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SOCIO-ECONOMIC ANALYSIS OF FUELWOOD PRODUCTION AND CONSUMPTION IN IMO-STATE.

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TITLE PAGE

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By

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Department Of Agricultural Economics
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April, 2001.

CERTIFICATION

Henry Chiaka Unaeze, a postgraduate student in the Department of Agricultural Economics and with the Registration Number PG/MSC/97/23841 has satisfactorily completed the requirements for the degree of Master of Science in Agricultural Economics. The work embodied in this thesis is original and has not been submitted in part or full for any other diploma of degree of this or any other University.

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Date......7/5/2001......

DEDICATION

This research report is gratefully and affectionately dedicated to God Almighty who made it all possible, and my lovable uncle Dr. Unaeze Nwaeze, who taught me patience, determination and above all love for moving on in this world to his fatherly training I owed the better part of my education.

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ABSTRACT

This study was carried out to investigate the socio-economic analysis of fuelwood production and consumption in Imo State as there has been lack of information about socio-economic ramifications of fuelwood production and consumption in the state. A multi – stage sampling techniques was used in the selection of 400 rural and urban respondents. The data obtained were analysed using percentage, multiple regression model and chow test techniques.

It was found out that among the various socio-economic factors considered in this study, only total area under cultivation, measured in hectares (Ha) and amount of labour available measured in numbers (Nos.) were found to influence fuelwood production in positive direction, while the consumption rate of fuelwood were influence by total self produced fuelwood as a percentage of total consumed fuelwood (fsp) and household size (Hs). The chow-test result showed that there was a significant difference between the amount of fuelwood consumed by rural and urban households. And majority of rural farming households were assisted by their children while producing or sourcing fuelwood and time spent by most respondents (52.5%) are 2 – 4 hours and frequency of producing this woody resource is three times a week.

It was also found that in spite of the importance of fuelwood in rural energy system, its production and consumption impose dangers to those directly involved in its utilization (drudgery deforestation and health problems associated

with fire-wood "smoke"). Introduction of efficient wood burning stove has not been encouraged extensively. There is therefore need for government and international organizations to carry out poverty alleviation programmes in order to increase rural income so that they can afford alternative energy sources (like kerosene and gas) thereby reducing pressure on their forested land.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

Fuelwood is wood and pulp material obtained from trunks, branches and other parts of trees and shrubs which is used as fuel for cooking, heating or generating energy through direct combustion, not only in households but also in rural industries (Curing, smoking, etc) (FAO, 1981).

Fuelwood is the most commonly used fuel energy in areas classified as developing economies. The vast majority of the rural dwellers in these parts of the world depend on fuelwood for cooking and heating and for other domestic and non-domestic purposes. Domestic consumption represents by far, the larger share of total consumption; rural consumption accounts for much more than urban consumption.

Therefore, fuelwood is an important source of energy in rural households.

There is evidence that demand for fuelwood is rapidly increasing in Nigeria (Aliyu and Bakshi, 1997). This is probably because of scarcity and high cost of alternative energy sources. There is also strong evidence that supply of fuelwood is rapidly increasing. This has led to uncontrolled exploitation of virgin forest which culminate into environmental degradation.

Evidence from appendix 1, shows that demand/supply gap of fuelwood is increasing in positive terms over the years. This rapid increase in gap according to

Igbozurike (1981) has caused scarcity of wood resources as a result of pressures on the available forested areas. This has precipitated serious physical, social and economic problems. For example, less time is given to agricultural activities as a result of time given to fuelwood production. Also lack of dietary intakes of rural dwellers, as attention is shifted to food with less cooking time, serious health hazard, as a result of fuelwood consumption, especially the smoke.

It becomes obvious, then that this accelerating energy demand and its concomitant problem are most realistically seen in the perspective of whole national economies.

In 1995 World Energy Council estimated that between 700 million and 1350 million hectares of land are needed for fuelwood energy production by the middle of the next century to close the global energy balance (Nilsson, 1996).

Evidence around in official report that the demand for fuelwood is greater in developing countries than in the developed nations. (FAO, 1981). For example, In 1975, while the developed countries recorded a decrease of 48.62 per cent from 80.99 million metric tones to 41.66 million metric tones, the developing region consumption rate increases from 531.25 million to 640.47 million mt (FAO, 1975). Generally, Africa's consumption rose by 23.08 per cent from 154.45 million mt to 190.21 million mt in 1975 (FAO, 1975). In addition, Adeyoju (1965) noted that the world consumed an average of 805.41 million (mt) of fuelwood. And in 1975 the figure was 878.99 mt a 9.13 per cent increase. Also in Nigeria, the annual fuelwood demand was 86.36 million mt in 1975 (FAO, 1975).

Similarly FAO (1981) observed that in Africa between 90 and 98 per cent of energy needs in the rural areas are met by fuelwood, which accounts for more than 90 per cent of national energy supplies. In Nigeria, consumption of fuelwood represents 80% per cent of the total energy consumed (NEST, 1991). Igbozuruike (1981) stated that in Owerri, Imo State, fuelwood consumption by 88 households ranges from 2.25 kg daily or 0.822 tones per annum for a single person household to 31 kg daily or 11.323 tones per annum for a sixteen person households.

Since fuelwood is a major source of energy in rural households in Nigeria as well as other developing countries, it therefore becomes necessary to identify the factors affecting fuelwood consumption and production in Nigeria. Dewee (1983) noted that a lot of socio-economic variables affect fuelwood production and consumption in rural communities. Some of the socio-economic factors according to Dewee are, household size, household income, labour, level of education, access to fuelwood among others.

1.2 PROBLEM STATEMENT

Fuelwood is an important source of energy for both rural and urban households in developing countries, Aliyu and Bakshi (1997). Pandy and Ball (1998) noted that this increasing need of fuelwood in both rural and urban households, was as a result of scarcity and / or high prices of the alternative energy source (such as kerosene, gas, electricity among others). Worse still, these alternative uses to which the fuelwood materials can be put, compete with basic need of the fuelwood used in cooking food or heating the homes among other notables uses of fuelwood. This competition and attendant scarcity, therefore increases the burden of fuelwood energy search and availability. It has been reported that fuelwood problems are part of a wider crisis of survival for rural and urban households (NEST, 1991).

Specifically, Apsey and Reed (1995), estimated households fuelwood energy demand to be 4.5 billion m^3 in the world while the supply is currently put at 2.5 billion m^3. In view of the apparent shortage, World Energy Council (WEC, 1995) estimated that between 700 million and 1350 million hectares of land are needed for biomass energy demand by the middle of the next century, to close the global energy balance. This rapid gap between the demand and supply of fuelwood among the households has contributed to serious negative implications on biodiversity of the developing countries. The rapid demand for fuelwood has contributed to some environmental problems like soil erosion, declining soil fertility, deforestation and so on.

The crisis of fuelwood shortages facing a vast proportion of people in the third world for whom it is principal and often, the sole source of alternative energy are enormous (Agarwal, 1986). The shortages are manifested also in long hours spent (especially by women and children) for gathering fuelwood thereby affecting the time they devote, to productive agricultural activities. Also families go hungry because they do not have enough firewood and as such dietary intake is low, as attention is being shifted to foods with less cooking time than highly proteinous food with longer cooking time, even in cities (Kamweti, 1980).

In fact the recent shortages in fuelwood supply has resulted to major socio-economic problems among the rural households who are mostly farmers.

Even though many studies have been under taken to appraise rural fuelwood in Nigeria, very few have taken into account, the socio-economic ramifications of fuelwood production and consumption, as a result, there is inadequate research information and empirical guide for future programmes wanting to address the socio-economic dimension of fuelwood consumption and production in rural farming households.

Moreso, socio-economic analysis of fuelwood consumption and production forms one of the main concerns of important analysis of the development process and this study is aimed at empirically address this issue of major development significance.

1.3 OBJECTIVES OF THE STUDY

The broad objective of this study is to assess the socio-economic factors affecting fuelwood production and consumption in Imo State.

The specific objectives are:

1. to determine and examine the fuelwood production patterns.

2. to identify and examine the constraints of fuelwood production, and consumption.

3. to determine and assess the socio-economic factors affecting fuelwood production, by farming households

4. to determine and examine the socio-economic factors affecting fuelwood consumption by farming households

5. to compare fuelwood consumption patterns and their determinant in rural and urban areas.

6. to make policy recommendation for improving fuelwood economy.

1.4 RESEARCH HYPOTHESES

1. Fuelwood production is not influenced by socio-economic characteristics of farmer-producers.

2. Fuelwood consumption is not affected by the socio-economic characteristics of farmer-producers.

3. Fuelwood consumption patterns among rural households do not significantly differ from that of urban households.

1.5 JUSTIFICATION OF THE STUDY

Fuelwood plays a tremendous role in rural energy system. It supplies about 80 per cent of the total energy required (NEST, 1991). But due to traditional way of fuelwood production and consumption, some questions have been raised on how to conserve this woody resources, in order not to face exhaustion and other problems faced by those who are involved in their collection, for example, low dietary intake, serious health hazard as a result of fuelwood consumption, ecological degradation and problems of biodiversity and so on.

In view of the problem of unstable and high cost of alternative energy sources, like kerosene, electricity and gas, transition is likely to take some time, as, emphasis is still on fuelwood,and the rate at which transition to alternative energy source will occur, depends on the income and some other socio-economic factors of the rural populace and developmental policies (World Bank, 1996). The extent to which rural dwellers use fuelwood, coupled with population growth, shows that for many years to come, fuelwood will still be the major source of rural energy.

And this study will go to help fashion a way of improving the method with which fuelwood are sourced and consumed . And promoting more sustainable ways to supply fuelwood . Also it will be beneficial to researchers and students as a reference material.

CHAPTER TWO

LITERATURE REVIEW

THE RURAL ENERGY SITUATION

Fuelwood plays a major role in supplying energy to the rural masses and the poorest groups in the towns. It occupies a special place in rural energy systems, owing to the importance of the domestic consumption for which it is mainly used and the fact that it is produced within the system itself (FAO, 1981).

Traditional fuels plays a dominant role in the provision of fuel representing about 77 per cent of total energy consumption. These traditional fuels are mainly fuelwood, shrubs, cow dung and crop residues. (Mohapeloa et al., 1992). The World Bank (1996) recognised the fact that approximately one-third of all energy consumption in developing countries are derived from the burning of wood crop residues and animal dung.

Fuelwood consumed domestically is often gathered in the form of twigs and branches from forest floors or from trees located on open roads and in fields, and removals are largely unrecorded (Agarwal, 1983).

Nigerian Environmental study Action Team (1991) observed that fuelwood is the most important of all traditional fuels. The vast majority of rural Nigerians depend on fuelwood for cooking and heating for both domestic and non-domestic purposes. Domestic consumption represents the largest share of the total consumption. They also went on to note that in many rural areas of Nigeria, fuelwood supplies over 80 per cent of the total energy consumed for all purposes.

In rural areas, wood is usually burnt directly as fuel in most households. Of the total traditional energy (from firewood, crop residues and dungs), consumed in Third World Countries 79 percent is as firewood, 17 per cent as crop residues and 4 per cent as dung, (Smile, 1979). In Nigeria and Indonesia, the percentage for firewood is even higher, it accounts for 92 per cent and above. To a large proportion of the people in the rural areas of the Third World, especially in Asia and Africa, firewood constitutes the main and for some, the sole source of inanimate energy. Given that in the majority of these countries 70 per cent or more of the population are rural based, this would account for a significant dependence by their people on firewood. Wood, whether burnt directly as firewood or after conversion to charcoal, may be seen to be the most important source of energy, especially domestic energy in use in much of the Third World.

In most rural areas, firewood has been and still largely tends to be non-monetized, so that people usually have to depend on what they can gather themselves. By one estimate, for rural India, only 12.7 per cent of total firewood consumed is purchased, the rest being obtained either from ones own land or from the land of others (Government of India, 1982).

Further more as urbanisation increases, the gap between rural and urban consumption is more localised in geographic space than rural consumption (NEST, 1991).

FAO (1981) observed that the contribution of fuelwood as a source of energy is not limited to rural energy systems or to subsistence sectors, urban areas account for an increasing share of fuelwood consumption, owing both to the migration of country people who conserve a rural way of life and to the dependence of the poorest families, who continue to rely on wood for their domestic needs. However, urban demand, constitute an important factor, disrupting rural energy supplies.

Rural area depends predominantly on fuelwood, while urban areas depend more on charcoal, this explains why consumption of fuelwood predominates over charcoal. Fuelwood accounts for 80 per cent and charcoal for 15 per cent. (Nyoike and Okech, 1992).

There is almost no competition for fuelwood resource between the two main types of consumers: households and industry. These group tend to be physically isolated from each other and to obtain their raw material from different sources; for instance, fuelwood for cooking and home heating in rural areas where most people live in developing countries is supplied primarily from dead trees pruning and other woody wastes (Pandy and Ball, 1998). They went further to note that household and commercial users (bakeries, restaurants, street food vendors) of fuelwood from large urban centres are characterised by their high demand for fuelwood derived from a relatively small area. And this type of use can lead to serious fuelwood shortages and depletion of forests.

In another development they noted, that areas with a combination of urban and peri-urban fuelwood users, for both household and commercial activities consideration need to be given to the competition that forms between the different users. For example, in parts of the Sudan, local bread making industries are highly resented by household fuelwood users, because they use trucks and motorized equipment to remove comparatively large quantities of wood for energy.

Conflicts among the different users are not apparent on a general scale. However, in certain geographical areas and during some periods of the year, there is competition for wood raw-material among energy and industrial consumers. For example, this conflicts occurs between the pulp and paper industries, iron makers and cement factories in certain areas of the state of Minas Gerais, where such users dispute the control of some forest resources (FAO, 1996). When fuelwood are scarce in rural areas, the time people spend collecting it reduces the time they devote to productive agricultural activities.

2.2 ALTERNATIVE PRODUCES OF ENERGY IN RURAL AREA

Fuelwood energy shortages have reached a crisis level, and in facing this crisis different energy choices will have to be made. When it becomes scarce, households are forced to rely on low quality fuels, sticks twigs, agricultural residues and animal dung (Dewees, 1983).

Kerosene and electricity can substitute favourably with fuelwood. This is because, kerosene is possible fuelwood energy substitutes. However, only small proportion of rural households use kerosene for their daily cooking or heating. This may be due to fuel distribution and the total cost of adopting the technology. Like the introduction of traditional metal stove in 1900's in Kenya, which was adopted widely (Juma and Namye, 1987), the charcoal burning stove that was introduced is inefficient. It loses a lot of heat, and the ceramic jiko (KCJ) developed recently in Kenya is an improvement upon charcoal burning stove and traditional metal stove.

Moreover a number of studies, suggest that other renewable energy alternatives, such as solar and wind technologies or even biogas are not yet at a stage of development where they can be adapted successfully to adequately serve the needs fuelwood currently serve in third world countries like Nigeria. A variety of specific problems in addition to high costs, in adapting solar cookers for home use, such as the time of cooking, the adequacy of sunlight etc are seen to make them unsuitable in a particular cultural and physical environment (Prasad, 1979).

Since tradition in cooking methods plays a very major part, it is doubtful if much could be done in changing traditional methods; efforts made to introduce solar cookers in villages, have completely failed (Walton et al., 1978).

Adoption of electricity for cooking and heating was examined in some rural areas, which later became a beneficiary of the rural electrification program (Government of Kenya, 1983).

2.3 EFFECTS OF FUELWOOD SHORTAGE ON FOOD CONSUMPTION

According to Fleuret (1998) fewer meals are cooked due to shortages in fuelwood supplies, and fuelwood shortages have in some cases reduced households to one cooked meal a day. Similarly, observation were made by Kamweti (1980), National Research Council (1981) and Cecelski (1984), that it is difficult in many cases to separate reductions in cooking, due to lack of fuel and those due to lack of time. Shortage of fuelwood leads to reduced frequency of preparation of appropriate foods for infants, toddlers and the sick (Kamweti, 1980, and Cecelski 1984).

Energy shortages lead to the consumption of raw or inadequately cooked foodstuffs, rather than fully cooked items (Flueret, 1979), while Pimentel and Pimentel (1985) noted that shortages of fuelwood lead to a reduction in or abandonment of fuel intensive food processing and storage technologies.

In situations of fuel shortage, the consumption of gruels by the entire household has been shown to increase. These gruels have short cooking times compared to those for the preparation of normal adult fare, Fleuret (1985). Foods with shorter cooking times are substituted for those with longer cooking times, as a result of fuelwood shortage (Kamweti, 1980). Two examples are substitution of greens for beans and of rice for sorghum.

National Research Council (1981) observed that shortage of fuelwood leads to the purchase of food from street foods shops, market places and itinerant vendors.

2.4 GENDER ISSUES IN FUELWOOD PRODUCTION AND CONSUMPTION

The vast majority of rural Nigerians depend on fuelwood for cooking and heating for both domestic and non-domestic purposes. The division of labour by gender in Nigeria ensures that women, assisted by girls are largely responsible for fuelwood collection for household use. For example, it is common on the Jos Plateau to see women desperately hacking away at shrubs and deadwoods with children on their backs. They trek up to 5 km into the hills seeking for fuelwood, and they make such trips two or three times a week (NEST, 1991).

As fuelwood becomes a commercial commodity, its control and management shift from women to men (Carloni, 1984); and female labour time reallocation as a consequence of fuelwood scarcity makes increased demands on human energy and increases the possibility of a negative female energy balance.

Further, Jongma and Arnold (1977) Adams et al (1980) and Cecelski (1984) believed that increasing women's workloads lengthening their working day or substituting more physically demanding work for less intensive activity has the potential to affect negatively energy balance, energy reserves and nutritonal status.

Fuelwood shortage and consequent increased labour demands, may lead to the reallocation of collection responsibility to others, particularly children (Fleuret, 1978).

Sending female children to school has significant effects on their mother's workload and time allocation, because the result is net labour loss, particular for domestic maintenance activities (Barnes, 1982).

Fuelwood is usually gathered by women and children for family's own needs in the immediate vicinity of the home, gathering the family's energy supply is an essential chore, which may occupy a considerable part of the working day (FAO, 1981).

Similarly, observation was made by Astra (1981) that the collection of fuelwood in most parts of the Third World is done primarily (and sometimes exclusively) by women and children, with men usually (but not always) providing some supplementary labour. The actual time taken for collection varies in different regions according to the availability of tree reproduces, but in most cases, it is a strenuous and time consuming task. In a significant number of cases the time is 3 – 4 hours per day or more. In some areas, as in the Sahel, women, have to walk up to 10 km for this purpose. In Gambia it takes from midday to nightfall to gather an evening supply, while in parts of India, women spend five hours per day on an average travelling 5km or more over a difficult mountainous terrain.

In Tanzania, every aspect of fires and fuels is the work of women, and no other task is considered to be as tiring or as demanding or to have so little to show for itself (Fleuret 1978). In some parts of East Africa, the collection of firewood is considered appropriate only for married women, although in most countries, children especially young girls, help their mothers (Devres, 1980).

Women are always the ones that sell firewood in some areas. And they are mostly belonging to the poorer households, who take the wood to nearby towns. Also firewood sales represents the sole produce of income in many cases (Digerness, 1977). Fore example in some parts of India, women of poor tribal households, travel 8 – 10 km in search of firewood (which is usually procured illegally) then catch a truck or train to the nearby town (Ranchi) spend the night at the station and return with a meager earning of Rs 5.50 on an average for a headload of about 20kg of wood (Bhaduri and Surin, 1980).

2.5 THE EFFECTS OF FUELWOOD CONSUMPTION ON HEALTH

Apart from the economic hardship associated with gathering and cooking with fuelwood, the indoor air pollution created by such fuels constitutes health hazards, particularly to women and children (World bank, 1996).

A study was carried by World Bank, (1992) on smoke from the use of fuelwood in rural areas in which it was discovered that non-smoking women who are exposed to biomass smoke have been found to have abnormally high levels of chronic respiratory disease, with mortality from this condition, occurring at far earlier ages than in other populations, and at rates comparable to those of male heavy smokers.

Levels of solid particulate matter that regularly exceed the safe levels have been discovered (Smith et al, 1993) and it was cited in World Health Organisation guidelines by several orders of magnitude. They discovered that cooking can expose women and children to such levels for several hours a day. This has serious health effect, which have been studied systematically and found that, they are often just as serious as the effects of cigarette smoking. Carbon monoxide emissions may give rise to ambient concentrations that interfere with the body's normal absorption of oxygen. Estimates indicate that smoke contributes to acute respiratory infections that kill 4 million infants and children a year. Recurrent episodes of such infections show up in adults as chronic bronchitis and emphysema, which can eventually lead to heart failure.

Fuelwood as a Source of energy in rural communities, has an adverse effect on the health of women and children, especially children (Smith, 1987). He went further to say, that provision of improved wood stoves along with household education and extension programmes can help remedy this health hazard caused by consumption of fuelwood. A study of 500 children under five years of age in Gambia found that girls who were carried on their mother's back as they cooked in smoky huts, had a risk of acute respiratory illness, six times that of other children. Also a study in Papua New Guinea and India, showed that non-smoking women who have cooked on wood stoves for many years exhibit a higher prevalence of chronic lung disease than those who have had lower levels of exposure to cooking smoke (Smith, 1991).

2.6 ENVIRONMENTAL EFFECTS OF FUELWOOD CONSUMPTION

The costs to the environment of fuelwood use, in terms of increased deforestation, soil erosion and reduced, soil fertility have attracted much attention. Collection of fuelwood frequently leads to ecological damage to forest, woodlands and farmlands, where trees cover losses were severe, all the natural cycles through which nutrients were returned to an initially rich topsoil will be washed away. This happens through losses of grasses, crop residues and dung, as they are used for fuel, instead of being used to fertilize the soil (Newcombe, 1984).

Farms with good tree cover, where farmers have planted trees as windbreakers or shelter belts, have yielded 20 to 50 per cent higher than those without good tree cover. It is becoming increasingly accepted that, the primary causes of deforestation are more closely related to land clearance to support agricultural expansion. (Bajracharaya, 1983).

Fuelwood harvesting by itself is not necessarily a destructive form of tree management, as it could only involve hacking off a few branches from a live tree or the collection of dead wood. This is because, as long as the root stock is not dstroyed, the productivity of woodlands under this type of stress brought about by fuelwood harvesting can be significantly higher than woodlands which are not stressed this way (Klee, 1980 and FAO, 1986). Fuelwood scarcity is as much a consequence as a cause of deforestation (Eckholm et al., 1984).

2.7 SOCIO-ECONOMIC ATTRIBUTES OF FUELDWOOD PRODUCTION AND CONSUMPTION.

Household labour use and availability is the single most important factor associated with households level of fuelwood consumption and production (Cecelski, 1987).

Consumption decline with less availability of labour. Number of children and household structure affects production and consumption of fuelwood.

Household size has direct relationship with fuelwood consumption level. Household with the largest number of children would tend to produce and consume more fuelwood (Igbozurike, 1981). Household level of education limit fuelwood consumption and production (Kumar and Hotchkiss, 1988). As household level of education, increases the less fuelwood consumption as a result of ease of accepting an innovation towards alternative source of energy; for example, wood stove in Kenya. It was found that those with high educational level were able to accept an innovation (wood stove) through extension contact.

Household income level determines the rate at which fuelwood is produced and consumed. As household income increases, the less fuelwood is utilized as a produce of energy because attention will be shifted to alternative energy produce like kerosene, gas etc (Digerness, 1977).

Sex plays a tremendous role in determining fuelwood production rate. In 1978, Nag et al., found out that fuelwood production or collection is principally a woman's task. However, the evidence suggests that the gender division of labour is not always so straightforward. Studies of household labour use, differentiated by task, sex and age, for instance, provide startlingly different information about the role of men, women and children in fuelwood production. However, Carloni (1984) noted that as fuelwood becomes a commercial commodity, its control and management shifts from women to men.

The division of labour by gender ensures that women, assisted by girls are largely responsible for fuelwood production for household use (NEST, 1991). Households headed by mothers infirm women, have expressed particular interest in concentrating toddler and fuel reproduces on or around the farm (Rocheleau, 1985).

Households belief system (world view), have a direct influence on the rate at which they produce and consume fuelwood. This can be expressed on cultural restrictions on some trees species utilization as fuelwood by households. For example OFO tree *Detarium microcarpum*, is believed that it is from this tree that the single most important artifactual symbol, that is, OFO of Igbo traditional religion is exclusively fashioned, (Ojo, 1979). Much the same sort of taboo is associated with many of the true epiphytes, especially *loranthus*, which is avoided with almost equal care; one of the reasons commonly given being that it features prominently in the herbal preparations of native medicine men (Igbozuruike, 1981).

2.8 TOWARDS SUSTAINABLE FUELWOOD PRODUCTION AND USE

Forest and trees provide a significant share of global energy requirements both in developing and developed countries. Besides their traditional utilization as fuel for cooking (the primary energy produce for more than two billion people) the use of fuelwood as a modern and environmentally suitable produce of energy for industry and power generation is expanding (FAO, 1995) Fuelwood at present accounts for more than 16 percent of total energy supply in Sweden, Finland, Austria and other European union countries (FAO, 1997). Recent international fora and agreements, .have highlighted the environmental advantages of bio-energy utilization, mainly with regard to the carbondioxide (Co_2) cycle and greenhouse gas emission mitigation creating an additional thrust for fuelwood energy expansion (UN, 1997).

Although wood resources are renewable, they are not infinite and the increasing demand on forests and trees for energy and also for other wood and non wood product (including, but not limited to timber wood for pulp and paper production) raises the question of the sustainability of long term supply.

Fuelwood is the primary source of household energy for the developing world. More than 2000 million people use wood or charcoal to cook and preserve their food. But in the face of population pressure and widespread deforestation fuelwood supplies are being depleted rapidly. (FAO, 1981).

Annual deforestation of the woodlands in the northern part of Nigeria runs to about 92,000 hectres a year. The fuelwood extraction rate in the country is estimated to be about 3.85 times the rate of regrowth and almost ten times, the rate of regeneration (Okafor, 1990).

These speculative figure give a rough idea of the magnitude of the problem and the degree of severe population pressure on woody species in many parts of our arid and semi-arid regions. NEST (1990) noted that, as population increases, wood will become scarcer.

When free wood energy supplies are exhausted or are too difficult for people to tap into, fuelwood markets develop. Many attempts to develop plantations in peri-urban areas, exclusively for fuelwood, have met with limited success. Sufficient land to fulfil the fuelwood demand was unavailable or the cost of plantation establishment and management were too high. However, the central issue is not how to supply more energy (in whatever form) but rather how to ensure that the energy needs of sustainable development paths are met in the most effective manner. Energy is a crucial factor for sustainable socio-economic development in many regions. In 1995, it was estimated that 4 billion people did not have the energy required for sustainable development (Soussan et al., 1991).

Nilsson (1996) estimated the requirement for fuelwood and charcoal at 4.5 billion m^3 by the year 2020. This varies significantly from conventional demand estimates based on consumption trends. Also, 2.5 billion m^3 for the same year was estimated by Apsey and Reed (1995). These conventional estimates mainly deal with household demands and the developing worlds energy requirements. In contrast, wood fibres are also expected to play a more important role in large scale energy systems in the future.

A large amount of between 700 million and 1350 million hectares of land are needed for biomass energy production by the middle of the next century to close the global energy balance. However, this estimate was made prior to the conference on climate, the outcome of which postulates an even greater importance of wood for energy in the future (World energy council, 1995).

The total annual consumption of wood in Nigeria is about 50 to 55 million cubic metres of which about 90 per cent is firewood. Annual deficit of fuelwood in the northern part of the country is about 5 to 8 million cubic metres. Government efforts to reduce firewood consumption have not been successful because of frequent shortages of cooking gas and kerosene, that could be used as energy source alternatives. In any case these fossil fuels, besides their supply irregularities are now definitely priced out of the reach of most Nigerians, and are therefore no longer available as alternatives to fuelwood (NEST, 1991). However, there are likely lower-cost ways of creating additional energy supplies by conserving woodfuel. When conservation is no longer an option, other strategies can be undertaken to augment supplies.

Tree planting and management interventions, must be more responsive to the much broader range of the needs of the farming system. Some aid agencies, governments, non-governmental organisations (NGOs) and local organisations have of course done better than others in adopting a broader view of trees within development projects. The experience of programmes which have encouraged tree growing to provide multiple outputs has reinforced the assessment that farmers widely value trees for a variety of inputs, into their household and farming system, and will pursue tree growing strategies, which provide as large an aggregate as possible of multiple benefits (Dewees, 1989).

On the other hand, at the traditional villager's scale of operation and expectation, is to encourage ruralities, through "plant-a-tree" campaigns and other measures to cultivate more intensively, those species they prefer as fuelwood. Also, government or corporate level, is the intensification of efforts on the establishment of mixed fuelwood plantations and woodlots, not only in urban districts, where the few that are presently available in the country appear to be concentrated, but also in rural areas for it is in these rural areas, that the bulk of the fuelwood is consumed. In these efforts use should be made of the familiar fast growing species such as *Gmelina arborea* and *Eualypus spp.* as well as the uncommon or contemporarily exotic even faster growing and above all leguminous tree like *sesbania grandiflora, leucaena leucocephala, calliandra collothyrsus* and *Albizia alcuteria,* (Igbozuruike, 1981).

Trees are fundamental for truly sustainable development, but for a range of reasons. The challenge is really to find ways of responding to this broader range of household needs for tree products, for building timber, fodder, fruit, fibre, soil conservation and improvement shade and enjoyment and income generation, as well as for fuel (Dewees, 1989).

Also open fires should be replaced by simple and very cheap stoves, fuelwood consumption could be reduced by one third i.e. to 180kg/year per person. By using stoves, by the more efficient use of fuelwood and in part also by a change in eating and cooking habits, fuelwood consumption in the rural areas could be effectively cut down. (Maydell, 1986).

As fuelwood and charcoal will continue to be the prime energy produce, and the future demand must be expected to increase, an appropriate choice of tree species for natural regeneration and plantation is important. In view of the production costs the selection of species should aim at short rotations of approximately 5 years. (Maydell, 1986).

2.9 THEORETICAL FRAMEWORK

Production and consumption have been defined by various scholars. A method of production is the transformation of inputs into output. A unique relationship exists between the amounts of labour, capital, and land inputs utilized in productive activity and the creation of goods and services, and as a general rule, an increase in the utilization of resources results in an increase in the level of output. Technology defined as the society's pool of knowledge regarding the industrial arts is also important in setting the level of production. An increase in technology results in an increase in output, given the quantities of labour, land and capital. In other words, an increase in technology reduces the amount needed to produce any given level of output. This relationship between technology and resources on the one hand and output on the other is called the production function and it can be expressed as Y= F(N,K,L,T), where Y, N, K and L are real production, labour, capital and land inputs respectively and T is technology. (Leonards, 1979).

Also Koutsoyiannis (1979) stated that production function is purely a technical relation which connects factor inputs and output. It describes the laws of proportion, represents the technology of the and includes all the technically efficient methods of production. The choice of any particular production processes at any time is a decision which depends on the prices of inputs and output, and not a technical decision alone.

Efficiency means a production situation where there is no waste (Samuelson and Nordhaus, 1985). Technical efficiency is measured by relation the level of output achieved to the quantities of inputs used (Upton, 1979, Muller,1974).

Allocative or price efficiency is the ability to choose the level of inputs that maximizes profit given factor prices (Jeffrey, 1992, Mock 1981, Herdt and Maudac, 1981: Timmer 1970, Carlsson, 1972). Economic efficiency is a combination of technical efficiency and allocative or price efficiency. (Bravo-ureta, 1986).

Production function provides enough data needed to measure the efficiency of inputs used and the pattern of outputs which maximizes profits (Mock, 1981, and Olayide and Heady, 1982).

Production of fuelwood is going to be a function of ; total income of the household head in naira, amount of farm labour available (Farming household size), ownership of woodlots or woodland, total area under cultivation measured in hectares, educational level of households head, gender of household-head.Consumption on the other hand is a function of wealth, interest rate, and taste, expressed as C =F (N, I, T) (Milton,1957).Taste is influenced by age,household size etc.Milton (1957) developed a theory of aggregate consumption demand,called the permanent income hypotheses .This hypotheses explains the differences in the average propensities to consume among rural and urban black and non-black, and less educated and educated heads- of- household families of similar measured incomes by the same mechanism ,the difference between measured and permanent income. The permanent income of a non black (urban and highly educated head- of- household) family is larger on average than that of a black rural and less well-educated head-of –household family of similar measured income .

Permanent consumption developed by Milton depends on the size of the family and ages of its member, a change in these factors as well as taste affects permanent consumption , through changes in the socio-economic characteristics of the consumers and hence marginal propensity to consume, given permanent disposable income. Families consume according to permanent income, not measured income as it contains transitory element as well as permanent.

Consumption of fuelwood is influenced by household income (off-farm +farm) amount of alternative energy used, household size, education status of-farming household-head, self produced fuelwood as a percentages of-total consumed fuelwood in percentage. Production and consumption of fuelwood is determined by household income. As household income increases, the less fuelwood is utilized as a source of energy, as attention is shifted to alternative energy source like kerosene, gas and electricity(Digerness, 1977).Household size has direct relationship with fuelwood consumption level and production. Household with the largest number of children would tend to produced and consume more fuelwood,(Igbozurike,1981).Household level of education limit fuelwood consumption and production (Kumar and Hotchkiss, 1988). As household level of education increases, the less fuelwood consumption as a result of ease of accepting and innovation towards alternative source of energy, example woodstove in Kenya, coupled with extension contact. Household labour use and availability is the single most important factor associated with household level fuelwood production and consumption (Cecelski,1987).Production and consumption decline with less availability of labour.Carloni,(1984)noted, that as the price of fuelwood increases, that is becoming a commercial commodity its control and management shifts from women to men.

As there are multiple variables affecting fuelwood production and consumption. This study will use multiple regression analysis to fashion out rural production and rural/urban fuelwood consumption rate in the study area.

2.10 ANALYTICAL FRAMEWORK

The nature and purpose of a study determines the types of analysis that can be employed. While the calculation of rates, means, frequency distribution and percentage may be adequate for some exploratory studies, more detailed and higher level analysis will be required for case studies and sample surveys especially, those that deal with quantitative data (Eboh, 1998).

For analyzing dependence, regression analysis is the most commonly used technique. Specifically the regression model can be stated thus: $Y = F(X_1X_2, X_3 \ldots\ldots X_n) + e$, which states that Y, the dependent variable is a function of various explanatory variables represented by X (Koutsoyiannis, 1979). The Xs are fixed or pre-determined outside the model, hence they are called the independent variables. But the "Y" is to be determined by the X's, hence Y is called the dependent or endogenous variable. The way the x's are transformed to Y is the functional relationship "F".

The "e" is the error term which is introduced in the function to capture the effects of omitted variables. Apart from omitted variables, the error term "e" takes care of the erratic nature of human behaviour, error of measurement and the effects of aggregation (Loveday, 1980).

The objective of any econometric analytical technique is to obtain an estimate that is unbiased and has the least variance. The closeness of the estimate to the population parameter is measured by the mean and variance of the sampling distribution of the estimate of the different econometric methods. An estimate is said to be unbiased if the bias is zero i.e. $E(b) = b$ or $E(b) - b \overset{n}{=} 0$. This is interpreted to mean that the estimate converges to the true population value as the number of samples increase. Also an estimate is said to be best when it has the least variance in comparison with any other estimate obtained from any other econometric methods
i.e. $E(b - E(\hat{b} - E(\hat{b})^2 < E({}_b^e - E(b^e)^2$. (Where ${}_b^e$ – any other estimate obtained from other econometric method or the parameter b) (Koutsoyiannis, 1977).

In regression estimation procedure certain assumptions are observed and where these are violated, econometric problems like autocorrelation and multicollinearity will result. Such econometric problems result in biased estimates. It is the duty of the researcher to identify and control such problems in the regression estimation.

One assumption that guides the regression estimation is that the error terms are independent of one another i.e. $Cov(e_i, e_j) = 0$. But when this assumption fails to hold, then autocorrelation will occur and this means that ei = f(ej). Autocorrelation in regression model can be detected by Durbin-watson statistic. Another assumption establishing the regression technique is that explanatory variables are independent of each other i.e. Cov $(X_1X_2) = 0$, when this fails, multicollinearity problem occurs which means rx1, $X_2 = 1$ or $X_1 = F(X_2)$ (Koutsoyiannis, 1977). Multicollinearity makes it impossible to separate the effect of one variable from the other on the dependent variable. This problem can be controlled in the regression estimation by increasing the size of the sample or changing the functional form e.g. from linear to double logarithm or semi-logarithm form.

Halim (1976) used this method to determine the effects of some socio-economic variables on consumption of rice by some rural farmers in Laguna.

Multiple regression will be used in this study to know the effects of some variables that affects fuelwood consumption. Two linear Regressions models will be used to test equality between rural and urban consumption, and this is known as chow test, technique.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 THE STUDY AREA

The study area is Imo State of Nigeria. It lies in the South Eastern part of the country, in the tropical Rain forest belt. It lies between latitude 5° 10' and 6° 35' North of the Equator and between longitude 6° 35' and 7° 31' East of Greenwich meridian. It shares boundaries with Abia State on the East, Anambra State on the north and Rivers State on the South.

It was part of what used to be the former Eastern Region in the three and four regional structure of the Nigerian nation. In 1967 in the twelve state structure, Eastern Region was broken up into three states of Rivers, Cross-River and East Central States.

The present Imo State was part of East Central (E.C.S). On 3rd February 1976, the twelve state structure gave way to the nineteen state structure. Consequently, East Central State was broken up into Anambra and Imo States. In August 1991, the fifteen year old Imo State was divided into Imo and Abia State. (Imo commerce and industry, no date).

Imo State, is one of the smallest states in landmass, but with high population density (Imo B.P., 1986). It has a population of about 2,485,499 persons and a landmass of 5,530km^2 (F.O.S., 1993). It has three agricultural zones, namely Owerri, Okigwe and Orlu zones. It has twenty-seven local government areas.

Owerri, Okigwe, and Orlu are the major towns, while the rest of the areas are rural communities.

The majority of the population in these communities are found in traditional settlements, that are largely dependent on agriculture. These traditional settlement are made up of scattered rural settlements with dispersed farmlands. Much of the forest has been reduced to secondary plant cover as a result of human activity.

The area is dominated by tropical rainforest vegetation, while dominant plant species that are used for fuelwood are: (P*ennisetum purpurem –Eelephant/Napier grass, Adropogon tectorum – Gamba grass etc)* **herbs:***(Chromolaena odorata- Siam weed,Helianthus annus-Sun flower)* **Shrubs**: (*Acioa barteri* – Oil seed *Ricinus communis – Castor Plant),* **Wood Climbers** (*Landolphia owariensis – White rubber vine Ficus spps – Fig plant)* and even dry cassava stem (*Manihot esculenta)* and maize stems (*zea mays – Maize plant),* and so on.

A rural household utilize well over 40 different species of plants in a year. Also the range utilized as fuelwood appears to be limited principally by two groups of conditions. One group comprises, proximate site factors, for example, relative household distance from the nearest bush or from its closest farmland or from the fence separating it from its neighbours. (Igbozuruike, 1981).

3.2 SAMPLING PROCEDURE:

For the purpose of this study both multi-stage and purposive sampling technique were employed.

In Imo-State there is one type of vegetational feature i.e. (tropical rainforest vegetation) with the same settlement pattern and the same traditional way of production and consuming fuelwood. Ten local government areas were randomly selected for this study in the first stage of the sampling procedure. The second stage, was selection of communities. One community was selected randomly from each of the ten local government areas, making a total number of ten communities. Third stage, was the selection of villages, one village was selected randomly from each of the ten communities, making a total number of ten villages. Fourth stage was the selection of respondents, i.e. (household-heads). Twenty household-heads, were selected randomly from each of the ten villages, making a total number of Two hundred households-heads.

There are four recognized urban centers in the state, purposive sampling technique was used in order to fashion out the disparity of fuelwood consumption between rural and urban areas of the state. The urban areas are Owerri, Orlu, Okigwe and Uguta urban. Also fifty household heads were selected randomly from each of the urban area. Making a total of two hundred household- heads from the four urban areas.

So with the total number of the rural and urban households heads, four hundred households heads will be interviewed in this study.

3.3 DATA COLLECTION METHOD

Data needed for the study was generated from both primary and secondary sources. Primary data were obtained using questionnaire, interviews and direct observation while secondary data were collected mainly from available journals (published and unpublished materials) of relevance to the study.

Data for consumption of fuelwood, were generated, primarily, using questionnaire, interview and direct observation and this include, total self produced fuelwood as a percentage of total, consumed fuelwood (derived by dividing the quantity of total produced fuelwood (kg) by the total consumed fuelwood (kg)) in percentage in a year.

Educational attainment of household-heads was in number of years spent in formal schooling. Income status of household-heads was measured in Naira.

Access to alternative energy produce was in dummy variable. I, if household uses alternative energy produce, 0, if otherwise, while household size, was in numbers.

3.4 METHOD OF DATA ANALYSIS

Data collected during the study were analysed using relevant econometric and statistical tools in order to achieve specific objectives.

Objective 1 and 2 will be realized, using descriptive statistics such as frequency tables, mean rating and percentages and so on.

Objectives 5, 3 and 4 will be achieved using multiple regression analysis in order to relate volume or quantity of fuelwoods produced and consumed by the rural and urban households, to various socio-economic variables affecting them. And chow test, will also be employed for the test of differences between rural and urban consumption in objective 4.

3.5 SPECIFICATION OF MODELS

The regression model for realizing objective 2 is implicitly specified as fuelwood production model.

$F_p = f(C_a, W_o, L_b, G_b, E_d, I_s)$

Where:

F_p = quantity of fuelwood produced by the household in kg per year.

C_a = total area under cultivation measured in hectares (ha).

W_o= woodlot/forest ownership- dummy variable, 1, if farmer owns woodland or forest, 0 – otherwise.

L_b = amount of labour available for fuelwood production (household size) in numbers.

G_h = gender of household head; (dummy variable will be used 1, if household is male headed. 0 = otherwise.

E_d = educational level attainment of the household head (in Years)

I_s = total income (off farm + farm income) of the household head in naira.

The regression model for achieving objective 3 and 4 are implicitly specified as fuelwood consumption model.

$F_c = F(F_{sp}, E_d, I_s, A_e, H_s) + e$

Where,

F_c = amount of fuelwood consumed by a household in kilograms per year

F_{sp} = self produced fuelwood as a percentage of total consumed fuelwood in percentage (%) in a year.

E_d = educational attainment of household head (in years)

I_s = income status of household head in naira

A_e = access to alternative energy source(dummy variable) 1,if household uses alternative energy source. 0, otherwise.

H_s = household size in numbers.

E = error term.

This fuelwood consumption model will be estimated for both rural and urban households separately. For comparative purposes, the two estimated fuelwood consumption equations will be compared using the Chow-test for the test of differences between two estimation of the same model.

CHOW TEST MODEL

Given the samples on the variables, FC_1 and (Fsp_1, Ed_1, I_s, Ae, Hs_1) where FC_1 is the fuelwood consumption for the 1st sample (rural) FC_2 for the 2nd sample (urban fuelwood consumption). (F_{sp1}, Ed_{d1} I_{s1}, A_{e1}, H_{s1}) are the independent variables for the 1st sample (rural and (F_{sp2}, E_{d2}, I_{s2}, A_{e2}, H_{s2}) are for the 2nd sample (urban). We can use these two samples separately for the estimation of relationship between fuelwood consumption FC and the independent variables F_{sp}, E_d, I_s, A_e, H_s, both in the rural and urban consumption. This way, we have two estimates of the same relationship for a comparative study of differences in levels of fuelwood consumption between rural and urban areas given as follows:

$$FC_1 = b_o + b_1 F_{sp1} + b_2 E_{d1} + b_3 I_{si} + b_4 A_{e1} + b_5 H_{s1} \qquad \text{-------(2)}$$

and

$$FC_2 = BO + B_1 F_{sp2} + B_2 E_{d1} + B_3 I_{s2} + B_4 A_{e2} + B_5 H_{s2}$$

We want to know (i) if there is any significant differences in the level of fuelwood consumption between rural and urban areas and to what extent i.e. $b_o \neq Bo$ (ii) if there is a change in any of the independent variables F_{sp}, E_d, I_s, A_e, H_s, from rural to urban i.e. $b_i \neq B_i$, i = 1,2,3,4,5. To achieve these we shall perform an F test suggested by Chow using the following steps:

Step 1 We pool together the two samples thereby forming a sample of (n_1 + n_2) observations from which we obtain a 'pooled' function.

^

$FC_p = \propto_0 + \propto_1 Fsp + \propto_2 Ed + \propto_3 I_s + \propto_4 A_e + \propto_5 Hs$

and we estimate the unexplained variations.

$$\sum e_p^2 = \sum FC_p^2 - \sum \hat{F}C_p^2$$

with ($n_1 + n_2 - K$) degrees of freedom where p stands for 'pooled' and K is the total number of b's, including the intercept b_o. In this case, $K = 6$.

Step 2 We perform regression analysis on each sample separately. From the 1st sample we have

$$FC_1 = b_o + b_1 F_{sp1} + b_2 E_d + b_3 I_s + b_4 Ae_1 + b_5 H_6$$

$$\sum e_1^2 = \sum FC_1^2 - \sum \hat{F}C_1^2$$

with $n_1 - k$ degrees of freedom and from the 2nd sample we obtain.

$\hat{F}C_2 = B_o + B_1 F_{sp} + B_2 E_d + B_3 I_s + B_4 Ae_2 + B_5 H_s$

$\sum e_2^2 = \sum FC_2^2 - \sum FC_2^2$ with $n_2 - K$ degrees of freedom.

Step 3 We add together the unexplained variations of the two samples and form a total unexplained variation

$$\sum e_1^2 + \sum e_2^2$$

with $(n_1 - K) + (n_2 - K) = n_1 + n_2 - 2K$ degrees of freedom.

Step 4. We subtract the above sum of residual variations from the 'pooled' residual variance of step 1 and we have

$$\Sigma e_p^2 - (\Sigma e_1^2 + \Sigma e_2^2) \text{ with } (n_1 + n_2 - k) - (n_1 + n_2 - 2k) = K$$

degrees of freedom.

Step 5 We form the ratio

$$F^* = \frac{[\Sigma e_p^2 - (\Sigma e_1^2 + \Sigma e_2^2)]/k}{(\Sigma e_1^2 + \Sigma e_2^2) / (n_1 + n_2 - 2k)}$$

Where: F^* = F. ratio calculated from the sample data.

Σe_p^2 = Sum of residual deviation of pooled sample of all observation.

Σe_1^2 = Sum of residual deviation of determinants of rural fuelwood consumption.

Σe_2^2 = Sum of residual deviation of determinants of urban fuelwood consumption

K = Number of variables.

n = number of samples.

We want to test

H_o: $b_i = B_i$, i.e. there is no difference in fuelwood consumption between rural and urban

Vs

H_i: $b_i \neq B_i$, i.e. there is a significant difference.

We compare the observed F^* ratio with the theoretical value of $F \propto$ where $\propto$ is the level of significance with $V_1 = K$ and $V_2 = n_1 + n_2 - 2K$ degrees of freedom. The theoretical value of F defines the critical region of the test.

IF $F^* > F\propto$ we reject the null hypothesis and accept the alternative and conclude that there is a significant difference in the level of firewood fuel usage between rural and urban areas.

CHAPTER FOUR

4.1 FUELWOOD PRODUCTION PATTERNS

Fuelwood are produced mainly from three major sources in rural communities namely: forest, farmland and fallow vegetation. Although during scarcity period, mostly rainy seasons, some rural household buy from those who sell. This method of production behaviour from forest, farmland and fallow vegetation resulted to multiple responses recorded in rural areas of the study.

The result of the distribution of respondents according to fuelwood production pattern in rural areas is presented in table 1.

Table 1: Distribution of respondents according to fuelwood production patternsin rural areas.

Fuelwood	**Frequency**	**Percentage**
Farmland	120	50
Forest/woodlot	80	33.3
Fallow vegetation	40	16.7
Total	240	100

Multiple responses recorded:

Source: Field Survey 2001

Table 1 above shows the non-market fuelwood production pattern by rural respondents.

Majority of the respondents produced fuelwood from farmland (50%). This was followed by those who produced from forest (33%). The least number produced from fallow vegetation (17%). The facts that majority of the rural respondent produced fuelwood from farmland, was because farmland is the major source of fuelwood in rural areas, followed by forest. This fact was also supported when all the rural respondents interviewed stated strongly, that wood species on their farmland was their major source of fuelwood.

Fuelwood production and members of households that assist in rural areas is presented in table 2.

Members of Household	**Frequency**	**Percentage**
Children	133	66.5
Adults	67	33.5
Total	200	100

Source: Field survey, 2001

The result in table 2, shows that 66.5 percent of the rural respondents who assist in fuelwood production are children, while 33.5 percent are adult. This result agrees with the findings of FAO (1981) and Astra (1981).

Time spent by rural household while producing fuelwood in a trip is presented in table 3.

Table 3: Time spent by rural household in producing fuelwood in a trip.

Time spent	Frequency	Percentage
Below 2 hours	13	6.5
2 – 4 hours	105	52.5
4 hours and above	82	41
Total	200	100

Source: Field survey 2001

Table 3: above shows the time spent by rural households in producing fuelwood in a trip. Majority of the household (52.5%) spent 2 – 4 hours per trip and is similar with the findings of Astra (1981). They are followed by those who spend 4 hours and above (41%). The least were those respondents (6.5%) that spend below 2 hours. This may be as a result of proximate site factors as it was suggested by Igbozuruike (1981).

The result of rural respondents according to frequency of fuelwood production is presented in table 4.

Table 4: Distribution of rural respondents according to frequency of fuelwood production.

Number of times fuelwood are produced (weekly)	Frequency	Percentage
Less than thrice	56	28
Thrice	108	54
Four times	24	12
Five times	8	4
Above five times	4	2
Total	200	100

Source: Field survey, 2001.

The table above shows the frequency of fuelwood production in a week by rural farming households. It was found that majority of the respondents (54%) produced fuelwood three times in a week. This was followed by those respondents (28%) who produced less than thrice a week. The least are those that produced above five times in a week. The fact that majority of the respondents produced fuelwood three times a week is in consonance with the findings of Nest (1991).

Distribution of rural households according to their cultivated average farmland size is presented in table 5.

Table 5: Distribution of rural households according to their cultivate average farmland size.

Average farmland size in hectares	**Frequency**	**Percentage**
0 – 0.03 ha		
0.04 – 0.06 ha	42	21
0.07 – 0.12 ha	128	64
0.13 – 0.14 ha	22	11
0.15 – 0.16 ha	8	4
Total	200	100

Source: Field survey 2001.

From the result of the table above, we will find that majority of rural households has an average farm size of 0.07 – 0.12 hectares. They are represented by 64%. They are followed by those with an average from size of 0.04 – 0.06 hectares. They are also represented by 21%, and 11% for those with average from size of 0.13 – 014 hectares. The least are those with average farm size of 0.15 – 0.16 hectares. The reason why majority of rural farming households farm on small area of land is due to the problem of land tenure system and low rural income that restrain them on mechanized farming.

CHAPTER FIVE

5.1 PROBLEMS OF FUELWOOD PRODUCTION AND CONSUMPTION.

Farming households encounter some problems, while producing and consuming fuelwood from forest/woodlots, farmland and fallow vegetation. Some complained that they encountered more than one problem, while producing fuelwood from these sources. The various problems they encountered resulted to multiple responses recorded in the study area. The result of problems encountered while producing fuelwood is presented in table 6.

Table 6: Distribution of farming households according to the problems encountered while producing fuelwood from farmland, forest/woodlots and fallow vegetation.

Problems encountered while producing fuelwood	Frequency	Percentage
Inadequate trees	15	5.9
Ownership conflicts	28	11.0
Labour shortages	32	12.5
Drudgery problems	180	70.6
Total	255	100.

*Multiple responses recorded.

Source: Field survey, 2001

The major problem encountered by most rural respondents, while producing or sourcing fuelwood from farmland, fallow vegetation and forest are drudgery problems. This is represented by 70.6%, followed by labour shortage, as a result of youth migration to urban centres. This is represented by 21.3%, while 11.0% complained of ownership conflicts on some forested lands and fallow vegetations. The least are those who complained of inadequate trees as their major problems.

The result of the problems associated with fuelwood consumption by rural farming households is represented in table 7.

Table 7: Distribution of respondents according to problems associated with fuelwood consumption.

Problems associated with fuelwood consumption	**Frequency**	**Percentage**
Health problems especially the "Smoke".	200	75.5
Inefficient combustion problems, especially during rainy seasons	65	24.5
Total	200	100

*Multiple responses recorded.

Sources: Field survey, 2001

Problems associated in using fuelwood as an energy source are presented in the above table. From the table, 75.5 percent of rural household complained of health problems associated with fuelwood "smoke", as their major problem, while cooking with fuelwood. While 24.5% respondent complained of inefficient combustion problems as their major problems. This is always during the time of rainy season. However the analysis of this table has shown us that firewood smoke is the major problem encountered by rural households, while cooking with fuelwood. This findings is in consonance with the findings of Smith (1991), World Bank (1992), Smith et al (1993) and World Bank (1996).

5.2 REGRESSION RESULTS

The result of the regression analysis is reported in this section. Based on standard statistical and econometric criteria of estimates (SE) F-ratio and the signs and magnitude of the regression coefficients, only the double logarithmic form out of the three functional specifications of the regression model was chosen for the analysis. This was due to the fact that double log function gave the highest value of R^2, number of significant variables, lowest standard errors and consistency of signs of coefficient with a priori expectation. This was also suggested by Olayemi and Olayide (1981) for demand and production function.

The regression estimates for rural fuelwood production, rural and urban fuelwood consumption rate are summarized below. Their pooled double log regression estimates for comparative purposes are also outlined.

The double log regression equation and estimated parameter for the amount of fuelwood produced in kilograms by rural households is as followes:

$$\text{Log RFP} = 11.481 + \underset{(0.024)}{0.251\text{CA}^{**}} - \underset{(0.006)}{0.010\ \text{logED}} + \underset{(0.009)}{0.007\ \text{LogGN}} - \underset{(0.054)}{0.406\ \text{logIS}^{**}}$$

$$+ \underset{(0.055)}{0.123\ \text{log LB}^{**}} - \underset{(0.050)}{0.009\ \text{log Wo}}$$

R^2 70%, SE = 0.2447, F = 75.024

** significant at 5% probability level.

Where the values of parentheses are the standard errors.

The total area under cultivation measured in hectare (ha) in the equation is statistically significant and has a positive sign. This implies that as total area of farm size cultivated increases, the amount of tree species used for fuelwood increases. This is further explained by the positive correlation coefficient of (0.744) with amount of fuelwood produced by rural households, showing that total area under cultivation is a very vital factor in the amount of fuelwood produced by rural households.

Educational attainment by rural households was found to be statistically insignificant and with negative sign. The negative influence of this variable is consistent with a priori expectation. This is because as educational attainment of rural households increases, amount of fuelwood produced decreases as attention is shifted to alternative energy sources like kerosene and gas. Also the variable has a negative correlation coefficient with the amount of fuelwood produced (-0.403). The sign of this correlation coefficient tends to show that, as educational attainment of rural households increases, the less fuelwood is produced.

Gender of household head was also found to be insignificantly related to amount of fuelwood produced although positive. This could mean that majority of rural households are male headed, but production of fuelwood is always carried out by female population assisted by their children. And during scarcity period when fuelwood market develops and becomes a commercial commodity, its control and management shifts from female to male. Also the variable had a positive correlation coefficient with the amount of fuelwood produced. The sign of this correlation coefficient is enough to conclude that as fuelwood productions becomes a commercial commodity its control and management shifts from female to male (Carloni, 1984).

Income status of rural households influenced the amount of fuelwood they produced in a negative direction. This is consistent with a priori expectation, because as rural households income increases there is the tendency for the rural households to revert to alternative energy sources like kerosene and gas. The sign of this variable could be attributed to the fact that majority of the rural households income are low. The value of the income elasticity (-0.406) implies that for a 1% increase in total income of the rural households, the amount of fuelwood produced falls by 0.406%. This view is also supported by the negative correlation coefficient of (- 0.706) between amount of fuelwood produced and income status of the rural households.

Amount of labour available for fuelwood production (household size), not only had a positive relationship with the amount of fuelwood produced by rural households, but also it significantly influenced the amount of fuelwood produced. The positive sign of this variable, could be attributed to the fact, that as members of household who assist in fuelwood production increases, the amount of fuelwood produced also increases. The increase is however more in households with more members. Also the variable had a positive correlation coefficient with the amount of fuelwood produced (0.302) (with elasticity of 0.123). The sign of this correlation coefficient tends to conclude that as household size increases so also the amount of fuelwood produced.

Woodlot/forest ownership was found to be statistically insignificant and with negative sign. The negative influence of this variable could be attributed to the fact, that woodlot/forest ownership are always community and kindred based. Only very few individuals owns forest through inheritance. So production of fuelwood are always low as many rural dwellers do not own individual woodlot/forest.

The standard error of the mode (SE = 0.2447) is very low showing evidence of good fit. On the other hand, the R^2 of 0.700 is further evidence of good fit of the model on the data obtained.

The double log regression equation and estimated parameter for the amount of fuelwood consumed in kilograms by rural households is as follows:

$$\text{Log RFC} = 17.739 + \underset{(0.044)}{0.144} \log fsp^{**} - \underset{(0.005)}{0.017} \log Ed^{**} - \underset{(0.052)}{1.215} \log Is^{**}$$

$$- \underset{(0.022)}{0.010} \log Ae + \underset{(0.035)}{0.164} \log Hs^{**}$$

$R^2 = 0.890$, SE = 0.1580, F* = 315.123

Where the values in parentheses are the standard errors.

* = significant at 5% probability level.

Recall that total self produced fuelwood as a percentage of total consumed fuelwood (FSP) was derived by dividing the quantity of total self produced fuelwood (kg) by the total consumed fuelwood (kg) in a year.

The total self produced fuelwood as a percentage of total consumed fuelwood (FSP) in the equation is statistically significant and has a positive sign. This implies that as total self produced fuelwood increases, the amount of fuelwood consumed by rural households also increases. This is further explained by the positive correlation coefficient of (0.667) with amount of fuelwood consumed by rural households showing that total self produced fuelwood as a percentage of total consumed fuelwood is a very vital factor in the amount of fuelwood consumed by rural households.

Educational attainment by rural households were found to be statistically insignificant and with negative sign. The negative influence of this variable is consistent with a priori expectation. This is because as educational attainment of rural households increases, amount of fuelwood consumed decreases as attention is shifted to alternative energy source like kerosene and gas. Also the variable has a negative correlation coefficient with the amount of fuelwood consumed (-0.496). The sign of this correlation coefficient tends to show that as educational attainment of rural households increases, the less fuelwood is consumed.

Income status of rural households influence the amount of fuelwood they consumed in a negative direction. This is consistent with a priori expectation, because as rural households income increases there is the tendency for the rural households to revert to alternative energy sources like kerosene and gas. The sign of this variable could be attributed to the fact that majority of the rural households income are low. The value of the income elasticity (- 1.215) implies that for a 1% increase in total income of the rural households, the amount of fuelwood consumed falls by 1.215%. This view is also supported by the negative correlation coefficient of (- 0.934) between amount of fuelwood consumed and income status of the rural households.

Access to alternative energy was also found to be negative and statistically insignificant. This could be as a result of the fact that rural households mostly depends on fuelwood as their major energy source. However, the variable has a positive correlation coefficient (0.131). The sign of this correlation coefficient tends to show that as access to alternative energy sources like kerosene and gas increases with higher prices, the more fuelwood will be consumed.

Households size, not only had a positive relationship with the amount of fuelwood consumed by rural households, but also it significantly influenced the amount of fuelwood consumed. The positive sign of this variable could be attributed to the fact that as members of family who assist in fuelwood production increases, the amount of fuelwood consumed also increases. The increase however is more in households with more members. Also the variable has a positive correlation coefficient with the amount of fuelwood consumed (0.322) (with elasticity of 0.164). The sign of this correlation coefficient tends to conclude that as households size increases so also the amount of fuelwood consumed.

The standard error of the model (SE = 0.1580) is very low showing evidence of good fit. On the other hand R^2 of 0.890 is further evidence of good fit of the model on the data obtained.

URBAN

The double log regression equation and estimated parameters for the amount of fuelwood consumed in kilograms by urban households is as follows:

Log UFC= 12.303 + 0.166 log Fsp –6.661 log Ed** - 0.080 log Is
(0.146) (1.182) (0.197)

– 0.498 log Ae** + 4.170 log Hs**
(0.241) (0.702)

R^2 = 0.472%, SE = 4.03, F* = 34.723

Where the values in parenthesis are the standard errors.

* = significant at 5% probability level.

The equation above shows that among the basic variables mentioned in the model, total self produced fuelwood as a percentage of total consumed fuelwood (fsp) was found to be statistically insignificant in increasing the amount of fuelwood consumed by urban households. This is because urban households do not produce fuelwood as there are no forest, fallow vegetation and farmland near to them. And most of them are civil servants who commonly use alternative energy source kerosene and gas in cooking. Although the variable had a positive correlation coefficient with the amount of fuelwood consumed (0.336). The sign of this correlation coefficients tends to show that as self produced fuelwood increases especially by poor urban households, where villages are close to where they reside in the urban centre or who resides close to, any forest, fallow vegetation, tends to produce and consume more fuelwood especially during periods of kerosene scarcity. Also the elasticity of this variable is 0.166, which implies that for a 1% increase in total self produced fuelwood especially during periods of kerosene scarcity in urban areas, the amount of fuelwood consumed increases by 0.166%.

Educational attainment by urban households were found to be negatively influenced the amount of fuelwood consumed. This negative relationship is consistent with a priori expectation. This is because as educational attainment of urban households increases, amount of fuelwood consumed decreases, as attention will always be shifted to alternative energy sources. This is in consonance with the findings of (Kumar and Hotchkiss, 1988). Also the sign of this variable could be attributed to the fact that majority of the urban households educational attainment were high. The variable also had a negative correlation coefficient with the amount of fuelwood consumed (- 0.587). The sign of this correlation coefficient tends to show that as educational attainment of urban households increases, the amount of fuelwood consumed decreases.

Income status by urban households were found to be statistically insignificant and negative. The negative relationship of this variable is consistent with a priori expectation. This is because as income status of urban households increases, amount of fuelwood consumed decreases, as attention will always be shifted to alternative energy sources, like kerosene and gas. The sign of this variable could be attributed to the fact that majority of the urban households income were high. Therefore fuelwood is an inferior source of energy in the urban households energy system. The variable has a negative correlation coefficient with the amount of fuelwood consumed (- 0.282). The sign of this correlation coefficient tends to show that as urban households income increases, the less fuelwood is consumed.

Access to alternative energy were also found to be statistically significant but negative. This could be as a result of the fact, that urban households mostly depend on alternative energy sources like kerosene and gas. Therefore consumption of fuelwood is low. This is further explained by the negative correlation coefficient of the variable with the amount of fuelwood consumed by urban households (- 0.308). The sign of this correlation coefficient also tends to show that, as access to alternative energy sources increases (kerosene and gas) by urban households, the less fuelwood is consumed.

Household size, not only has a positive relationship with the amount of fuelwood consumed by urban households, but also it significantly influence the amount of fuelwood consumed. The positive sign of this variable, could be attributed to the fact, that as alternative energy sources, kerosene and gas becomes so scarce in urban centres which is the true position as of now households are forced to rely on fuelwood which they source from market or non-market sources.

Also the variable had a positive correlation coefficient with the amount of fuelwood consumed (0.538) (with elasticity of 4.170). The sign of this correlation coefficient tends to conclude that as household size increases so also the amount of fuelwood consumed during scarcity periods increases.

The coefficient of multiple determination R^2 is however low (0.472). This implies that only 47.2% of the observed variabilities of the amount of fuelwood consumed by urban households were explained by the explanatory variables included in the model. The implication of this is that some relevant explanatory variables has not been included in the regression model. These variables such as proximite site factor for fuelwood production by urban households, seasonal variation factors, rainy/dry season or periods in which kerosene and gas are always scarce, types of business urban households are engaged in, whether they engaged in restaurant or bakery business. All these will be recommended for further study as they were beyond the scope of this study.

The pooled double-log regression results for the amount of fuelwood consumed both in rural and urban households in kilograms are presented below:

$$\text{Log PFC} = 3.850 + \underset{(0.094)}{0.480 \log fsp^{**}} + \underset{(0,074)}{0.074 \log Ed} - \underset{(0.141)}{0.550 \log Is^{**}}$$

$$- \underset{(0.157)}{0.384 \log Ae^{**}} + \underset{(0.406)}{3.175 \log Hs^{**}}$$

$R^2 = 64\%$, SE = 3.26, F* = 141.905.

When the amount of fuelwood consumed by rural and urban households are pooled together, the regression results showed that total self produced fuelwood as a percentage of total consumed fuelwood (fsp), income status of the respondents (Is), access to alternative energy source (Ae) and households size (Hs) were statistically significant in explaining the observed variability of the dependent variable. Their respective correlation coefficient were (0.739), (- 0.683), (- 0.716) and (0.494).

The regression coefficients for educational attainment (Ed) was statistically not different from zero in the pooled regression. And its negative correlation coefficient was (- 0.538). The F-calculated recorded is 141.905 and the theoretical value of F at 5 percent level of significance with $V_1 = 6$ and $V_2 = 388$ degrees of freedom is 1.75. Thus F – calculated > F – tabulated at 0.05 level of significant and hence, we reject the third null hypothesis and accept the alternative, that there is a significant difference between the amount of fuelwood consumed by the rural and urban households.

Generally, the R^2 values for the pooled regression were 0.640, which implies that 64% of the observed variability of the pooled dependent variable were explained by the explanatory variables used in the model. The implication of this is that relevant explanatory variables were included in the regression model.

CHAPTER SIX

6.0 SUMMARY, RECOMMENDATION AND CONCLUSION

6.1 Summary

The aim of this research was to determine and analyse the socio-economic analysis of fuelwood production and consumption in Imo state.

The research was guided by the following hypothesis

1) Fuelwood production is not influenced by socio-economic characteristics of farmer producers.
2) Fuelwood consumption is not affected by socio-economic characteristics of farmer-producers
3) Fuelwood consumption patterns among rural households do not significantly differ from that of urban households.

A total of 200 household heads were randomly selected from rural and urban areas in Imo State making a total of 400 household heads from the state. One set of structured questionnaire was administered to both rural and urban areas of the sampled respondents. In addition, oral interviews were used in gathering more information that could not be covered in the questionnaire. Percentages, multiple regression and chow test technique were used in analyzing the data.

The study showed that fuelwood production was influenced by socio-economic characteristics of farmer-producers, hence hypothesis 1 was rejected

Fuelwood is produced from forest/woodlots, farmland and fallow vegetation. Market source involves buying from those who sell during scarcity period mostly during rainy seasons. The study revealed that 50% of rural households produced fuelwood from their farmland. The result of the regression model for the amount of fuelwood produced by rural households showed that the total area under cultivation measured in hectares (ha), amount of labour available, that is household size (LB) were found to be not only statistically significant but positive while income status was also found to be significant but in negative direction. This could be as a result of the fact that, as rural households income increases, their taste is shifted to alternative energy sources like kerosene and gas. Also the results of the three regression models for the amount of fuelwood consumed in rural and urban centres of the study area revealed that amount of fuelwood consumed as a percentage of total produced fuelwood (fsp), household size (Hs) were found to be not only statistically significant but positive, while income status was also found to be significant but in negative direction. This could also be as a result of the fact that as rural households income increases, their attention will be shifted to alternative energy sources like kerosene, gas and electricity.

Approximately seventy percent (R^2 = 70%) of the variation in amount of fuelwood produced by rural households was explained by independent variables (X's). This means that there was a strong influence of these variables on the amount of fuelwood produced. Also eighty-nine percent (R^2 = 0.890%) of the variation in amount of fuelwood consumed by rural households was explained by independent variables (X's). This means that there was also a very strong influence of these variables on the amount of fuelwood consumed by rural households.

The F-ratios calculated are 75.024 and 315.123 from the regression equation for rural fuelwood production and rural fuelwood consumption rate and their respective F – ratio tabulated are (2.25) [illegible] at 5% probability level. Since the F-ratios calculated at 5% probability level is greater than F-ratios tabulated at the same probability level, the first and second null-hypotheses was rejected, while their alternative was accepted meaning that fuelwood production and consumption are influence by farmers producers socio-economic characteristics in the study area.

The amount of fuelwood consumed by urban households, household size (Hs) was positively significant while their educational level and access to alternative energy were found to be significant but in negative direction. Approximately forty-seven percent (R^2 = 0.472%) of the variation was explained by independent variables (X's). This also shows a significant influence of these variables on the amount of fuelwood consumed by urban households.

In the pooled regression, total self produced fuelwood as a percentage, total consumed fuelwood and household size were positively significant while income status and access to alternative energy were found to be significant but in a negative direction. Also the F-ratio calculated (141. 905) was greater than F-ratio tabulated (1.75) at 5% probability level, hence the third null hypotheses was rejected, while its alternative was accepted. This means that, there is significant difference between amount of fuelwood consumed by rural and urban households.

The constraints of fuelwood production are as follows, inadequate trees, ownership conflicts, labour shortages and drudgery, while cost, health problems caused by fire wood "smoke" and inefficient combustion of some tree species are the major consumption problems. Among all these problems, drudgery and health problems caused by fire wood "smoke: are the major problems associated with fuelwood production and consumption.

6.2 Recommendations

Based on the findings of this study, the recommendations necessary to improve fuelwood economy are outlined.

1) Establishment of woodlots should be encouraged by the federal government so that deforestation will be minimized by rural dwellers.

2) Total self produced fuelwood by rural households should also be minimized. Federal government should try and make alternative energy sources cheaper and accessible. This will help in reducing time spent in sourcing for fuelwood, reducing the environmental problems associated with deforestation resulting from over-fetching of fuelwood and increasing time devoted to productive agricultural activities.

3) Government and international organizations should try to harness gas flaring in some part of Nigeria, as this will go a long way in reducing cost and scarcity problems faced by most Nigerians in obtaining alternative energy sources (kerosene and gas).

4) Government and international organization should carryout poverty alleviation programmes, in order to increases rural income, so that they can afford alternative energy sources like kerosene and gas, thereby reducing fuelwood consumption and environmental problems resulting from deforestation.

5) Rural households cook on three stones or tripod stand, which is less efficient in terms of caloric values, transformed into useful cooking energy. The total efficiency could be higher if simple improvement for example, a mud enclosures is made around on open fire to protect it and improve efficiency considerably. This will go a long way in reducing firewood smoke, responsible for health problems associated with fuelwood consumption.

6) The rural households should be motivated to enroll into adult education programmes, which is available in most rural areas. This will enable them to have better opportunity and ready to accept innovations towards improving their cooking efficiency.

7) Problems of fuelwood production and consumption could be improved through reforestation and introduction of efficient wood burning stove.

8) It is quite obvious that households in rural areas are directly dependents on fuelwood production and consumption, but many programmes are designed without mention of rural households and without recognition of the impact of the proposed activity on them. Policy makers should therefore focus their attention to rural dwellers and plan with them rather than for them.

6.3 Conclusion

This study examined the socio-economic analysis of fuelwood production and consumption in Imo State. Data were obtained by the administration of questionnaire and direct observation by the researcher and from other sources like journals, books and magazines.

It was discovered that farmland was the major source of fuelwood in rural areas. Total area under cultivation measured in hectares and amount of labour available for fuelwood production, significantly influence the rate of fuelwood production in positive direction by rural farming households.

While their fuelwood consumption rate were influence positively by total self – produced fuelwood as a percentage of total consumed fuelwood (fsp) and household size (Hs). Also there is a significant difference between the total amount of fuelwood consumed by rural and urban households.

Inspite of the importance of fuelwood in rural energy system, its production and consumption impose dangers to those who make use of it (drudgery and health problems associated with fire-wood smoke). Introduction of efficient wood burning stove has not been encourage extensively. There is therefore need for government and international organizations to carryout poverty alleviation programmes, in order to increase rural income so that they can afford alternative energy sources (like kerosene and gas) thereby reducing pressure on their forested land.

6.4 Suggestion for Further Research

There is need to explore the implication of types of fuelwood and production on deforestation, to fully ascertain the impact of fuelwood production and consumption on environmental degradation. There is also the need to explore the different species of trees used for fuelwood and seasonal variation factors on fuelwood production and consumption in different farming households (rural and urban).

It is hoped that research into these areas will go a long way in reducing deforestation, erosion and soil infertility problems and help in improving fuelwood economy.

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APPENDIX 1

Projected demand,and supply-demand gap from 1996-2010 (000m^3)

Year	Fuelwood Demand	Fuelwood Supply	Demand/Supply gap for fuelwood,
1996	89287	69561	19726
1997	92144	71787	20357
1998	95093	74084	21009
1999	98136	76455	21681
2000	101276	78901	22375
2001	104517	81434	23083
2002	107861	84048	23813
2003	111313	86746	24567
2004	114875	89531	25344
2005	118551	92405	26146
2006	122345	95371	26973
2007	126260	98433	27827
2008	130300	101593	28707
2009	134470	104854	29616
2010	138773	108220	30553

Source: (FORMECU, 1994.)

APPENDIX II

Correlation coefficient of amount of fuelwood produced by rural households is presented below

	RFP	CA	ED	GN	IS	LB
RFP	1.000	.744	-.403	.119	-.706	.302
CA	.744	1.000	-.281	.033	-.542	.181
ED	-.403	-.281	1.000	-.246	.414	-.274
GN	.119	.033	-.246	1.000	-.123	.027
IS	-.706	-.542	.414	-.123	1.000	-.259
LB	.302	.181	-.274	.027	-.259	1.000

APPENDIX III

Correlation of amount of fuelwood consumed in rural households and independent variables.

	RFC	FSP	ED	IS	AE	HS
RFC	1.000	.667	-.496	-.934	.131	.322
Fsp	.667	1.000	-.691	-.699	.113	.010
Ed	-.496	-.691	1.000	.555	-.104	-.252
Is	-.934	-.699	.555	1.000	-.206	-.241
Ae	.131	.113	-.104	-.206	1.000	-.297
Hs	.322	.010	-.252	-.241	-.297	1.000

APPENDIX IV

Correlation of amount of fuelwood consumed in urban households and independent variables.

	UFC	FSP	ED	IS	AE	HS
UFC	1.000	.336	-.587	-.282	-.308	.538
Fsp	.336	1.000	-.437	-.162	-.356	.165
Ed	-.587	-.437	1.000	.422	.250	-.407
Is	-.282	-.162	.422	1.000	.046	-.240
Ae	-.308	-.356	.250	.046	1.000	-.205
Hs	.538	.165	-.407	-240	-.205	1.000

APPENDIX V

Correlation of amount of fuelwood consumed both in rural and urban households and independent variables.

	PFC	FSP	ED	IS	AE	HS
PFC	1.000	.739	-.538	-.683	-.716	.494
Fsp	.739	1.000	-.695	-.782	-.888	.315
Ed	-.538	-.695	1.000	.623	.624	-.337
Is	-.683	-.782	.623	1.000	.726	-.354
Ae	-.716	-.888	.624	.726	1.000	-.355
Hs	.494	.315	-.337	-.354	-.355	1.000