermum	-	-	-	-	-	-	-	-	-	-	8	-	10	7	-
Acacia	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-
Microdesmis	-	-	-	-	-	-	-	-	-	-	5	7	-	-	5
Hymencoardia	-	-	-	-	-	-	-	-	-	-	5	10	5	5	5
Amogfissus	-	-	-	-	-	-	-	-	-	-	-	-	6	6	11

<u>Category label</u>

1 -> 5 (most important -> least important)

Table 6.24 Personal Views of Statement on Firewood

Statements	Ife				Ibadan				Ogbomoso				Combined			
	O	U	P	T	O	U	P	T	O	U	P	T	O	U	P	T
1	2	17	36	45	4	26	27	43	-	12	42	46	6	55	105	134
2	2	8	35	55	3	16	40	41	-	5	66	29	5	29	141	125
3	2	8	35	60	4	15	37	44	-	9	36	55	6	32	103	159
4	2	4	12	82	3	1	16	80	-	4	28	68	5	9	36	230
5	2	37	23	38	2	41	38	19	-	11	61	28	4	89	122	85
6	2	16	31	51	3	15	30	52	-	10	34	56	5	41	95	159
7	3	18	38	41	4	16	26	54	-	11	26	63	7	45	90	158
8	3	2	18	77	3	8	26	63	1	8	61	30	7	18	105	170
9	3	6	9	82	7	18	34	41	1	13	36	50	11	37	79	173
10	2	-	6	92	4	7	13	76	1	5	34	60	7	12	53	228
11	2	3	13	82	3	9	36	52	-	16	55	29	5	28	14	163
12	2	6	21	71	4	17	34	45	-	7	34	59	6	30	89	75
13	1	8	29	62	3	21	41	35	-	7	46	47	4	36	116	144
14	1	44	27	28	4	34	50	12	-	9	73	18	5	87	150	58
15	1	11	5	83	4	2	13	81	-	9	24	67	5	22	42	231

Category label

U Untrue
P Partly true
T True

1 : It is cheap
2 : It is accessible
3 : It has a reliable supply
4 : It is more readily available in dry season
5 : It is easy to use
6 : It is namely used by poor classes of society
7 : It is used mainly by illiterates
8 : It is suitable for traditional cooking
9 : It is suitable for use in institutions such as hostels, hospitals, prisons
10 : It is suitable for use in some factories such as brick-making and bakeries
11 : It is the favorite fuel of cooked food sellers
12 : It is most preferred fuel source to most people in the locality
13 : It has assured future in the energy requirements of rural areas
14 : It can be used in the modern type house
15 : It is now scarcer in quantity than it was ten years ago.

Table 6.25 Respondent Satisfaction with Existing Facilities for Cooking, Lighting

Category	Ife	Ibadan	Ogbomoso	Combined
0	1	1	-	2
Yes	30	18	20	70
No	69	81	78	228
Total	100	100	100	300

Table 6.26 Solar Cooker Use

Category	Ife	Ibadan	Ogbomoso	Combined
0	1	-	-	1
Yes	96	98	98	292
No	3	2	2	7
Total	100	100	100	300

Table 6.27 Difficulties in Adopting Modern Cooking and Lighting Facilities

Category	Ife	Ibadan	Ogbomoso	Combined
0	2	-	-	2
1	14	63	62	199
2	18	12	17	47
3	5	21	15	41
4	1	4	6	11
Total	100	100	100	300

Category label

1 - No money
2 - Facilities unknown to me
3 - Facilities are known but not available
4 - Present accommodation is unsuitable for such facilities.

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