# ASSESSMENT OF RURAL HOUSEHOLD ENERGY ACCESS, UTILIZATION AND SUSTAINABILITY: A CASE OF MBUYU SUB-LOCATION OF NYANDARUA DISTRICT, KENYA

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DECEMBER, 2011

## DECLARATION

I, ROSE N. WAMBUI hereby declare that this thesis is my original work and has not been presented for a degree in any other university or for any other award.

Signature _____ Date: 1/12/2011

Rose N. Wambui-H60/10309/2007

## SUPERVISORS' APPROVAL

We confirm that the work reported in this thesis was carried out by the candidate under our supervision as University Supervisors.

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## DEDICATION

To my beloved mother Jane, my brothers Nicholas, Sammy and my grandparent Jerioth whose inspiration, endless prayers and unfailing hope enabled me to complete this thesis.

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## LIST OF ABBREVIATIONS AND ACRONYMS

**AFREPEN** African Energy Policy Research Network

**FAO** Food and Agricultural Organization

**IEA** International Energy Agency

**ITDG** Intermediate Technology Development Group

**LPG** Liquefied Petroleum Energy

**M o E** Ministry of Energy

**NDDP** Nyandarua District Development Plan

**NDSP** Nyandarua District Strategic Plan

**UNDP** United Nations Development Programme

**UNEP** United Nations Environmental Programme

**W H O** World Health Organization

## ABSTRACT

The purpose of this study was to assess the rural household energy access, utilization and sustainability in Mbuyu sub-location of Nyandarua District, Kenya. The objectives of the study included: to identify the type of household energy sources used in the study area; to establish the challenges faced in accessing household energy sources; determine various energy efficient technologies utilized by the rural households; determine the constraints towards energy sustainability and to establish interventions for energy sustainability. The study was based on the family system theory by Deacon and Firebaugh (1988). Systematic random sampling technique was used to select a sample of 136 households from the accessible population of 1,367 households from which data was collected. Data collection instruments included interview schedules and observation checklist. Descriptive statistics and cross tabulations were used to analyze quantitative data. Inferential statistics such as Pearson correlation and chi-square were used to test the hypotheses. Data was presented using graphs, charts, means and percentages. Results showed that firewood was the most common source of energy, (95.6%) for cooking. Charcoal was predominant in space heating (71.3%) while kerosene was used by 94.9% of the respondents for lighting. Other sources included solar, biogas and agricultural residues. Challenges in access to energy sources included: frequent price hikes, shortage in market supply especially for the gas (LPG) and kerosene and fear of wildlife attacks and rapes in the forest during firewood collection. Results from Pearson product moment correlation test revealed significant correlation between household income and the expenses of energy used($r=0.371$, $p=0.001$). Chi-square test results showed a statistically significant relationship in energy efficiency awareness between the male and female respondents ($\chi^2=5.013$, $df=1$; $p=0.025$). The study concluded that access to household energy sources demanded valuable time, money and physical energy. Adoption of energy efficient technologies like solar, biogas and raised hearth was very low with 4.4%, 0.7% and 33.1% respectively. This was due to installation costs and lack of awareness of the new technologies. It was established that limited interventions for energy sustainability existed. The study recommended the creation of awareness of energy efficient technologies to improve energy saving, time and labour in rural households, use of alternative sources of energy like briquettes for space heating instead of charcoal, and activities such as agro-forestry and afforestation should be encouraged and supported to provide fuel wood, to conserve the environment and to mitigate the effects of global warming.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Background Information

Disparities in household energy access and use exist between rural and urban populations, between high and low-income groups within a country, and among countries. The major factors contributing to these differences are levels of urbanization, economic development, and living standards (UNDP, 2005).

In many developing countries, particularly in rural areas, traditional energy sources such as firewood, charcoal and agricultural waste, constitute a major portion of total household energy consumption. Use of these fuels with proper technologies like improved stoves can positively impact on human health and environment. Unfortunately, diffusion of these technologies, especially in developing countries, is slow hence a negative impact on the sustainability of the available sources (Sum Low, 2005).

In Africa, energy access base is correspondingly among the lowest in the world. For instance, 80 % of people in sub Saharan Africa have no electricity. Poor people spend up to a third of their income on energy, mostly to cook (Sum Low, 2005). Other studies indicate that in rural Sub-Saharan Africa, women carry 20 kilograms of firewood, an average of five kilometers every day (IEA, 2004). Apparently, access to efficient energy would free the poor, especially women and girls, from the drudgery of collecting fuel wood, thus expanding opportunities for schooling, after-school study and income generation. Use of clean and reliable energy sources would also reduce damage of health from exposure of high levels of indoor air pollution from burning of solid fuels (wood, cow dung etc) for cooking and heating. Similar studies show that sustainability of these

energy sources is as critical as the access and consumption. Sustainability could be increased by increasing the productivity of the existing forest resources, establishing new forests and encouraging the alternatives like solar energy by increasing their supply, in addition to improving the technology and raising the efficiency of wood-fuel production and consumption (COMESA, 2008).

In Kenya, biomass energy is the commonest source of energy. It is noted that problems relating to environmental degradation, land clearance, overgrazing, deforestation, drought and desertification are placing more and more pressure on dwindling biomass energy resources (Mugo & Kituyi, 2002). Household energy is mainly used for cooking, lighting, keeping warm and heating water for other uses. The most common source of energy used by households for cooking and heating in Nyandarua District is firewood and charcoal. Only 9.5% of the households have electricity connection while alternative sources such as solar are yet to be popularized with only 1.5% of the households using it. (Nyandarua District Development Plan, 2002-2008).

**1.1 Problem Statement**

Though research has been carried out regarding rural household energy such as Karanja (1999), MoE (2004), Yieko (2001), no data however exist on how the rural households access, use efficiently and sustain the available energy sources. In Nyandarua District, at present, there is limited up-to-date data on the access, utilization and sustainability of household energy. While a number of studies have been carried out on rural household energy in this region, most of the studies have relied predominantly on the rural electrification as the solution to rural energy problems. There is little documentation and focus on the energy sources available and affordable, how they are utilized and their

sustainability. According to Miranga (2008), a range of barriers hinders access, utilization and sustainability of energy sources including time, household energy income, the level of education, availability and level of awareness among energy end users about energy conservation practices, options and benefits and insufficient information about energy efficient technologies. This cross-sectional survey sought to address these gaps by assessing the household energy access, utilization and sustainability among the rural households in Mbuyu Sub-location of Nyandarua District.

## 1.2 Purpose of the Study

The study sought to assess the rural household energy access, utilization and sustainability in Mbuyu Sub-location.

## 1.3 Objectives of the Study

i. To identify the types of household energy sources accessed in the study area.

ii. To establish the factors considered in access of household energy sources.

iii. To determine the energy efficient technologies utilized in the study area.

iv. To establish interventions for energy sustainability.

v. To determine the constraints faced in energy sustainability.

## 1.4 Null Hypotheses

$H_0$-1 There's no significant relationship in energy efficiency awareness between the male and female respondents.

$H_0$-2 There is no significant relationship between the household income and the cost of energy.

## 1.5 Significance of the Study

The research findings on energy opportunities and coping strategies in ensuring energy sustainability could be of benefit to Nyandarua district's rural households and households in similar ecological or socio-economic conditions as those of the study area. The results of this study may form a basis for laying strategies in the household energy planning, provision and utilization to the energy sector including the government, Non-governmental organizations and the community-based organizations. From the findings, comprehensive and adequate information on energy situation in the district could be generated which would be a base for future studies. The study could also make practical suggestions that would be beneficial during the energy policy revision to ensure rural household energy issues are integrated in the Nyandarua district development plans.

## 1.6 Theoretical Framework

### Family Resource Management-Family as System

In the Deacon and Firebaugh managerial system model (1988), the family is viewed as a social system that transforms the energy, information, and matter that enter the system into outcomes that the family desires. The model is composed of three major components: input, throughput and output. In the family system, inputs are known as demands and resources. Resources are means capable of meeting demands while demands are either goals or events that require action. The throughput component is further identified as having two sub-systems: the managerial sub-system and the personal sub-system. The managerial sub-system suggests that the family achieves its goals or responds to events through planning the use of its resources and implementing the plans.

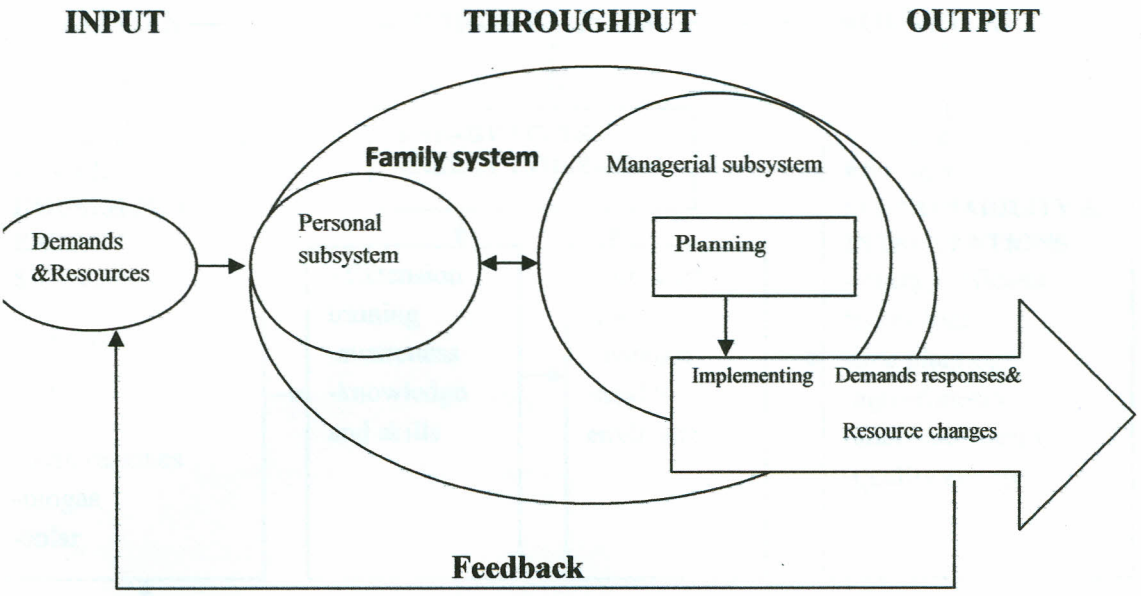


**Figure 1: Family system with managerial subsystem emphasis.**

**Source: Deacon & Firebaugh (1988). Family Resource Management (Principles and Applications)**

The role of personal sub-system is to receive input from external forces and clarifying values. It describes an individual's approach to decision making as intuitive or rational. Output is matter, energy or information produced by a system in response to input and from throughput processes.

### 1.7 Conceptual Framework

From the conceptual framework, sources of energy are the input. During the access and utilization of household energy, family resources are involved. For instance, time, money, physical energy, awareness on energy issues, environmental and human health influences on what energy sources to get and how to use them. This triggers the need to have sustainable energy sources.

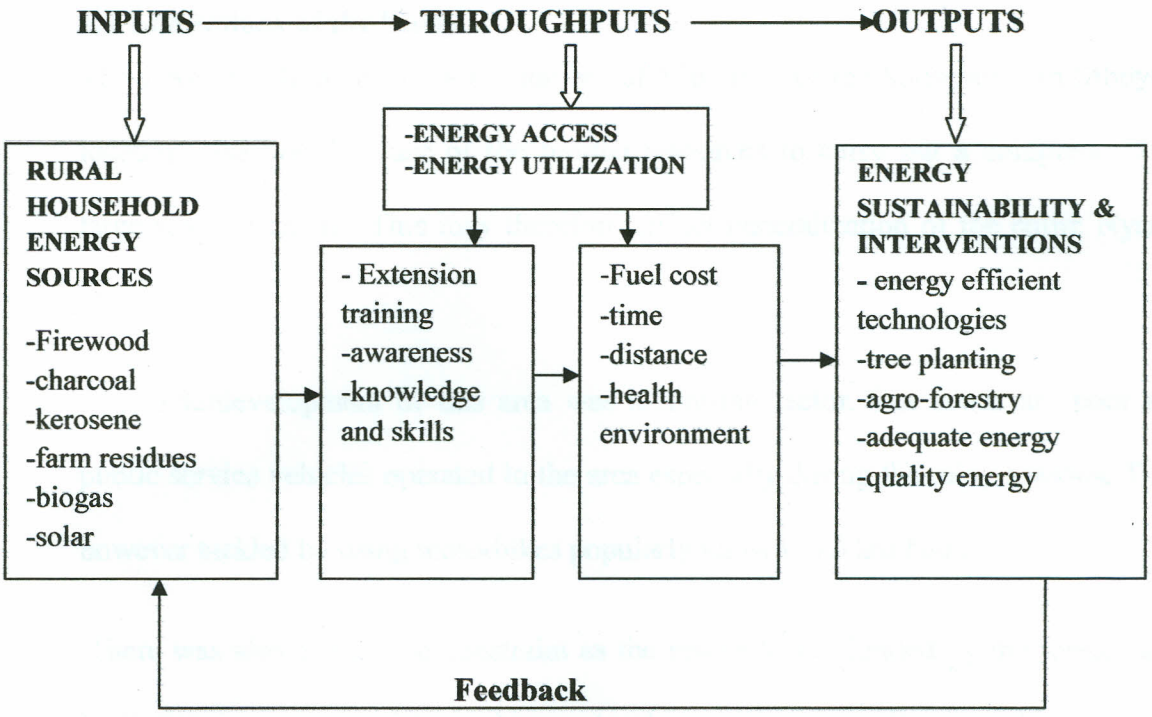


**Figure 2: Conceptual framework showing relationships between household energy access, utilization and sustainability**

Energy sustainability strategies and interventions are the outcomes or outputs which come about as a result of the decisions or action taken at the throughput level and in return this impacts on the input.

### 1.8 Assumptions of the study

i. Majority of the households in the study area used firewood as the main source of energy.

ii. Most of the rural households in the area of study lacked awareness of the efficient energy utilization and sustainability measures.

## 1.9 Limitations of the Study

The study was limited to a total number of 136, 10% of the households in Mbuyu Sub-location; this was because of the limited resources to carry out a comprehensive and large-scale research. This may therefore, affect generalization of the entire Nyandarua District.

The underdevelopment of this area was a limiting factor. The roads are poor and no public service vehicles operated in the area especially during the rainy seasons. This was however tackled by using motorbikes popularly known as *boda boda.*

There was also a financial constraint as the research was funded by the researcher; this limitation was countered by seeking out volunteers in data collection which reduced the total costs.

## 1.10 Definition of Operational Terms and Concepts

**Biomass Energy:** Refers to charcoal, firewood and agricultural residues.

**Energy Access:** Energy that is available to the households.

**Energy Efficiency:** Using less energy to provide the same level of energy service.

**Energy Sustainability:** It is the provision of energy such that it meets the needs of the present without compromising the future generation.

**Energy Efficient Technologies:** Devices produced with the ability to substantially reduce energy consumption such as wood or charcoal.

**Energy Source:** Fuel used for cooking, lighting or heating.

**Energy Utilization:** Different uses of household energy.

**Environmental Conservation:** Is a practice of protecting the environment, at the individual, organizational or governmental level, for the benefit of the natural

environment and (or) humans.

**Fuel Wood:** Firewood.

**Household:** A group of people living in the same compound (fenced or unfenced) but answerable to the same head and sharing a common source of food or income.

**Household Energy:** Type of energy utilized in a household.

**Physical injuries:** any bodily harm resulting from wood fuel collection.

**Wood Fuel:** Firewood and charcoal.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

In this chapter, literature on household energy access, utilization and sustainability was reviewed under the following topics:

i. Global household energy use
ii. Household energy access and development
iii. Household energy use and the rural poor
iv. Household energy sources
v. Biomass energy situation in Kenya
vi. Energy efficient technologies in rural areas
vii. Household energy sustainability
viii. Energy policies in Kenya
ix. Summary

## 2.1 Global Household Energy Use

The household sector is responsible for about 15 to 25 per cent of primary energy use in developed countries and for a higher share in many developing countries. Average per capita household energy use in developed countries is about nine times higher than in developing countries, even though in developing countries a large share of household energy is provided by non-commercial fuels that are often not reflected in official statistics (Dzioubinski and Chipman, 1999).

The most notable trend is the decline in per capita household energy consumption in North America, which in 1970 had much higher household energy consumption than any other region. The difference remains considerable but it decreased substantially. This decline is a result of several factors, including increased energy efficiency and saturation with domestic electrical appliances. Statistics also indicate higher household energy consumption in Africa than in other developing regions. This appears to be due to the higher share of fuel wood and other biomass as energy sources in Africa compared to Asia and South America and consequently lower energy efficiency.

Household energy accounts for about half of India's total energy consumption. About 72 per cent of India's population lives in rural areas, where biomass is the primary source of energy. Cooking and water heating account for about 90 per cent of household energy use. Space heating is not a large component due to India's subtropical and tropical climate, whereas air conditioning is still a luxury confined to a small percentage of households.

Biomass dominates cooking fuel. Household energy accounts for about 30 per cent of total energy consumption in the Republic of Korea. Biomass use is now negligible, with only a 5 percent share of household energy demand. Because it is a small country with high population density, there are few differences in lifestyles between urban and rural areas. The climate largely determines household energy consumption patterns. Space heating absorbs almost 70 per cent of total household energy demand, with lighting and appliances accounting for 17 per cent, and cooking for 14 per cent.

In China, about 70 per cent of the population still lives in rural areas and rely on biomass (mainly crop stalks and fuel wood) for about 80 per cent of their fuel. Cooking and space heating account for over 95 per cent of household energy consumption in rural areas and 90 per cent in urban areas. While urban households have adequate fuel supplies and access to electricity, many rural areas still suffer from fuel shortages, and about 40 million rural households have no access to electricity. China has great potential for fuel savings in cooking and water heating. Promoting efficient firewood and coal stoves has been a priority of the government since the early 1980s. By the end of the 1980s, about 50 per cent of all rural households were equipped with firewood stoves with a high thermal efficiency of 25 to 30 per cent.

**2.2 Household Energy Access and Development**

According to the ecology-first scenario presented at the World Energy Council held in 1998, the world energy supply in 2100 will be dominated by new and renewable energy sources, incorporating 40% photovoltaic, 30% hydro and 15% biomass. Major energy organizations also forecast greater dependence on new and renewable energy in the future (IEA, 2000).

Development of Sub-Saharan Africa therefore, requires sharp increases in the supply of energy inputs as well as great improvement in the present abysmally low levels of efficiency in the use of energy (Sum Low, 2005).

Addressing basic energy needs for cooking and lighting is a key element in improving the living standards of people especially those in rural areas. Energy is central to practically all aspects of human welfare including access to water, agricultural productivity, health

care and nutrition, education, job creation and environmental sustainability, however, just as energy has the potential to instigate development, it can also act as one of the greatest barriers. While the poor can most benefit from improved access to energy sources, they are also the most likely to suffer from the effects of unsustainable energy use such as climate change, deforestation, adverse health impacts and desertification. (Miranga, 2008).

In developing countries like Kenya, millions of households still lack access to safe and reliable energy and pay high prices for poor quality substitutes. Moreover, poor people spend much of their income on energy, more than a third of household expenditures in some countries. They also devote a large proportion of their time on energy related activities (World Resource Institute, 2003). According to Muchiri (2008), due to fuel wood scarcity, local women are finding their domestic chores increasingly difficult. They are compelled to walk longer distances. In desperation, women are turning to potentially toxic options such as cow dung and old plastic containers which are injurious to their health. This has, therefore, been a contributing factor of the underdevelopment in the rural areas due to the stressed family resources which would otherwise have contributed in improving the livelihoods of these households.

**2.3 Household Energy Use and the Rural Poor**

Over half of all people relying on biomass for cooking and heating live in India and China, but the proportion of the population depending on biomass is heaviest in Sub-Saharan Africa (IEA, 2004). Extreme poverty and the lack of access to other energy sources mean that 80% of the overall Africa population relies primarily on biomass to meet its residential needs (UNDP, 2005).

For the poor, access to greater quality and quantity of energy services is an essential prerequisite to making the transition from subsistence livelihoods to increased productivity, income generation, and improved living standards. Providing the rural poor with access to clean, efficient, affordable energy services has multiple, synergistic impacts on productivity, education, health and gender equality (UNDP, 2005). Access to efficient energy frees the poor, especially women and girls, from the drudgery of collecting fuel wood, thus expanding opportunities for schooling and after-school study. Use of clean and reliable energy sources also reduces damage of health from exposure to high levels of indoor air pollution from burning of solid fuels (wood, cowdung etc) for cooking and heating (WHO, 2002).

**2.4 Household Energy Sources**

According to the Ministry of Energy (2004), there are three main sources of energy in Kenya. These are wood fuel, petroleum and electricity, accounting for 70 per cent, 21 per cent, and 9 per cent of total energy use respectively. Renewable energy is also becoming important although it remains insignificant in the country's overall energy mix.

Firewood: Close to 89% of rural and 7% of urban households report regular use of firewood, giving a national average of 67% of all households. The average annual per capita consumption is approximately 741 kg and 691 kg for rural and urban households, respectively. For urban areas, it is the lowest income households who depend on firewood the most. This is in line with previously documented consumption patterns for the country. Firewood comes from agro forestry or on-farm sources (84%), from trust

lands (8%) and from gazetted forests (8%). Approximately 76% of households obtain all their firewood free, 17% of households regularly purchase it while 7% supplement their free collection by purchasing some firewood. Firewood is mainly used for cooking and space heating (Mugo & Kituyi, 2002)

Charcoal: Use of charcoal is about 47% at the national level representing 82% and 34% of urban and rural households, respectively. Per capita consumption is 156 kg in urban areas and 152 kg in rural areas. Total charcoal consumption is 2.4 million tonnes (67 million 36-kg bags), representing an annual business of approximately KSh 17 billion at a weighted price of KSh 261 per bag. This is about 53% of the 1998 bill for imported oil. Some 40% of this amount is spent at source in rural areas with the balance being accounted for by transport and marketing at the end-use.

Among the various energy conservation initiatives that have borne fruit in Kenya is the introduction of improved cook stoves (*jikos*) with about 47% of charcoal-using households indicating that they had these units (Muchiri, 2008). The major developmental issue with charcoal is that it is based on wood regarded as a 'free good' and obtained mainly from communal lands. This discourages charcoal production based on grown wood. Production and transportation of the commodity is subject to issuance of movement permits. As most authorities are not willing to issue such movement permits for fear of being associated with environmental destruction, most transportation is done during the nights using very old Lorries.

Petroleum: The fuel is imported into Kenya in the form of crude oil from the Middle East and is refined in the country's only refinery at Mombasa. Kerosene as a cooking and

lighting fuel is important for the poor in rural and urban areas and has in some cases served as a substitute for wood fuel. Hence, any efforts to increase kerosene consumption will undoubtedly relieve pressure on wood use. Indeed, the government has often used tax reduction or non-increase for kerosene for this purpose and also as a poverty mitigation measure (Mugo and Kituyi, 2002).

Electricity: According to Ministry of Energy (2004), 0.5% of the rural households have access to grid electricity while population growth exceeds the rate of rural connections despite major investments in the rural electrification program.

Farm residues: Overall, about 21% of households use farm residues, but their use is mainly in rural areas with 29% households as compared to 0.5% in urban households. The annual per capita consumption is about 435 kg and 351 kg for rural and urban areas respectively. The continued use of farm residues compromises opportunities to improve soil fertility.

Wood Waste: According to Mugo and Kituyi (2002), only 2.5% of households reported using wood waste, a decline from 5.1% noted in the 1980 Beijer Institute study and attributed to shortages of industrial wood. Use is mainly in urban areas by 3.7% of households as compared to 2.1% in the rural areas. The consumption is about 15,600 tonnes, estimated from industrial by-product production (sawdust, timber rejects, off-cuts etc).

Liquefied Petroleum Gas (LPG): This is not widely used with only 7.8% (23% urban and 1.8% rural) households using it due to various constraints. Average per capita consumption is only 3.6 kg and 9.7 kg for rural and urban areas respectively. LPG is used

along with firewood in rural areas while in urban areas; it is used as a supplement for electricity. LPG-based appliances are expensive and regulators are incompatible between different major dealers, making it difficult to interchangeably buy LPG from a variety of companies.

Solar: The main use of solar energy is for lighting and heating water. Most households that use solar energy have a single photovoltaic panel with a power rating of 12-25 watts. A total of 150,000 units have been introduced. The main issue is capital cost as most consumers find the technology expensive. Skilled technicians for backup maintenance are also in short supply.

Biogas: According to the Intermediate Technology Development Group (ITDG), approximately 1,100 biogas units are operational in Kenya. Maintenance technology and the fact that most households do not have piped water are among the constraints to wider adoption of biogas.

Renewable energy resources including solar energy, windmills, power alcohol and biogas have the potential to contribute to social, economic and environmental dimensions of sustainable development.

**2.5 Household Energy Sustainability**

Energy sustainability refers to the availability of energy sources that are diverse, in reliable quantities, affordable, support economic growth, assist in poverty alleviation measures and does not harm the environment. Access to reliable energy is a major factor in human welfare, climate change, health care and environmental sustainability (UNDP, 2002). Moving towards energy sustainability will require changes not only in the way

energy is supplied, but in the way it is used, and reducing the amount of energy required to deliver various goods or services is essential. Opportunities for improvement on the demand side of the energy equation are as rich and diverse as those on the supply side, and often offer significant economic benefits. These include access to renewable sources, human activities such as re-afforestation, agro-forestry and extension training on efficient technologies.

Renewable energy and energy efficiency are sometimes said to be the "twin pillars" of sustainable energy policy. Both resources must be developed in order to stabilize and reduce carbon dioxide emissions. Efficiency slows down energy demand growth so that rising clean energy supplies can make deep cuts in fossil fuel use. If energy use grows too fast, renewable energy development will chase a receding target. Likewise, unless clean energy supplies come online rapidly, slowing demand growth will only begin to reduce total emissions; reducing the carbon content of energy sources is also needed. Any serious vision of a sustainable energy economy thus, requires commitments to both renewable energy and efficiency.

**2.6 Biomass Energy Situation in Kenya**

Biomass energy refers to charcoal, firewood and agricultural residues. Firewood is mainly a rural fuel with over 90% of the rural population dependent on it while charcoal is mainly an urban fuel, with over 50% of the urban population using it. (Sagar, 2005). Studies indicate that about 2% of Kenya's land area is covered by forests, which produce about 45% of the biomass energy resources including wood wastes. The balance is derived from farmlands in the form of woody biomass as well as crop and animal residues. There is a widening gap between supply and demand for wood fuel.

A comparison of the sources of fuel wood for household consumption in 1980 and 2000 shows that in 1980s, the main sources were agricultural land 47 %, gazetted forests 25 % and rangelands 28 %, while in 2000, the main sources were agro forestry 64 %, trust land 8 %, gazetted lands 8 % and purchased outside the household 20 %. Although there are apparently large wood volumes available from the various vegetation types in the country, not all of it is accessible for energy. Accessible wood depends on a number of factors: legal issues, environmental issues, ownership, distances, infrastructure and quality of materials (Kamfor, 2002). Efficient use of biomass energy is not only safe to the users but also environment-friendly and therefore, woodlands and forests will not be under threat and biological diversity will not be threatened. Apparently, the introduction of the biomass efficient technologies such as improved household stoves has had a positive impact in the attempt to sustain this important source of energy.

According to the Ministry of Energy (2004), Kenya has actively engaged in activities that are aimed at conservation of natural resources. Effective conservation of natural resources is necessary in sustainable development; this is only possible when information on the state of environment in the whole country or in some cases, part of the country is available. Indeed, improvement on household energy access, use and sustainability is significant. It is important to know what sources of energy are available, how and what they are used for, and their reliability to the consumers.

## 2.7 Energy Efficient Technologies in Rural Areas

Out of four billion people in the developing world, about two billion, mostly in rural areas, are still without electricity. Access to safe, affordable energy for heating, lighting

and cooking is an immense challenge in many countries. Options are often expensive, inefficient, and can have negative health and environmental impacts. In response, several programs initiated an Energy Efficient Technologies (EET) portfolio of initiatives that focuses on enhancing the welfare of the poor in developing regions through the development, testing and diffusion of low-cost, energy- related technologies that meet real needs, emphasize energy efficiency and minimize negative environmental impact(Muchiri 2008).

Currently, 99.5 % of rural Kenyan household have no access to electricity. The overall energy demand in the country will continue to grow at a rate of 4.4% per annum. Technologies that could enable Kenya to grow economically while reducing or stabilizing energy use are currently of limited availability (ITDG, 2002). What's more, even when such technologies are economically competitive over the long-term, they tend to require more upfront capital than Kenya can afford unless it receives support from aid agencies or other international funding sources. Solar energy appears to be an ideal solution towards the resolution of Kenya's energy requirement for the 21st century; however, there are few issues and problems that must be ironed out for proper use and acceptance of this energy source. Installation and capital costs have been the main hampering factors to the development of a more generalized and mature solar market, and for equitable distribution of this technology to the most obvious beneficiaries, who are generally people residing in remote rural countryside and low-income earners in urban areas (Karanja, 1999). Benefits expected from renewable energy implementation will include less impact on health and environment since it is basically an indigenous energy source and is available everywhere even within rural areas.

To help address the deepening deforestation crisis, researchers at KENGO (Kenya Energy and Environment Organizations) developed a more energy efficient jiko (KCJ, appendix ii). The new stove uses up to 50% less fuel and is light (3-6 kg) and portable. Ideal for low-income families, it reduces the cost of fuel while decreasing cooking time. For example, water can be brought to a boil faster and for a longer period using the improved jiko. Because of its shape, the stove's heat is directed only to the desired location, right under the cooking pot.

**2.8 Energy Policy in Kenya**

The energy policy in Kenya has tried to address to a certain degree of success the issues of energy access, availability, affordability and sustainability. To address the foregoing biomass energy supply demand imbalance, the government and collaborating organizations have adopted various strategies like expanding the biomass supply through on farm tree planting and biomass substitution and improvement on conversion and end-use efficiencies.

Rural energy focus proposed in sessional Paper No.4 on energy, on dependence on biomass through fuel substitution mainly with LPG, may improve on the management of the family resources resulting to socio-economic development of the rural households. The demand side management strategies pursued in the past and present namely, improved efficiency stoves and energy conservation is not able to keep pace with the depletion rate of the sustainable supply.

The energy policy objectives also spell out measures to be undertaken in resolving energy supply in the country. The policy measures for biomass which is the commonly used energy source in the rural households include enhancing research and development,

streamlining the production and marketing of charcoal, increasing the adoption of improved stoves, promoting inter fuel substitution and promoting tree planting for energy production. Policies for energy investments should target increasing access to energy for increased productivity and reducing drudgery for women as failure to invest in low-cost energy supply systems condemns women to continue using low-quality energy sources for cooking and lighting with associated health and environmental problems.

While the strategies may ultimately help, their formulation and implementation are not clearly stipulated. This may inherently constrain the achievement of full benefits envisaged. Therefore in policy making or revisions of the Energy Policy in the future, it is imperative that integration with related sectors be seriously considered.

**2.9 Summary**

The quality of household energy matters as much as its quantity, hence there is need for greater understanding of this important sector. Developing nations not only use small amounts of energy, they also tend to rely on lower quality sources such as animal dung, agricultural wastes and fuelwood. Reliance on these low quality sources limits the household energy service that can be supplied, resulting to human health and environmental problems. The key issues and challenges of household energy include expanding access to energy, improving household energy efficiency and ensuring reliability of these energy sources.

There are a number of gaps in the current energy policy that require necessary revamping during its revision. Adequate coverage of rural household energy issues including:

biomass energy, energy processing marketing, and renewable energy is not given. Implementation on how to ensure adequate, reliable, cost-effective and affordable supply of energy, fuel substitution and sustainability measures of the biomass energy which is commonly used by the rural households is not clearly outlined.

For rural energy planning and integration with other aspects of development, adequate information is required. A comprehensive and reliable information system needs to be developed and updated regularly. It should include assessments of rural energy needs and availability on an area basis, patterns and trends in household energy consumption and also sustainability measures to ensure reliability of the affordable energy source.

In Nyandarua District, little focus and information on rural household energy issues such as access, utilization and sustainability have been partly documented. This study was, therefore, conducted in Mbuyu Sub-location of the said district to narrow the observed gaps from the literature.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.0 Introduction

This study intended to assess rural household energy access, utilization and sustainability. This chapter describes the research design, study area, target population, sample size and sampling design, data collection instruments and data analysis procedure.

## 3.1 Research Design

This is a cross-sectional survey study that incorporated both qualitative and quantitative research methods. The approach entails observation of some subset of a population at a single point in time. (Mugenda & Mugenda, 1999). In this study, the design enabled the researcher assess the energy situation and describe the population. Data was collected once, analyzed and conclusions, recommendations and suggestions for further research were made.

## 3.2 Study Area

According to Nyandarua District Development Plan 2002-2008, Nyandarua District is the largest of the 7 districts in Central Province with area coverage of 3,304 $km^2$. It lies between latitude $0^0$ 8′ north and $0^0$ 50′ south and between $35^0$ 13′ west and $36^0$42′ east. The District borders Laikipia District to the north, Nyeri and Murang'a District to the east, Kiambu District to the south and Nakuru District to the west. It comprises of six administrative Divisions namely Ndaragwa, North Kinangop, Ol Kalou, South Kinangop, Ol Joro Orok and Kipipiri. Rainfall varies from 1,400 mm to about 700mm. The

temperatures are moderate but can get as low as $7.1C^0$ in the cold seasons of July, resulting in frost. The District falls in the highland savannah zone, characterised by few scattered trees and expansive grass cover. It has a gazetted forest, covering about 11% of its total area. Population estimate for the district is 562,975 persons constituting 104,401 households. As indicated by the District Statistics Office, 86% of this population lives in the rural areas.

Mbuyu Sub-location is the area under focus. The area has a total number of 1,367 households. The Sub location is categorized as a semi-arid area characterized by poor infrastructure including transport and communication network. It is a rural setting with no major social amenities (NDDP, 2002 – 2008) and therefore, it was purposively selected. Moreover the area experiences fuelwood scarcity and since the District records 99% of fuelwood users, there was need to assess the household energy situation in the area. Mbuyu Sub-location therefore served as a representative sample for the rural and marginalized regions in Kenya.

### 3.3. Target Population

A target population is that which a researcher wants to generalize the results of a study (Mugenda & Mugenda,1999)

The target population in this study was all the 1367 rural households in Mbuyu Sub-location of Nyandarua District. Majority of the population engage in livestock farming for commercial purposes due to the warm conditions in the area. Food insecurity however is common in this area due to droughts and frost.

### 3.4 Sample Size

A sample is a representative subset of a population (Mugenda, 2008). According to Gay (1996), a sample size of 10% of the accessible population is enough for descriptive studies. From an accessible population of 1367 households, 136 households were selected as a representative sample.

### 3.5 Sampling Design

Simple random sampling was used to select the sample size. The procedure is a statistical method involving the selection of a random sample from a population without any order. It was preferred since the households were not arranged in any systematic order.

Using this procedure, each element in the population has a known and equal probability of selection (Mugenda, 2008). A list of all the 1367 households was compiled and each household was assigned a number. With the required sample size of 136 households, the researcher blindly picked a number and the household assigned this number was included in the sample. This was done repeatedly until the desired sample size was acquired.

### 3.6 Data Collection Instruments

Data was collected using an interview schedule and observation checklist (appendix II and III). An interview schedule is a list of questions that the interviewer reads out to the respondents and writes down the responses (Mouly, 1978). This method was deemed appropriate as it allowed the researcher to understand and capture the respondent's point of view through probing any incidental information given (Aluko, 2005). Moreover, most rural people are semi-literate and could therefore not handle a self administered

questionnaire. The method also requires the physical presence of the researcher thus enabling her to make observations. The respondents were visited in their homes for interview sessions and responses were filled in the interview schedule. The instrument contained both the open-ended and closed questions which yielded qualitative and quantitative data respectively. It was divided into four parts. The first part was used to collect socio-demographic data. The second part was to collect data on energy access, the third part on energy efficiency and utilization while the fourth part was to collect data on community interventions and energy sustainability. Observation checklist was used to strengthen data interpretation.

### 3.7 Pre-testing of Interview Schedule

Pretesting of the interview schedule was carried out for accuracy and clarity prior to the main study on randomly selected 13 respondents who qualified to be in the sample but was not included in the study. The pretesting was done in Karago-ini sub-location an area that was not covered by the study. The procedure used in pre-testing the instrument was identical to the one used in actual study. Ambiguities and weaknesses in the instrument were identified and changes made in preparing the final interview schedule. Research assistants were also trained to ensure there was consistency in observing, measuring or assessing the characteristics under study.

### 3.8 Data Analysis Procedure

Upon collection, the data was cleaned and coded by creating categories using numeric values. It was then entered into spreadsheets and analyzed using Statistical Package for

the Social Sciences (SPSS). Descriptive statistics and cross tabulations were used to analyse quantitative data. Inferential statistics were performed to establish the significance of relationships between different variables and to test the hypotheses. Data was presented using graphs, charts, tables and percentages.

### 3.9 Research Variables

**3.9.1 Dependent Variables:** Energy access, utilization and sustainability. Energy access was measured by asking the respondents the type of energy sources they used, how they acquired them and challenges faced in the access. Utilization was measured by how the sources were used and the energy efficient technologies available to them. Energy sustainability was measured by energy conservation and interventions in place.

**3.9.2 Independent variables:** they include age, education, household income, gender and occupation of the respondents.

### 3.10 Reliability and Validity

Reliability was measured by pretest of the instrument to ensure it yielded consistent data after repeated trials. Areas of the interview schedule that were found insufficient were revised and the instrument adjusted accordingly. Content validity was established by use of two competent people in the field of energy who were requested to assess the relevance of the content used in the interview schedule. They examined the instrument individually and provided feedback to the researcher. Their recommendations and suggestions were integrated and incorporated in the final interview schedule.

### 3.11 Ethical Considerations

Research authorization was obtained from Ministry of Higher Education, Science and Technology through the School of Graduate Studies, Kenyatta University. Informed consent was obtained from the respondents before data were collected and confidentiality was maintained throughout the research process.

# CHAPTER FOUR

# RESULTS AND DISCUSSIONS

## 4.0 Introduction

This chapter presents results of the study and discussions of the findings. The discussions are presented in the sections addressing research hypotheses and study objectives and involved the use of descriptive and inferential statistics including frequencies, percentages, chi-squares and pearson correlation coefficient. The data were presented in tables, graphs and pie charts. The sections of the report include: summary of the sample description statistics, household energy access, energy efficiency, energy utilization, interventions and energy sustainability measures.

## 4.1 Sample Description and Characteristics

The socio-economic characteristics of the sample were examined to give an overview of the status of the respondents in the study area. These include age, gender, educational level, occupation and household income.

### 4.1.1 Age of the Respondents

***Table 1: Age of the Respondents***

| **Age in years** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| 15-25 | 18 | 13.2 |
| 26-35 | 58 | 42.6 |
| 36-45 | 41 | 30.1 |
| Above 45 | 19 | 14.0 |
| **Total** | **136** | **100** |

Out of the total sample of 136 respondents, 13.2% ranged between 15 and 25 years, 42.6% of the respondents ranged between 26 and 35 years, 30.1% ranged between 36 and 45 years and 14.0% were above 45 years of age. Majority of the population in the study area fell between the age brackets of 26-35 and 36-45 which indicates that most of the respondents were young and productive.

### 4.1.2 Gender of Respondents

The respondents were asked about their gender, the gender of respondent was important in order to establish the relationship between gender and household energy issues such as access, efficiency in use and sustainability.

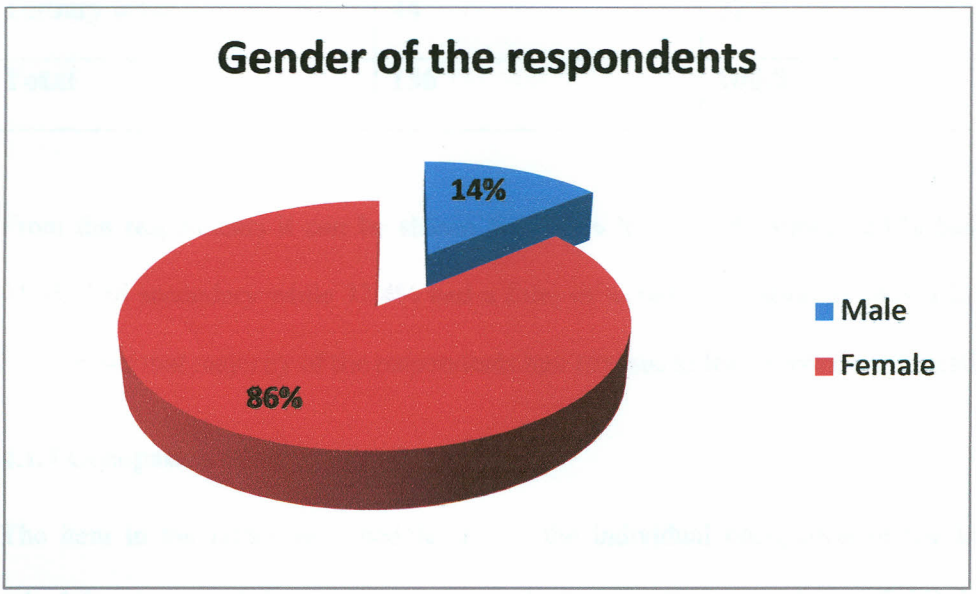


***Figure 3: Gender of Respondents***

From Figure 3, the gender of the respondents was 14% males and 86% females. These findings concur with report by Muchiri (2008) that women are the main collectors, users and producers of household energy in the rural areas. It was noted that men preferred women to be interviewed since they were responsible in household energy provision and domestic chores like cooking.

### 4.1.3 Education of the respondents

The respondents were asked about their formal education. This was pertinent because community participation in energy provision, efficient utilization and adoption of sustainability strategies depended on how ready they were in embracing new ways of doing things.

***Table 2: Education of respondents***

| **Educational level** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| No education | 4 | 2.9 |
| Primary level | 31 | 22.8 |
| Secondary level | 57 | 41.9 |
| Tertiary level | 44 | 32.4 |
| **Total** | **136** | **100.0** |

From the respondents it can be shown that 2.9% had no education, 22.8% had primary level, 41.9% had secondary while 32.4% had a form of tertiary education as shown in Table 2 above. This shows that majority of the respondents had attained at least secondary education.

### 4.1.4 Occupation of the Respondents

The item in the interview schedule sought the individual occupation of the interviewee. The schedule categorized the responses as casual labourers, permanently employed, business persons and those unemployed.

From Table 3 below, the respondents' occupational levels were 41.9% casual laborers, 6.6% permanently employed, 14.7% businesspersons, and 36.8% were not employed. Majority of the respondents were casual labourers followed by the unemployed.

***Table 3: Occupation of respondents***

| Occupation | Frequency(N) | Per cent (%) |
|---|---|---|
| Casual | 57 | 41.9 |
| Permanent | 9 | 6.6 |
| Businessperson | 20 | 14.7 |
| Not employed | 50 | 36.8 |
| **Total** | **136** | **100.0** |

### 4.1.5 Household Incomes of the Respondents

This item of the interview schedule sought to find out the amount of income (Kshs) families earned per month. This was important in understanding the budget allocation towards household energy.

***Table 4: Household incomes of the respondents***

| Household income(Kshs) | Frequency (N) | Per cent (%) |
|---|---|---|
| 1500-3000 | 67 | 49.3 |
| 3500-7000 | 37 | 27.2 |
| 7500-15000 | 26 | 19.1 |
| 15500-30000 | 6 | 4.4 |
| **Total** | **136** | **100.0** |

Results in Table 4 show that, 49.3% respondents earned a household income ranging between Kshs.1,500 to Kshs. 3,000, 27.2% Kshs.3,500 to Kshs.7,000, 19.1% Kshs.7,500 to Kshs.15,000 while 4.4% obtained Kshs.15,500 to Kshs.30,000. Majority of the

respondents had an income ranging Kshs.1,500-3,000, which means most respondents were low-income earners hence this would affect their choice of household energy type.

### 4.2 Energy Sources in Mbuyu Sub-location

In Mbuyu Sub-location, the respondents used a variety of energy sources namely; firewood 95.6%, kerosene 98.5%, electricity 5.9%, gas (LPG) 15.4% solar 23.5%, charcoal 67.6%, agricultural residues 21.3%, biogas 5.9%, and plastics by 1.5%.

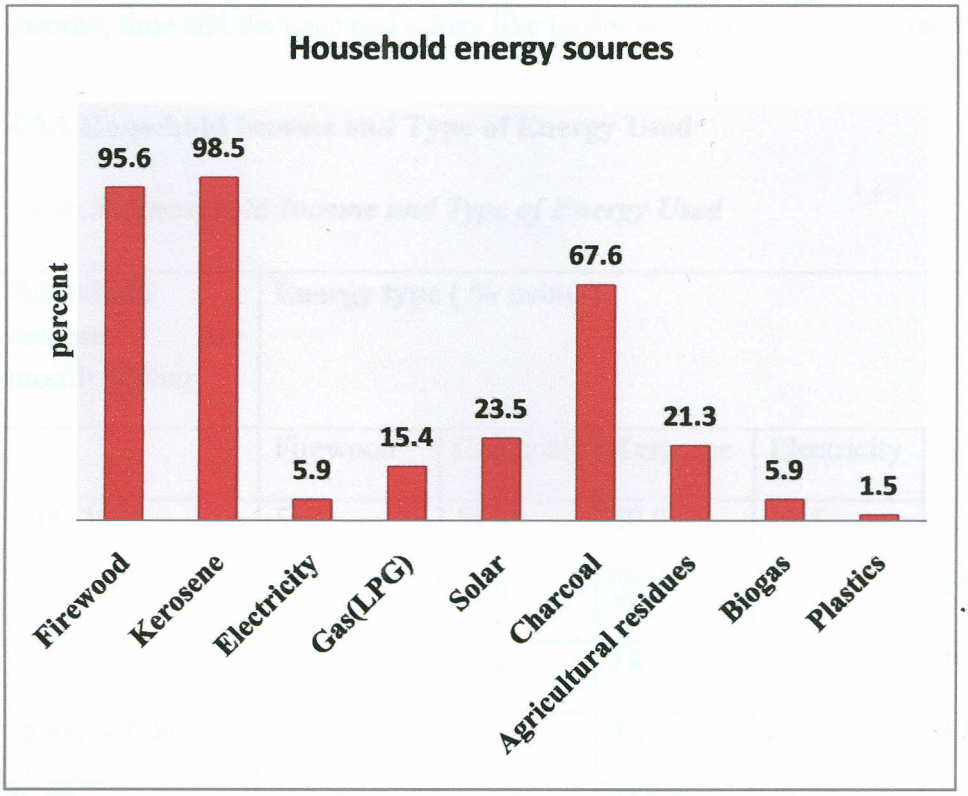


***Figure 4: Household energy sources in the study area***

Firewood and charcoal were chiefly used as energy sources for cooking and kerosene mostly for lighting. Electricity, though not a common energy source, was used by a few households for lighting. Solar and biogas were used by a minority because of the high costs of installation and the cited cases of cattle rustling therefore, low availability of raw

materials (cowdung) for the latter. Plastic materials were used by two households for heating water. These findings concur with observations by Miranga (2008) that biomass energy is the dominant energy form for most African countries.

### 4.3 Factors Considered in Energy Access by Rural Households

While examining types of energy, particular emphasis was put on factors that most likely affected the preference of the type of energy used. These aspects included monthly income, time and distance and others like health and environmental concerns.

#### 4.3.1 Household Income and Type of Energy Used

***Table 5: Household Income and Type of Energy Used***

| **Household income per month (Kshs)** | **Energy type ( % using )** | | | | | |
|---|---|---|---|---|---|---|
| | Firewood | Charcoal | Kerosene | Electricity | LPG | Solar |
| 1500-3000 | 51.5 | 54.3 | 50.0 | 12.5 | 5.9 | 28.1 |
| 3500-7000 | 27.7 | 19.6 | 27.6 | 12.5 | 55.9 | 28.1 |
| 7500-15000 | 16.9 | 19.6 | 18.7 | 12.5 | 29.4 | 31.3 |
| 15500-30000 | 3.9 | 6.5 | 3.7 | 62.5 | 8.8 | 12.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

***Multiple responses allowed**

Income is likely to influence the type of energy used since higher incomes make it affordable to access efficient energy sources. The commonly used energy sources irrespective of the household income were firewood, charcoal and kerosene. The study results concur with observations by Muchiri (2008) that in rural households of a given area; the types of fuels used were nearly uniform among all income groups. Nevertheless

majority of the respondents who used electricity and solar had an income of Kshs. 15500-30000. Those using LPG, the income level was Kshs.3500-7000.

Ho-1: There is no relationship between household energy and cost of energy

Pearson product moment correlation coefficient was performed to establish the relationship between the household income and the expense on energy.

***Table 6: Pearson correlations on household income and cost of energy.***

| | | Household income | Expense of energy |
|---|---|---|---|
| **Household income** | Pearson Correlation | 1 | .371** |
| | Sig. (2-tailed) | . | .000 |
| | N | 136 | 136 |
| **Expense of energy** | Pearson Correlation | .371** | 1 |
| | Sig. (2-tailed) | .000 | . |
| | N | 136 | 136 |

** Correlation is significant at the 0.05

It revealed that there was a positive correlation between household income and the cost of energy (r=0.371, p=0.001) as shown on Table 6. This means that as household income increased the energy expenses also increased. This is supported by Yieko (2001) who reported that the higher the income the more expensive the type of energy used. The null hypothesis was therefore rejected.

### 4.3.2 Environmental Factors

***Table 7: Environmental factors***

| Choice of household energy | Frequency | Per cent (%) |
|---|---|---|
| Environmental concerns | 20 | 14.7 |
| Not environmentally concerned | 116 | 85.3 |
| **Total** | **136** | **100.0** |

From Table 7, only 14.7% of the respondents considered environmental effects of the household energy they were currently using while 85.3% did not. This agrees with a study by Karekezi and Ranja (2000) that a well-integrated concept in rural development program should include environmental concerns; in that biomass energy conservation impacts directly on the everyday life of whole family and it is a powerful factor in raising awareness of the need to protect environment at the individual household level. Environmental issues of household energy are important because they include indoor air pollution which is a leading cause of death in Sub-Saharan Africa.

### 4.3.3 Availability of the Household Energy

***Table 8: Availability of the household energy***

| **Choice of household energy** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| Availability | 114 | 83.8 |
| Availability not considered | 22 | 16.2 |
| **Total** | **136** | **100.0** |

From Table 8 above, about 83.8% of the respondents reported that they considered availability in their choice of household energy. This can be deduced to mean that majority of the respondents used what was readily available to them. This concurred with observations by Dzioubinski and Chipman (1999), that the predominance of firewood as the dominant source of energy for cooking despite its inefficiency and harmful impact on human health could be attributed to its availability as a 'free' source of energy. In most cases firewood is collected and not purchased.

### 4.3.4 Health Factors

***Table 9: Health concerns in choice of energy***

| Choice of household energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Health concerns | 4 | 2.9 |
| No health concerns | 132 | 97.1 |
| **Total** | **136** | **100.0** |

From Table 9, majority of the respondents (97.1%) did not consider health matters in the choice of household energy. The present study agrees with the report by UNDP (2005) that indoor air pollution from biomass use has been casually linked with serious and widespread health problems especially to women and children under five years due to persistent exposure to smoke in the kitchen.

### 4.3.5 Time Spent on Firewood Collection

The average time taken to collect firewood by 50% of the respondents was in the range of 3-4 hours.

***Table 10: Time spent on firewood collection***

| Time in hours per day | Frequency (N) | Per cent (%) |
|---|---|---|
| 1-2 | 12 | 9.2 |
| 3-4 | 65 | 50 |
| 5-6 | 21 | 16.2 |
| 7-8 | 32 | 24.6 |
| Don't use firewood | 6 | 4.4 |
| **Total** | **136** | **100** |

According to the respondents the time spent on collection was not much compared to purchasing other energy sources. Therefore most of the respondents used firewood in their households.

This concurs with the studies carried out by World Resources Institute (2003) which pointed out that in Kenya; the time spent gathering firewood averaged between 3 to 5 hours or about 75 per cent of the household time.

### 4.3.6 Distance Covered to Firewood Collection

***Table 11: Distance covered to firewood collection***

| Distance covered | Frequency (N) | Per cent (%) |
|---|---|---|
| Less than 1 km | 53 | 39 |
| 1-5 km | 35 | 25.7 |
| 6-10km | 30 | 22.1 |
| Over 10 km | 12 | 8.8 |
| No response | 6 | 4.4 |

The survey results established that 39% of the respondents covered less than one kilometre to gather firewood. This may explain why firewood was the predominant source of energy in the area. 25.7% covered 1-5km, 22.1% covered 6-10km, while 8.8% respondents covered a distance of more than 10 km. The above findings agree with Muchiri (2008) that due to fuel wood scarcity, many women in fulfillment of their gender roles are forced to travel long distances in search of fuel.

### 4.3.7 Affordability of Energy

*Table 12: Cost of energy (affordability)*

| Cost of energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Affordability (low cost) | 112 | 82.4 |
| Cost not considered | 24 | 17.6 |
| **Total** | **136** | **100.0** |

The results from Table 12 show that 82.4% of the respondents considered the price of household energy in the choice of the energy source the household used. Majority of the households were forced to use cheap sources of energy in relation to their household incomes. This finding agrees with a study by Douglas and Willem (1999) that one of the most important determinants of household access and fuel mix is the cost of various energy sources.

### 4.3.8 Sources of Firewood Collection

This item in the interview schedule required the respondents to indicate whether they gathered the firewood from their farms or other external sources.

*Table 13: Sources of firewood collection*

| Response | Frequency (N) | Per cent (%) |
|---|---|---|
| **Own farms** | 11 | 8.1 |
| **External sources** | 119 | 87.5 |
| **Don't use firewood** | 6 | 4.4 |
| **Total** | **136** | **100** |

Table 13 shows that, 8.1% respondents collected firewood from their own farms, 87.5% collected firewood from external sources while 4.4% respondents did not use firewood.

This shows that majority of the respondents set specific time to go to collect firewood elsewhere unlike the few who do it concurrently with other activities in their farms. This can thus be presumed that the area does not suffer fuel wood shortage or the respondents have small farms to support agro forestry. As indicated by Mbuthi (2005), fuel wood scarcity triggers on farm tree planting

### 4.4 Household Energy Sources for Various Tasks

This item sought to establish the different energy sources used for various tasks by the respondents in the households. From the results, firewood was the most commonly used energy type for cooking by 91.9% of the respondents, a typical phenomenon in most rural areas in Kenya.

#### 4.4.1 Household Energy Sources Used for Cooking

***Table 14: Energy sources for cooking***

| Type of energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Firewood | 125 | 91.9 |
| Kerosene | 5 | 3.7 |
| Charcoal | 6 | 4.4 |
| Gas (LPG) | 16 | 11.8 |
| Biogas | 9 | 6.6 |
| Solar | 5 | 3.7 |

***Multiple responses allowed**

The findings agree with Miranga (2008) who reported that firewood remains the most common fuel for cooking in most African countries.Those using gas (LPG) were 11.8% and biogas being used by 6.6% of the respondents. Solar and kerosene were the least used by 3.7% respondents each. Fuel mixing was common in the households in cooking.

### 4.4.2 Household Energy Sources for Lighting

Table 15 shows that 94.9% of the respondents used kerosene as the most preferred energy source for lighting, 21.3% used solar, 8.1% used electricity and the least was biogas by 0.7%.

***Table 15: Energy sources for lighting***

| Type of energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Kerosene | 129 | 94.9 |
| Electricity | 11 | 8.1 |
| Biogas | 1 | 0.7 |
| Solar | 29 | 21.3 |

These results indicated that the majority of the respondents used kerosene for lighting since it was affordable while biogas was adopted by a few households due to lack of raw materials (cow dung). Only few households had the electricity supply. This results concur with observations by Karanja (1999) that kerosene is the most widely used modern source for lighting in rural areas; electricity is however not an important option for low income households for lighting due to its high upfront costs.

### 4.4.3 Household Energy Sources for space heating

***Table 16: Energy sources for space heating***

| Type of energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Firewood | 1 | 0.7 |
| Charcoal | 97 | 71.3 |
| Plastics | 2 | 1.5 |

From Table 16, 71.3% of the respondents indicated using charcoal to keep warm in their households, 1.5% respondents used plastic materials while 0.7% household used firewood. From the results, charcoal is accessed by majority of households for space heating rather than for cooking or heating water for other purposes because of convenience. Charcoal jikos are portable and can be used in any room unlike sources like firewood which are only used in the kitchen.

### 4.4.4 Household Energy for Heating Water

From Table 17 below, 22.8% of respondents used firewood to heat water, 17.6% used agricultural residues, 3.7% used kerosene, 2.2% used charcoal and 0.7% of the respondents used gas (LPG).

***Table 17: Energy for heating water***

| Type of energy | Frequency (N) | Per cent (%) |
|---|---|---|
| Firewood | 31 | 22.8 |
| Kerosene | 5 | 3.7 |
| Charcoal | 3 | 2.2 |
| Gas (LPG) | 1 | 0.7 |
| Agricultural residues | 24 | 17.6 |

Firewood and agricultural residues were mostly used for this purpose due to their affordability and accessibility. Charcoal and gas (LPG) were the least used because of their increased cost compared to other energy sources.

### 4.5 Use of Energy Efficient Technologies

Various energy efficient technologies were used in the study area. The distribution was as follows: improved stoves 72.1%, raised hearth 33.1%, solar cookers, 4.4% biogas cookers, 0.7% and 19.9% used energy saving bulbs. Four point four per cent did not use any energy technology. Improved jikos were mostly adopted compared to the traditional metal jikos because they cooked faster and used less charcoal.

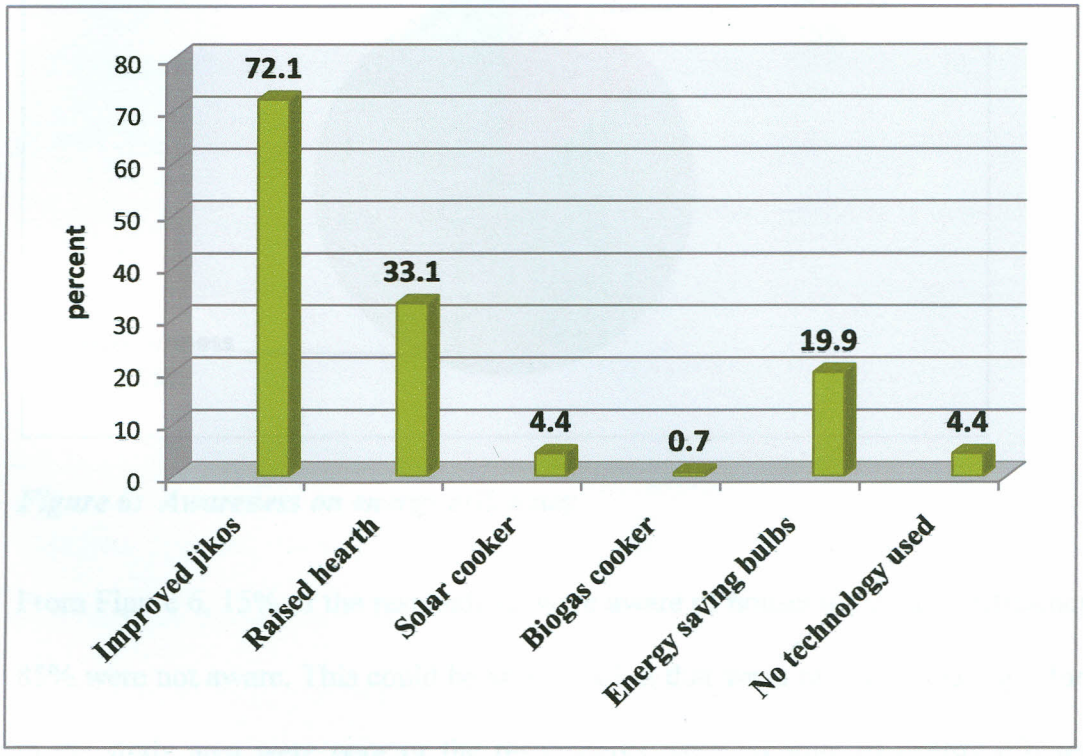


***Figure 5: Energy efficient technologies.***

Results in Figure 5 indicate that only 33.1% of the respondents who used firewood had adopted the raised hearth technology. This means that majority of the respondents still

used the three stone fire which was less efficient and consumed more firewood. Solar and biogas cookers were used to a lesser extent because they were not fully developed in the study area. This also agrees with observation by Karanja (1999) that installation and capital costs for solar and biogas are a barrier to people in remote rural countryside.

### 4.6 Awareness of Household Energy Efficiency

This item required the respondent to state if they were aware about household energy efficiency.

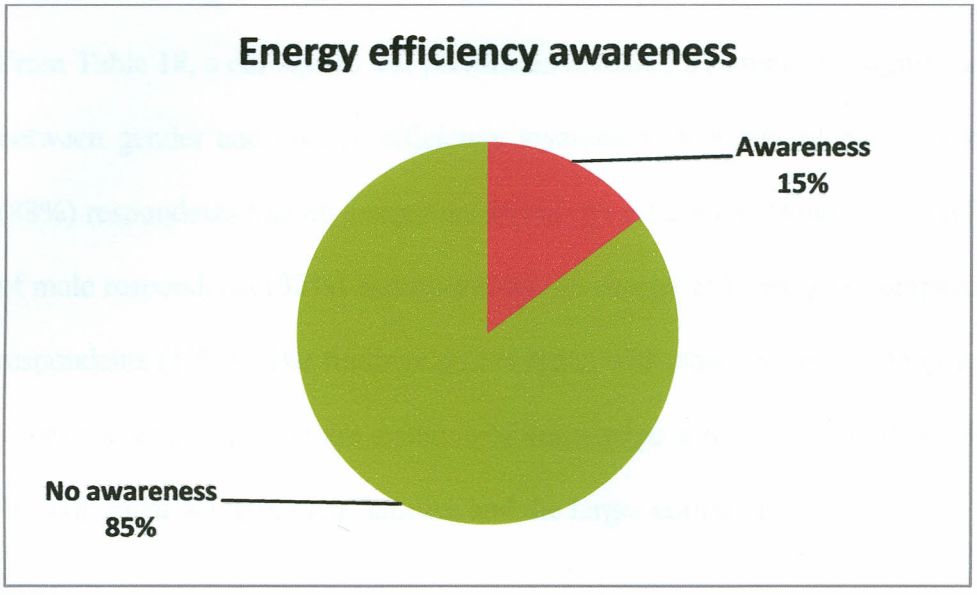


***Figure 6: Awareness on energy efficiency***

From Figure 6, 15% of the respondents were aware of household energy efficiency while 85% were not aware. This could be an indication that ways of disseminating information in the study area were poor or the respondents were ignorant of energy efficiency. In addition, a chi square test was performed to establish the relationship of energy efficiency awareness among the male and the female respondents.

Ho-2: There is no significant relationship between gender and energy efficiency awareness

***Table 18: Gender of respondent and Energy efficiency awareness Cross-tabulation***

| Energy efficiency awareness | Gender of respondent | | | | Total | |
|---|---|---|---|---|---|---|
| | Male | % | Female | % | N | % |
| **Aware** | 6 | 32 | 14 | 12 | 20 | 100 |
| **Not aware** | 13 | 68 | 103 | 88 | 116 | 100 |
| **Total** | 19 | 100 | 117 | 100 | 136 | 100 |

**$\chi^2$= 5.013 df=1 p=0.025**

From Table 18, a chi-square test performed revealed a statistically significant relationship between gender and energy efficiency awareness. Majority of male (68%) and female (88%) respondents had no awareness on energy efficiency. However, a higher percentage of male respondents (32%) had awareness on energy efficiency as compared with female respondents (12%). The findings do not agree with observations by Mburugu (1994) that women have groups that are a source of knowledge and awareness of development needs for individual women, their families and the larger community.

### 4.7 Impact of Energy Efficiency Awareness in Energy Utilization

This item required the respondent to state the influence of household energy efficiency awareness on household energy use. The results in Table 19 showed that 9.6% of those aware reported there was improved energy conservation whereby less energy was used in their households, 4.4% reported that they installed biogas and solar units since it was cheap and clean energy to use in the house and 86% did not respond to the question.

*Table 19: Impact of awareness programs in energy utilization*

| Impact | Frequency (N) | Per cent (%) |
|---|---|---|
| Less energy used | 13 | 9.6 |
| Install solar/biogas energy unit | 6 | 4.4 |
| No response | 117 | 86.0 |
| **Total** | **136** | **100.0** |

### 4.8 Efforts to Ensure Energy Conservation

The item required the respondents who were not aware of energy efficiency to state what they did to ensure that household energy was saved.

*Table 20: Energy conservation methods*

| Energy saving ways | Frequency (N) | Percent (%) |
|---|---|---|
| Cook food for 2 meals at once | 74 | 54.4 |
| Cook several foods in one pot | 43 | 31.6 |
| Use improved jikos | 99 | 72.8 |
| Close kitchen doors when cooking | 69 | 50.7 |
| Did nothing to save energy | 56 | 41.2 |

On energy conservation methods, results showed that 54.4% of the respondents reported that they cooked food for two meals at once, 31.6% cooked several foods concurrently in one pot, for instance boiling sweet potatoes in a pot cooking githeri while 72.8% indicated that use of improved ceramic jikos saved on energy when in use compared to the traditional metal jikos. Fifty point seven per cent closed kitchen doors to protect the

fire from the wind, 41.2% did nothing at all to save on energy when in use. From the results, it was observed that households used more than one way of saving energy.

### 4.9 Promoting Household Energy Efficient Technologies

The respondents were asked to suggest on what the government would do to promote household energy efficient technologies. About 57.4% of the respondents indicated that reduction of taxes to solar and biogas equipments would promote the technology due to low installation and maintenance costs, 36% suggested that government creation of awareness through education would promote energy efficiency in the households, 56.6% reported that extension of electricity supply in the study area would promote the use of household energy efficient technologies and hence improve their living standards.

### 4.10 Strategies for Sustainability of Household Energy.

This section addresses the fourth study objective which set to examine interventions on energy sustainability.

#### 4.10.1 Individual Strategies for Sustainability of Household Energy.

***Table 21: Individual strategies for sustainable household energy***

| Strategies | Frequency (N) | Per cent (%) |
|---|---|---|
| Agro-forestry & afforestation | 114 | 83.8 |
| Installation of biogas & solar units | 31 | 22.8 |
| Bulk collection of firewood | 3 | 2.2 |
| Save available energy | 2 | 1.5 |
| Use of efficient technology | 9 | 6.6 |

*** Multiple responses allowed**

Results in Table 21 showed that, 83.8% of the respondents would practice agro-forestry and afforestation; this would increase the tree cover and also reduce pressure on the

dwindling biomass sources of energy. Twenty two point eight percent supported installation of solar and biogas units, 2.2% suggested collecting enough firewood that would last for a year, 1.5% believed in saving on available energy sources while 6.6% reported that the use of energy efficient technology would ensure that energy is saved for one year.

### 4.10.2 Community Strategies for Sustainability

The item in the schedule sought community strategies for ensuring adequate household energy in the study area.

***Table 22: Community strategies for sustainability of household energy***

| Strategies | Frequency (N) | Per cent (%) |
|---|---|---|
| Agro forestry | 116 | 85.3 |
| Install biogas & solar in groups | 58 | 42.6 |
| Seek information on efficient technologies | 27 | 19.9 |
| Electrification through groups | 59 | 43.4 |
| Tree nurseries | 43 | 31.6 |

*** Multiple responses allowed**

Observations from Table 22 depict that 85.3% of the respondents would plant trees in their farms as a community, 42.6% would form social groups to install solar and biogas units, 31.6% would start tree nurseries, 19.9% would seek information and awareness on energy conservation and energy efficient technologies while 43.4% would avail rural electrification through self-help groups.

### 4.11 Community Interventions in the Study Area.

The respondents were asked to indicate whether they knew of any community like community-based organization (CBO) or a faith-based organization (FBO) that existed in their area that would assist them meet their energy needs.

***Table 23: Community interventions in the study area.***

| **Community intervention** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| CBO | 3 | 2.2 |
| FBO | 7 | 5.1 |
| No intervention | 126 | 92.6 |
| **Total** | **136** | **100** |

The results from Table 23 showed that 92.6% of the respondents were not aware of any organization that would help them meet their energy needs. Two point two per cent knew of CBOs such as The International Fund for Agricultural Development (IFAD) which had trained them on biogas formation and 5.1% knew of FBOs like Anglican Church of Kenya that trained them on energy saving strategies including use of improved stoves.

### 4.12 Government Intervention towards Energy Sustainability

The question was to establish if the respondent knew of any national or government intervention in the study area that was involved with energy issues in the division. The results are depicted in Figure 7 below.

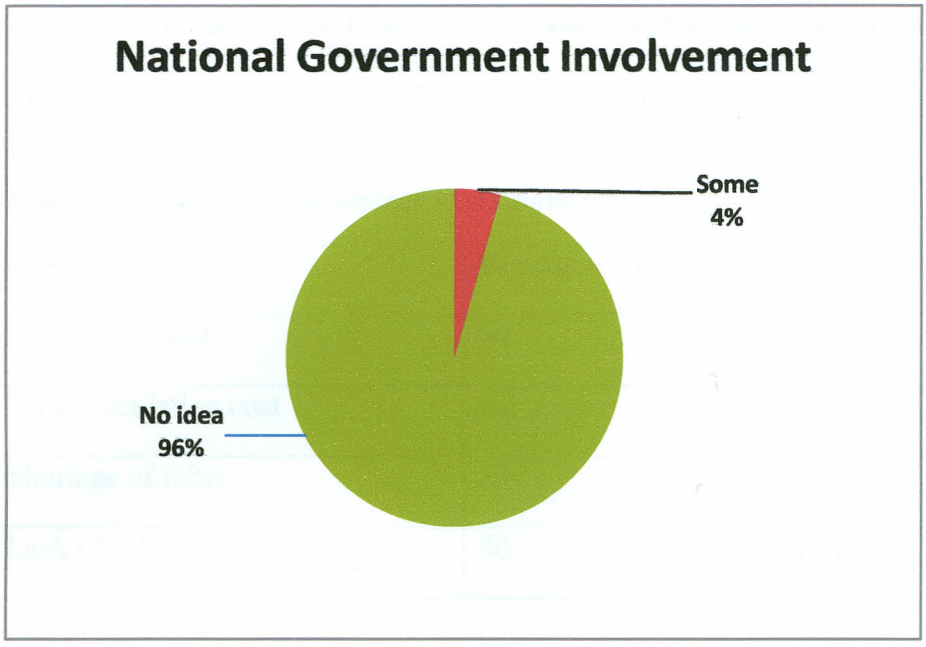


***Figure 7: Government involvement in energy issues***

From Figure 7, 95.6% of the respondents indicated that they had no idea of any government intervention while 4.4% said there was a government intervention that was in place to deal with energy issues in the division including Ministry of Environment and Natural Resources which advocated on tree planting in their farms and Home Economic Department in the Ministry of Agriculture who trained the communities on biogas formation.

### 4.13 Constraints in Energy Sustainability

It can be observed from Table 24 that there were challenges faced by respondents. They cited various challenges; 47.1% reported inadequate land to plant trees, 47.8% stated that the initial cost of installing solar and biogas units was too high for them considering their low incomes, 9.6% feared that the shortage of rains would be a challenge in afforestation

while 36.8% stated that lack of information would be a barrier in achieving energy sustainability.

***Table 24: Constraints in energy sustainability***

| **Challenges** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| Inadequate land | 64 | 47.1 |
| High installation cost | 65 | 47.8 |
| Shortage of rains | 13 | 9.6 |
| Lack of information | 50 | 36.8 |

### 4.14 Environmental Changes over the Last 10 Years

The item in the interview schedule required the respondents to state the environmental changes that had occurred in the study area over the last 10 years in relation to household energy access, utilization and sustainability.

***Table 25: Environmental changes over the last 10 years***

| **Environmental changes** | **Frequency (N)** | **Per cent (%)** |
|---|---|---|
| Lack of rains | 135 | 99.3 |
| Deforestation | 124 | 91.2 |
| Re-afforestation | 32 | 23.5 |
| Desertification | 11 | 8.1 |
| Frequent floods | 12 | 8.8 |

From Table 25, 99.3% of the respondents noted that there was no rain in the recent years, 91.2% complained of deforestation, 23.5 % reported there was re-afforestation, 8.1%

indicated desertification while 8.8% said there were frequent floods in the study area. The respondents indicated more than one environmental change in the area.

### 4.15 Field Observations

From the observation checklist, it was noted that the respondents used a variety of energy conserving technologies. This included improved jikos, solar cookers and biogas cookers. Few households had adopted raised hearth as majority still used the three stone fire. Majority of the households used firewood for cooking and heating water, charcoal for space heating while kerosene was used for lighting. Few households had electricity connection while solar and biogas cookers were relatively new technologies in the study area and were only used by a few individuals. Agricultural residues used in the area included maize stalks and cobs.

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.0 Introduction

This chapter covers the summary of the major findings, conclusions recommendations and gives suggestions for further research

## 5.1 Summary of Major Findings

Firewood was the predominant energy source in the division. However, majority of the respondents had access to other sources like charcoal, kerosene and agricultural residues. Few households accessed electricity, biogas and solar as it was observed and expressed by the respondents. This was due to the high costs of installation and maintenance. Biogas was not a common technology as majority of the respondents expressed fear of rearing cattle due to the frequent cattle rustling in the area; therefore, they could not have cow dung for raw material.

The study found that access to various energy sources was influenced by factors like household income level, time spent, distance covered and the availability of the energy source. The least considered factors were environmental and health in the choice of energy source. Several challenges towards the access of energy sources were established. They included frequent market price hikes, shortage in market supply especially for the gas (LPG) and kerosene and fear of wildlife attacks and rapes in the forest during firewood collection. Study findings showed that firewood was mostly used for cooking due to its availability and reliability. Charcoal was predominant in space heating because of the convenience while kerosene was used for lighting. Some households used

firewood, kerosene and agricultural residues for heating water. Some households used plastic containers for space heating despite the dangers they posed. Respondents had several ways of conserving energy. These included cooking enough food for two meals, cooking several foods in one pot and closing kitchen door while cooking to protect fire from the wind. The study shows that fuel mixing was practised in every household.

Widespread use of the three stone fires was established with few of the respondents adopting energy efficient technologies like raised hearth, solar and biogas. However, majority used improved jikos rather than traditional metal jikos. Constraints towards adoption of energy efficient technologies in the study area include; lack of information and awareness and high initial costs of installation. Findings from indepth interviews showed that most households were not concerned about sustainability of the energy sources they used as they had not taken any action yet. Majority of the respondents suggested strategies for sustainability including agro-forestry and afforestation, government intervention through awareness creation and tax reduction on efficient technologies and community interventions by pooling their incomes together to enable solar, biogas and electricity connection. It was established that only a few government programs, community-based organizations and faith-based organizations dealt with energy issues in the study area.

Results from the Chi-square and Pearson product moment correlation tests revealed significant relationships between gender and energy efficiency and household income and the expense of energy used. Households with high income levels used more expensive and efficient energy types as revealed by the Pearson correlation test. Chi-square test results showed a statistically significant relationship in energy efficiency awareness

between the male and female respondents. A higher number of male respondents (32%) had awareness on energy efficiency as compared to their female counterparts at 12%.

## 5.2 Conclusions

1. Accessing household energy sources in the rural areas demands valuable time, physical energy and money. Women whom the society has assigned the duties and responsibilities of energy provision and cooking are faced with challenges such as drudgery due to long distances to the source and have little time for leisure and other productive activities at home. Various sources of energy such as firewood, kerosene, charcoal, LPG, electricity, biogas and solar were used for cooking, space heating and heating water in these rural households.
2. Adoption and utilization of energy efficient technologies such as improved stoves, solar and biogas were minimal due to lack of information, awareness and financial constraints.
3. Household energy sustainability strategies included agro-forestry, afforestation and adoption of alternative efficient energy sources in reducing the cost of energy.

## 5.3 Recommendations

The research recommendations include the following:

1. Promotion of agro-forestry and afforestation to provide fuel wood and to conserve environment and mitigate the effects of global warming by the households and community.
2. Advocate on use of alternative energy sources such as briquettes instead of charcoal.

3. Provision of credit and loan facilities to assist rural households to install energy efficient technologies like solar and biogas by energy related agencies.
4. Create awareness on energy efficient technologies to improve energy saving, time and labour in rural households.
5. Expand rural electrification.

## 5.4 Suggestions of Further Research

This study recommends the following areas for further research:

i. A study on sustainable household energy solutions for rural households in Kenya.
ii. Similar studies should be replicated in different geographical areas to give more insight into access, utilization and sustainability of household energy.

## REFERENCES

Aluko, O. (2005). *Elements of Education and Social Research Methods. Institute of Research and Development*. Nairobi: Masola Publishers

Anami, A. (1992). *Environmental Implications of Utilization of Rural Domestic Energy: The Case of Sabatia Division, Kakamega District*. Unpublished Thesis, Kenyatta University.

Common Market for Eastern and Southern Africa (COMESA) (2008). *The COMESA Model Energy Policy Framework*. COMESA:Lusaka.

Bellevive Foundation (2000) Cooking with Less Fuel: Domestic Energy Consumption in Africa. Nairobi: Bellevive Foundation.

Deacon, R. &Firebaugh, F. (1988). *Family Resource Management: Principles and Applications* (2nd Ed.). Boston: Allyn&Bacon, Inc.

Douglas F. and Willem F. (1999). *Biomass Energy and the Poor in the Developing World*: Vol 53, Journal of international Affairs.

Dzioubinski O. & Chipman R.(1999). *Trends in Consumption and Production: Household Energy Consumption*. DESA Discussion paper No.6. New York: USA

Elias, R. &Victor, D. (2005) *Energy transitions in Developing Countries: A Review of Concepts and Literature Programs and Energy and Sustainable Development*. Working Paper #40 June 2005. http:// pesd.stanford.edu

Ezzati, M. & Kammen, P. (2002). *Evaluating the Health Benefits of Transition in Household Energy in Kenya*. Energy Policy 30(10): 815-826

Gay, L. (1996). *Educational Research: Competencies for Analysis and Application*. London: Charles E. Mairill Publishing Company.

Government of Kenya (2002). Kenya: *Nyandarua District Development Plan 2002- 2008*. Nairobi: Government Printer.

Howells, M. (2002) *Intergrated Energy Planning and Renewables. Department of Minerals and Energy*. Johannesburg, South Africa.

International energy agency (2000). *World Energy Outlook 2000*. Paris: OECD/IEA

International energy agency (2004). *World Energy Outlook 2004*. Paris: OECD/IEA

ITDG (2002). *Power to the People: Sustainable Energy Solutions for the World*

*Poor*. http//www.itdg/org/docs/advocacy/power-to-the-people.pdf

Kamfor, (2002). *Study on Kenya's energy demand, supply and policy strategy for Households, small-scale industries and services.* Nairobi: Kamfor Company Ltd.

Karanja, L. (1999). *Adoption of Energy Conserving Technologies by Rural Households in Kathiani Division, Machakos Distric*t. Unpublished Masters Thesis, Kenyatta University.

Karekezi S. and Ranja T. (2000). *Renewable Energy Technologies in Africa.* London: Zed Books Ltd.

KENGO (1991). How to Make and Use the KCJ,KENGO. Regional Wood Energy Programme for Africa. Nairobi: Kenya

Kenya National Bureau of Statistics, (2002). *Kenya 1999 Population and Housing Census: The Popular Report.* Nairobi: Ministry of Finance and Planning, Kenya.

Kenya National Bureau of Statistics. *Poverty Reduction Strategy Paper for Kenya 2001-2004.* Nairobi: Government Printer.

Mburugu, K. (1994). *An Assessment of Factors Affecting Adoption of Appropriate Technologies by Rural Women in, Meru and Kiambu Districts, Kenya.* Unpublished PhD Thesis, Kenyatta University.

Mbuthi, N. (2005*). Poverty and Linkages: Energy Access for the Rural Poor Workshop Report*. Nairobi: Ministry of Energy.

Ministry of Energy (2004). *The Energy Bill, 2004*. Nairobi: Ministry of Energy

Ministry of Energy (2002). *Study on Kenya's Energy demand Supply and Policy strategy for Households, small scale industries and Service Establishments*: *Final Report.* Nairobi: Kamfor Company Limited.

Miranga, O. (2008). *Environment and Energy Sources: Study of Domestic Energy Choices in Kasarani, Westlands and Makadara divisions in Nairobi.* Unpublished Masters Thesis, Kenyatta University.

Mouly, J. (1978). *Educational Research: The Art and Science of Investigation.* USA: Allyn &Bacon Inc.

Muchiri,L.(2008). *Report on Gender and Equity in Bio-energy Access& Delivery in Kenya*. Nairobi: Heinemann Printing Press.

Mugenda, A. (2008). *Social Science Research: Theory and Principles*. Nairobi: ARTS Press

Mugenda, O and Mugenda, A. (1999). *Research Method: Qualitative and Quantitative Approaches.* Nairobi: Act Press.

Mugo and Kituyi, E. (2002). *Lost opportunities: Wood fuel data and policy development concerns in Kenya.* Energy Policy Opinion Paper, WSSD Edition, Nairobi: African Centre for Technology Studies.

Nyandarua District Development Plan (NDDP) 2002-2008

Republic of Kenya (2009). *Kenya Facts and Figures 2009*. Kenya National Bureau of Statistics.

Republic of Kenya (2008). *Millennium Development Goals, Status Report for Kenya 2007*. Ministry of Planning, National Development and Vision 2030.

Sagar, A. (2005). *Alleviating Energy Poverty for the Worlds Poor: Energy Policy* Vol.33. No.11, pp.1367-1372

Sum Low, P. (2005). *Climate Change and Africa*. London: Cambridge University Press

United Nations (2004). *The Energy Challenge for Achieving the Millennium Development Goals*. Website: www.esa.un.org/un-energy

UNDP (2005). *Energizing the Millennium Development Goals*. New York: UNDP Report.

World Bank (1996). Rural *Energy and Development: Improving Energy Supplies for 2 Billion People*. Washington D.C: World Bank Publication.

World Health Organization (WHO), (2002). *The World Health Report.* Geneva: World Health Organization.

World Health Organization (WHO), (2006). *Fuel for Life: Household Energy and Health.* Geneva. World Health Organisation

World Resources Institute (WRI) (2003). *World Resources Institute for Environment and Development.* New York: Basic Books.

Yieko, S. (2001). *The Influence of Improved Stoves on Intra-household Resource Allocation among Rural Households in Luanda Division.* Unpublished Masters Thesis, Kenyatta University.

# APPENDICES

## APPENDIX I

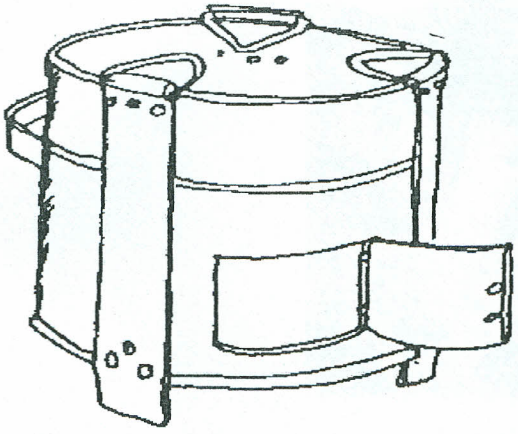

*Figure 7: Traditional metal jiko*

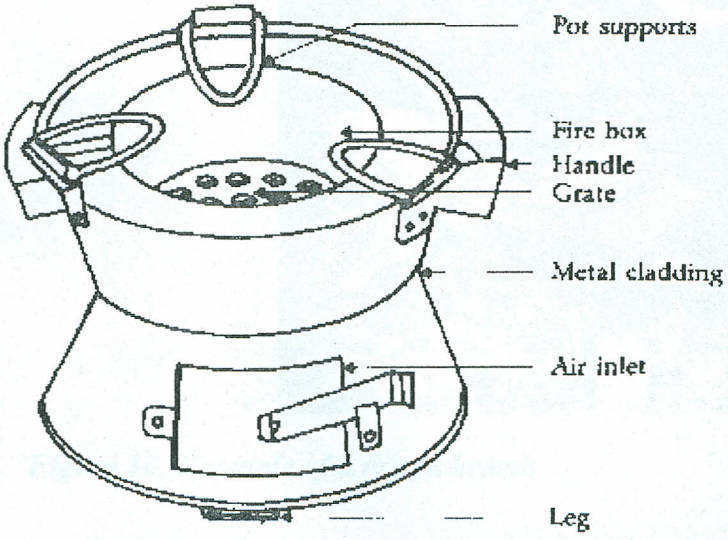


*Figure 8: Kenya Ceramic Jiko (improved jiko)*

# APPENDIX II

*Figure 9: Three stone fire*

*Figure 10: Example of a raised hearth*

# APPENDIX III

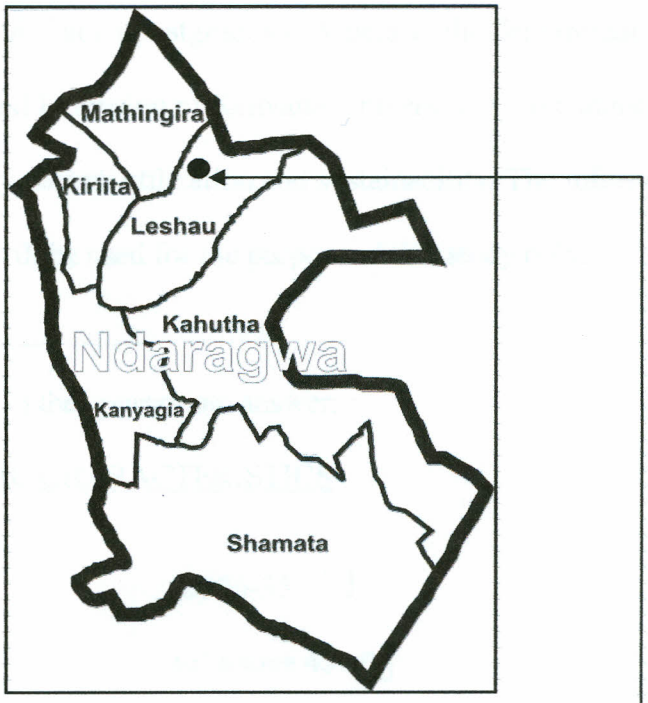


***Figure 11: Map of Ndaragwa Division showing Mbuyu sub-location***

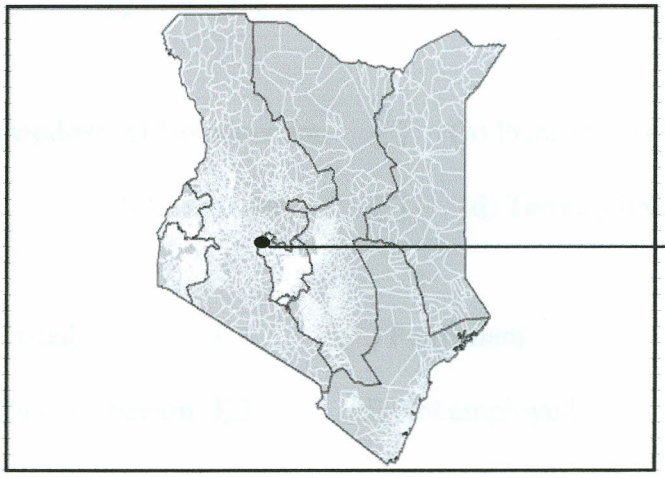

***Figure 12: Map of Kenya showing the study area***

## APPENDIX IV

### HOUSEHOLD INTERVIEW SCHEDULE

My name is Rose Wambui. I am a postgraduate student in the department of Community Resource Management and Extension of Kenyatta University. I am conducting a research on rural household energy access, utilization and sustainability. The information you give will be confidential and will be used for the purpose of this study only.

Household code no._____

Instructions: please tick (√) the appropriate answer.

PART I: DEMOGRAPHIC CHARACTERISTICS

1. Age (a) 15-25 ☐ (b) 26-35 ☐
   (c) 36-45 ☐ (d) above 45 ☐

2. Gender of respondent (a) Male ☐
   (b) Female ☐

3. Education of respondent (a) No education ☐ (b) Primary level ☐
   (c) Secondary ☐ (d) Tertiary level ☐

4. Occupation (a) Casual ☐ (b) Permanent ☐
   (c) Businessperson ☐ (d) Not employed ☐

5. Approximate household income per month (Kshs)

Kshs.1500-3000 ☐ Kshs. 7500-15000 ☐ Over 30000 ☐

Kshs.3500-7000 ☐ Kshs. 15500-30000 ☐

PART II: ENERGY ACCESS

1. What type of energy sources do you use?

(a) Firewood ☐ (d) Gas (LPG) ☐ (g) Agricultural residues ☐

(b) Kerosene ☐ (e) Solar ☐

(c) Electricity ☐ (f) Charcoal ☐

Other(s) specify_____

2. How much money do you spend on your energy sources per month?

(a) Kshs.100-500 ☐ (c) Kshs.1001-1500 ☐

(b) Kshs.501-1000 ☐ (d) Kshs.1500 and above ☐

(e) No cost ☐

3. What problems do you experience if purchasing the energy sources you use?

_____

_____

4. How often do you collect firewood? (a) Daily ☐ (b) Weekly ☐

(c) Monthly ☐

5. (a) Do you collect firewood within your compound? Yes ☐ No ☐

(b) If no, how long on average does each collection trip take? _____

6. What distance do you cover to collecting firewood?

(a )Less than 1km ☐ (c) 6-10 kms ☐

(b) 1-5 kms ☐ (d) Over 10 kms ☐

7. What problems do you experience during collection?

_____

_____

8. What factors do you consider in the choice of household energy? (Health, environmental…)

_____

_____

PART III: ENERGY EFFICIENCY AND UTILIZATION

1. What household energy sources do you use for:

(a) Cooking? _____ _____

(b) Lighting? _____ _____

(c) Keeping warm? _____ _____

(d) Heating water? _____ _____

Other tasks (specify) (_____) _____ _____

2. What energy efficient technologies do you use?

(a) Improved jikos ☐ (b) Raised hearth ☐ (e) Energy saving bulbs ☐

(c) Solar cookers ☐ (d) Biogas cookers ☐

(Others specify)_____

3. (a) Are you aware about household energy efficiency?

Yes ☐ No ☐

(b)If yes, what is the impact of the energy efficiency in household energy use for you?

_____

_____

(c) If no, what do you do to ensure energy is saved when in use?

_____

_____

4. What do you think the government should do to promote household energy efficient products or services?

_____

_____

PART IV: COMMUNITY INTERVENTIONS AND ENERGY SUSTAINABILITY

1. How can you ensure continued supply of household energy throughout the year as an individual? _____

_____

2. What measures can this community take to ensure adequate household energy throughout their lifetime? _____

_____

3. Do you know of any community interventions (CBOs, FBOs etc) that exist in this location that helps you to meet energy needs?

Yes ☐ No ☐

4. Do you know of any national or government interventions that have been put in place to deal with energy issues in this division?

Yes ☐ No ☐

5. What problems are you likely to face in ensuring energy sustainability?

_____

_____

6. What are the environmental changes that have occurred over the last 10 years in

relation to household energy supply?

(a) Deforestation ☐ (b) Re-afforestation ☐ (c) Desertification ☐

(d) Lack of rains ☐ (e) Frequent droughts ☐ (f) Frequent floods ☐

Others (specify) _____

**Thank you.**

# APPENDIX V

## HOUSEHOLD OBSERVATION CHECKLIST

| | (Indicate the task(s)in the space provided below) | (Please Tick where appropriate) | | |
|---|---|---|---|---|
| **Energy source** | **Task: cooking, lighting space heating, heating water** | **Type of cooking technologies** | **used** | **Not used** |
| Firewood | | Ceramic jikos | | |
| Charcoal | | Metal jikos | | |
| kerosene | | Solar cookers | | |
| Electricity | | Biogas cookers | | |
| Gas(LPG) | | Raised hearth | | |
| Biogas | | Three stones | | |
| Agricultural residues | | | | |
| Solar | | | | |