ADOPTION OF ENERGY-EFFICIENT WOODSTOVES AND CONTRIBUTION TO RESOURCE CONSERVATION IN NAKURU COUNTY, KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or any other award.

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DEDICATION

I dedicate this research thesis to my beloved wife Mary and my three children for their moral support over the period of the study.

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ABBREVIATIONS/ACRONYMS

CBO	Community Based Organization
CBS	Central Bureau of Statistics
DAEO	Divisional Agricultural Extension Officer
DANIDA	Danish International Development Agency
DFID	Department for International Development
FAO	Food and Agricultural organization
GHGs	Green House Gases
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
(German	Agency for Technical Co-operation)
ICS	Improved Cooking stoves
IAP	Indoor Air Pollution
IEA	International Energy Agency
KCJ	Kenya Ceramic Jiko
KENGO	Kenya Energy and Environmental Organization
KFSSG	Kenya Food Security Steering Group
LANAMEDUBA-	Lake Nakuru Menengai Dundori Bahati ecosystem
LPG	Liquefied Petroleum Gas
MDGs	Millennium Development Goals
MET.	Kenya Meteorological Department.
NEMA	National Environmental Management Authority
NGOs	Non Governmental Organizations
PSDA	Public Sector Development in Agriculture
RHRC	Rural Health Research Center
RWEDP	Regional Wood Energy Development Programme
SCODE	Sustainable Community Development Services

SPSS	Statistical Package for Social Sciences
TaTEDO	Tanzania Traditional Energy Development and Environmental Organization
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development

ABSTRACT

Biomass energy provides 68% of Kenya's national energy requirements and it is expected to remain the main source of energy for the foreseeable future. The current biomass demand in Kenya is estimated at 40.5 million tonnes against a sustainable supply of 16 million tonnes. Many of the rural households use traditional stoves which have low energy efficiency leading to using more woodfuel, increase in indoor air pollution and also putting alot of pressure on the biomass sources. There have been efforts to promote use of woodfuel conservation technologies. This programme has been spearheaded by the ministry of energy, Ministry of agriculture, and many NGOs. There are technologies promoted in Kenya that can reduce the consumption of biomass energy by 80%. They include the improved charcoal stoves (KCJ) which can save upto 50%, the improved fuelwood stoves (e.g Kuni Mbili) which can save upto 50% and the fireless cookers that can save upto 50%. This study was carried out to assess the levels of acquisition and use of these technologies in Lanet Division (Urban area) and Dundori Division (Rural area) both in Nakuru County, determine the social economic factors influencing adoption as well as assess the levels of awareness of weather changes and the need for environmental conservation among the people in the study area. The research study used questionnaires, interview schedule, photography and observation in data collection. Analysis of the data was done by use of SPSS. Data was analyzed by use of; Bar charts, percentages, means and standard deviation, t-Test, Pearson and Spearman Correlation test as well as multiple regression analysis. It was found out that the level of adoption of improved charcoal cookstoves (KCJ) was higher in the urban (93%) than rural areas (81%) while the level of adoption of improved firewood stoves was quite low both in rural (9.18%) and urban (1.08%) areas. Adoption of fireless cookers was also found to be low for both rural (1.53%) and urban (8.06%). Income of the household (r-0.230) and level of education (r-0.232) were positively correlated to acquisition and use of the energy saving technologies. While the numbers of dependants (t value- -3.365), cost of improved fuelwood stoves (t-value 6.658), cost of improved charcoal stoves (t-value -7.161) and the cost of fireless cookers (t-value -11.385) all with a p-value of 0.000 were found as some of the social economic factors influencing adoption of these technologies. The level of awareness on drastic changes in weather was found to be high (90%). There is need for various stakeholders to increase diffusion of quality charcoal cookstoves at an affordable price as well as intensify promotion of firewood improved stoves especially in the rural areas where majority of the people depend on firewood as their main source of fuel. There is also need to invest in the development and promotion of other renewable energy technologies such as biogas and solar energy whose uptake was negligible in the study area.

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Over 3 billion people throughout the world rely on traditional fuels, such as wood, charcoal, dung, and agricultural residues, for cooking and heating Nigel, (2004). The global total production of wood in 2000 reached approximately 3.9 billion cubic meters of which 2.3 billion cubic meters was used as woodfuels. This means that approximately 60 percent of the world's total wood removals from forests and trees outside forests are used for energy purposes (FAO, 2008**).**

Biomass energy provides 68% of Kenya's national energy requirement and it is expected to remain the source of energy for the foreseeable future Mugo and Gathui, (2010). The current biomass demand in Kenya is estimated at 40.5 million tonnes against a sustainable supply of 16 million tonnes Kamfor, (2002). The demand for firewood and charcoal in Kenya has continued to rise as the population continues to grow.

Biomass energy resources are derived from forests formation such as closed forests, woodlands, bushlands, grasslands, farmlands, plantations and agricultural and industrial residues.

The government has put a lot of restriction on collecting firewood from forests as this has led to severe deforestation in many parts of the nation causing environmental degradation. Dundori forest (in the study area) which is found within Dundori Division used to be the main source of firewood and charcoal for the people in the area while most of the people in Lanet division either depend on woodfuel purchased from traders or buy charcoal from charcoal dealers (KFSSG, 2006).

Following the 1980 United Nations Conference on New and Renewable Sources of Energy, many organizations began to work individually and collaboratively on improved stove development and dissemination. The organizations involved in the early 1980s included the Ministry of Energy, Ministry of Agriculture, the Appropriate Technology Centre, the Kenya Energy and environmental Organization (KENGO), United Nations Children's Fund, GTZ and many NGOs. Among the more popular stoves introduced were the charcoal burning '*Kenya Ceramic Jiko*' (KCJ), and the wood-burning '*kuni mbili'* and '*maendeleo jiko'* – known also as the *'Upesi'* stove (Okello, 2005).

The improved cookstoves use less woodfuel compared to the traditional three stone cooking stoves. When these stoves are used efficiently they can save 30% of the firewood Zheng et al, (1999) and Helga, (2007). The charcoal ceramic stoves (KCJ) are also energy conserving as compared to the metallic charcoal stove since they retain heat within the stove compared to metallic stove in which much heat is lost to the surrounding environment.

The current penetration of improved charcoal stoves as reported by Muchiri, (2008) is estimated at 60% of the rural households and over 80% for the urban UNEP, (2006). The level of penetration of improved efficient woodstoves for the rural households is still below 5%, yet there is enormous potential Muchiri, (2008). The adoption of these technologies has been slow and unevenly extended as there are still many households which are unaware of the technologies. This is despite the fact that the technologies were initiated over

30 years ago. Thus the objective of the Kenya government to reduce demand on woodfuel, conserve the forests and thus mitigate against increase in green house gases (GHG) and reduce indoor air pollution is yet to be achieved.

Evidence linking solid fuel use in developing countries to climate change is slowly but strongly building up and there are growing concerns that inefficient biomass burning may be contributing significantly to global warming Crutzen & Andreae, (1990); Rasmussen *et al*.,(1993); Sagar, (2005); Venkataraman *et al*., (2005); Johnson *et al*., (2008); Worldwatch Institute, (2009). Adoption and continued (sustained) use of improved biomass stoves in developing countries is therefore an important sustainability strategy which should be adopted by as many households as possible.

There was need to assess the levels of acquisition and use of the woodfuel saving technologies in order to be able to estimate how successful the government has been in reducing demand on fuelwood from forest and other sources as well as reducing the burden on women and children who are involved in gathering firewood and other domestic activities as well as improve on the indoor air conditions.

1.11 Statement of the problem

The acquisition and use of woodfuel energy conservation technologies is very important for Kenya to be able to decrease demand on woodfuel and tackle the problem of deforestation. Traditional fuels, normally available locally at low or no cost, are characterized by low combustion efficiency many times cited around 10% Kammen, (1995). Poor combustion efficiency leads to emission of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) causing an increase in GHGs when the rate of consumption of biomass is higher than its replacement (Sanga and Jannuzi, 2005).

The reduction of woodfuel demand from forests can assist in forest conservation which is very important because of the essential roles forests play such as; carbon sequestration and thus mitigating against climate change; as water catchment areas; habitat for many living organisms as well as increasing the aesthetic value of an area. There has been a shortage of woodfuel in many parts of Kenya Ngugi, (1988). This high demand causes people to turn to nearby forests for firewood and charcoal thus leading to deforestation and soil erosion (Wanambwa, 2005).

One way to minimize pressure on forests, reduce household's woodfuel demand, improve indoor air conditions as well as mitigate against global warming and climate change is by adopting woodfuel conservation technologies. These technologies do not only assist in energy conservation but they also emit less pollutants thus reducing women and children exposure to indoor air pollution. There has been a disparity in their adoption and limited data are available relating to adoption of these technologies. Thus this research study sought to examine the levels of acquisition and usage of woodfuel saving technologies, factors influencing adoption and household perception on weather changes and the need to conserve the environment in Nakuru County-Kenya.

1.3 Justification of the study

Majority of the people in Kenya depend on woodfuel either as charcoal or firewood. The number of households using this form of energy is increasing as the section of the population that has been using fossil fuel (gas and paraffin) is forced to use charcoal or firewood which is relatively cheaper as compared to fossil fuels.

The high costs of petroleum pushes the poor down the energy ladder from using kerosene and Liquefied Petroleum Gas (LPG) to using biomass fuels such as dung, plant residues, firewood and charcoal Wanambwa, (2005). Currently demand for woodfuel outstrips supply.

The improved fuelwood stoves have higher combustion efficiency which enables them to produce greater amount of heat and less smoke from the same amount of wood. By controlling the type of fuel used, burn intensity, air and flame mix, it is possible to achieve efficiencies of over 90%. There is also reduction in wood consumption where these stoves can use 30 - 60% less wood therefore assisting in conserving the forests enabling them continue with their role as carbon sinks (Zheng et al, 1999, Helga, 2007).

The improved charcoal stoves also reduce the amount of heat lost to the surrounding environment by about 30% while the fireless cookers tend to reduce the time spent cooking while also saving fuel of 40% Mugo and Poulstrup, (2003)). This means that the woodfuel saving technologies if fully accepted and adopted by the public will go a long way in reducing the demand on woodfuel thus conserving the forests, reducing women drudgery, improving indoor air conditions and help in saving a lot of money that would otherwise be use in fuel purchase. An increase in biomass use leads to an increase in land degradation. More land degradation comes from the use of dung and crop residues as fuel which deprive the soil of nutrients that would have been recycled back into the soil. An increase in land degradation leads to an increase in poverty and hunger from poor yields that result from poor soils of degraded land (Wanambwa, 2005).

This study is also in line with Kenya's efforts to achieve the MDGs e.g eradication of extreme poverty and hunger since adoption of the energy saving technologies will release the woman and children from the burden of spending many hours in search of woodfuel and thus be involved in more productive activities such as farming and small enterprises. There will also be improvement in maternal health and reduction in infant mortality due to the improvement of the indoor air conditions. Studies have shown that although most poor people accept indoor air pollution as a 'fact of life', it is, in truth, a very significant health problem, especially for women and children and adoption of relatively simple solutions such as improved cooking stoves (ICS) and the use of clean fuels such as biogas can reduce levels of indoor air pollution and significantly improve people's health (Krishna, 2008).

1.4 Researchable Questions:

1. How does the adoption of woodfuel conservation technologies in Lanet (urban) and Dundori (rural) Divisions of Nakuru County differ?
2. Which are the social economic factors that influence adoption of woodfuel conservation technologies in Dundori and Lanet Divisions?

3. What are the households' perception on weather changes and the need to conserve the environment?

1.5 Objectives of the Study

1.5.1 Main Objective

The main objective of the study was to assess the adoption of woodfuel conservation technologies in rural and urban areas of Nakuru County and to find out the social economic factors influencing adoption so as to promote resources conservation.

1.5.2 Specific Objectives

Specifically the study sought to:

1. Compare the levels of adoption of woodfuel conservation technologies in Lanet division (Urban) and Dundori division (Rural).
2. Determine the Social economic factors influencing adoption of woodfuel conservation technologies in Nakuru County.
3. Assess the level of awareness on weather changes and the need to conserve the environment.

1.6 Research Hypotheses

The study was guided by the following hypotheses:

1. There are significantly more people using woodfuel saving technologies in urban than rural areas of Nakuru County.

2. Adoption of woodfuel conservation technologies is significantly influenced by income and educational level.
3. There is higher level of awareness on weather changes and the need to conserve the environment in the rural than the urban areas of Nakuru County.

1.7 Significance of the study

The study is important because there is a knowledge gap as it relates to the current level of adoption of woodfuel saving technologies in Kenya. The outcome of the research will be useful to the government, Ministry of Agriculture and Ministry of energy as they continue to promote the design and use of these technologies. This will help in strategizing a new in order to address the shortcomings and reduce the disparity between the rural and urban households' adoption of the woodfuel conservation technologies. Environmental conservation is a very important issue and people understanding of the weather changes and the need to conserve the environment requires documentation especially in the light of people's eviction from Mau and rehabilitation efforts that have been put in place. Adoption of woodfuel saving technologies is one way in which a nation' environment can be conserved.

1.8 Conceptual framework

Woodfuel stoves and fireless cooker attributes, according to the diffusion of innovation theory by Rogers, (1995) perceived attributes of the innovation, enable adopters to judge and base their perceptions in view of five characteristics of innovation: trialability, observability, relative advantage, complexity, and compatibility. The theory holds that an innovation will experience an increased rate of dispersion if adopters perceive that the innovation:

- can be tried on limited basis before adoption and offers observable results;
- has advantages relative to other innovations and is not overly complex; and
- is compatible with existing practice and values (Rogers, 1995).
- Furthermore, high rates of adoption will depend on the extent to which members of social systems perceived the innovation (improved firewood and charcoal stoves, and fireless cooker) as useful to all aspects of their life and how user friendly it is (cheap to buy and run, less smoke, speed in cooking).

Social economic factors influence the type of fuel a household uses in kitchen activities. When a household has higher income it is possible to afford use of LPG, or electricity in cooking unlike the households with low monthly income. The type of fuel one uses determines the type of technology one purchases for use in the kitchen activities. A household cannot buy a kerosene stove when it only uses firewood for its kitchen activities.

The social economic factors and the type of fuel in use can determine the type of energy saving technology a household adopts. The type of technology in use in the kitchen activities has implication on environmental sustainability and conservation of resources. Adoption of less efficient stoves leads to use of more woodfuel causing deforestation leading to soil erosion as the land is left bare and eventually land will be degraded. It can also be true that the use of energy conservation technologies reduces demand on woodfuel and thus reduction in deforestation allowing for sustainable utilization of forest resources and conserving the environment. It also leads to improved indoor air conditions, time saved in cooking and also woodfuel use reduction. This has important implications for empowerment of women by greatly reducing their drudgery and toil, freeing them to engage in other income enhancement activities and/or socially rewarding pursuits (Wanambwa, 2005).

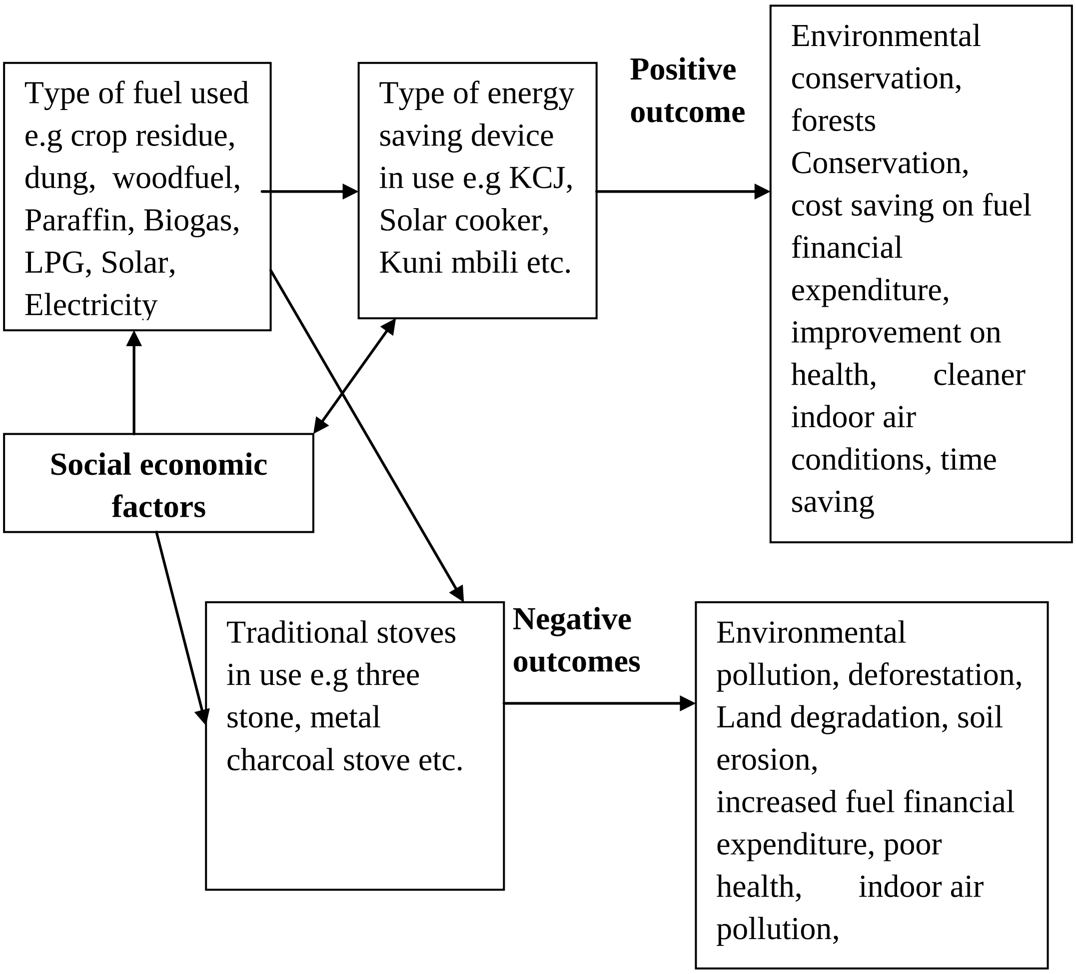


Figure 1.1: Conceptual framework

1.9 Limitations of the study

1. Language was a barrier as many rural people were not conversant with English language and yet the questionnaire was set in english thus it required the researcher to use either Kiswahili or an interpreter during the interviews.

2. Means of transport was limiting especially in the rural areas where the road conditions are very poor thus the researcher had to walk long distances.

3. Funds were also limiting since the research study was self sponsored.

1.10 Definition of Operational Terms

Adoption of technology- Making full use of a new technology as the best course of action available or the uptake of woodfuel energy saving technologies by households.

Biomass- Materials of plants and animals. It is organic based material that reacts with O_2 in combustion and natural metabolic processes to release heat. Examples are fuelwood, charcoal, crop residue and wood residues.

Climate change- Change in global weather patterns: long-term alteration in global weather patterns, especially increases in temperature and storm activity, regarded as a potential consequence of the greenhouse effect

Fireless cooker- This is a basket that is staffed with blanket waste in the inside and a cloth lining is sewn to cover the blanket waste and used for completing cooking of some foods and keeping the food warm.

Fuelwood- Wood used directly as firewood.

Greenhouse gas-Gas that absorbs radiation**:** a gas that contributes to the warming of the Earth's atmosphere by reflecting radiation from the Earth's surface, e.g. carbon dioxide, methane, nitrous oxide ,ozone, or water vapor.

Kenya Ceramic Jiko- The Kenyan Ceramic Jiko (KCJ) is a light, portable charcoal burning stove consisting of two distinct units - a metal cladding and a ceramic liner.

Kuni Mbili Jiko- a cookstove that is designed to take 'two pieces' of firewood at a time.

***Maendeleo Jiko*-** a device developed to replace the three stones with inbuilt ceramic liner that is inverted, bell bottom shaped with an opening for feeding fuelwood and V-shaped pot rest

Woodfuel energy- Energy or heat obtained from the burning of woody biomass (either firewood or Charcoal)

CHAPTER 2: LITERATURE REVIEW

2.1 Woodfuel situation

2.1.1 Global Wood fuel situation

The total production of wood in 2000 reached approximately 3.9 billion cubic meters of which 2.3 billion cubic meters was used for woodfuels. This means that approximately 60 percent of the world's total wood removals from forests and trees outside forests are used for energy purposes FAO, (2008**).** Thus it is very important for efforts to be made in order to reduce the demand on wood biomass and thus conserve the forests and the environment. Asia and Africa produces over 75% of the woodfuel Emily, (2001) (Fig. 2.1). The projections of global woodfuel consumption by 2010 ranged from 1.5 billion m³ (a decrease of 16% from 1998 levels) to 4.25 billion m³ (an increase of 136%) (Brooks, 1996).

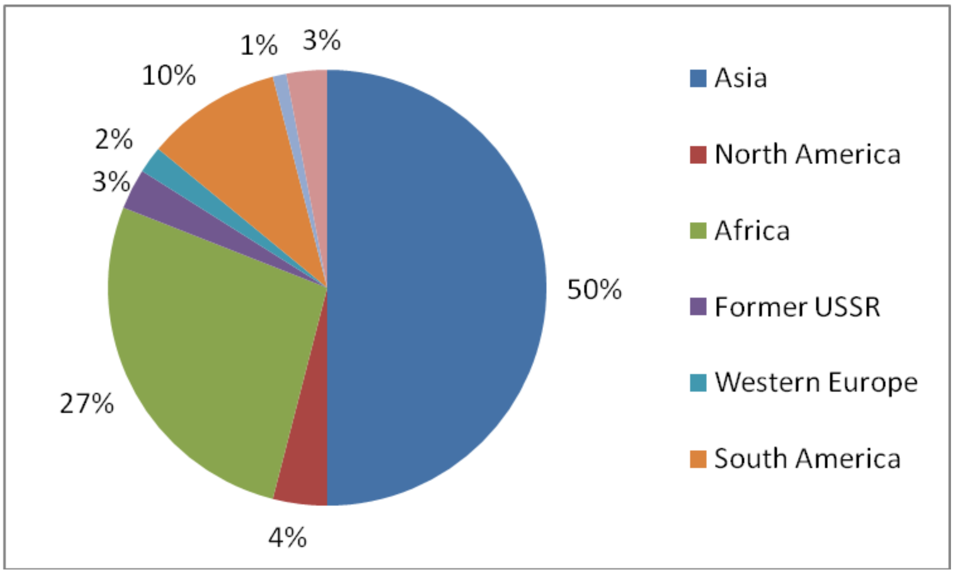


Figure 2. 1: Global Woodfuel Production, 1998 (Emily, 200 1)

2.1. 2 Wood fuel situation in Developing Countries

In Africa over 90% of the wood taken from forests is woodfuel. The majority is consumed directly as fuelwood, however, a varying but substantial amount is transformed into charcoal. More than 80% of it is used in urban areas making charcoal the most important source of household energy in many African cities (Seidel, 2008; Kammen et al, 2005, Amour, 1997).

Wood is the most important of several biomasses, however, in many individual nations, dependence on wood varies. In some countries, like Nepal in Asia, and Kenya, Uganda, Rwanda, and Tanzania in Sub-Saharan Africa, woodfuels provide 80% or more of total energy requirements. Table 2.1 shows that there will be a greater demand for woodfuel by the year 2030 in Africa and yet there is shortage in its supply currently. Thus there is need for adoption of technologies that minimize woodfuel consumption in order to make its usage sustainable and also encourage afforestation and re-afforestation.

Table2.1: FAO projections of woodfuel consumption to 2030 in Africa

	1970	1980	1990	2000	2010	2020	2030
	Fuelwood (million cubic metres)						
Africa	261.1	305.1	364.6	440.0	485.7	526.0	544.8
	Charcoal (million tons)						
Africa	8.1	11.0	16.1	23.0	30.2	38.4	46.1

Source: Adopted and modified from Arnold & Pearsson (2003)

Demand for fuelwood and charcoal is driven primarily by growing numbers of rural poor, who depend on wood for their cooking and heating needs. Charcoal is also an important fuel among the urban population, whose numbers are expanding rapidly. According to Mangat, (2009) , statistics provided by Camco Global shows that wood fuel is one of the major causes of environmental degradation and accounts for about 18% of the world's GHG (green house gases). It is estimated that 17-18% of green house gases are produced in tropical regions (most of the region covers developing nations) by land that is being cleared for agriculture, logging and activities that degrade the integrity of forests. The International Energy Agency estimated that the number of people using fuelwood and other biomass fuel in Africa will rise by more than 40% between 2000 and 2030 to about 700 million and that in the latter years there will still be about 1.7 billion users in Asia IEA, (2002). This has a serious implication on emission of GHGs unless efforts are made to adopt improved stoves in order to improve efficiency, reduce demand of biomass fuel from forests and thus mitigate against global warming and climate change.

Most households in developing countries use traditional stoves e.g the three stone and the metallic charcoal stoves which are less efficient in energy conservation. Many Sub-Saharan African countries share the problem of over-exploitation of wooded lands. Vast areas that were once highly productive in terms of biomass yield have been completely depleted. Estimates indicate that over 11 million hectares of tropical forests are lost annually under excessive clearance and mismanagement Sokona, (2008). This eliminates the ground cover making the land prone to soil erosion thus accelerating land degradation and reducing one of the main sources of woodfuel causing fuel shortage.

2.1.3 Wood fuel situation in Kenya

The current biomass demand in Kenya is estimated at 40.5 million tonnes against a sustainable supply of 16 million tonnes Kamfor, (2002). Biomass energy (mainly firewood and charcoal) constitutes 70 per cent of national energy supply, 90 per cent of which is consumed by households (UNEP, 2006).

To date, firewood and charcoal are still the most significant energy resources in Kenya and will be in the foreseeable future. Firewood is mainly a rural fuel with more than 90% of the population using it for cooking and heating. Charcoal is predominantly an urban fuel with 82% of the urban population as users. Due to decreased wood availability, some parts of the country are opting for agricultural residue and animal dung as energy for cooking (Kamfor, 2002). Since fuelwood is the major source of energy in rural areas of many developing countries, special efforts have to be made to improve one of the most efficient end-use namely, cooking. One of the ways to do this is by replacing the traditional "three stones" technique for cooking by improved stove Karekezi & Bhagavan, (1992). Due to the important role woodfuel energy plays in the day to day life of majority of Kenyans, more research needs to be done in order to plan how this important resource can continue being utilized in a sustainable manner.

2.2 Some Energy conservation technologies applicable to woodfuel

Promotion of fuel wood energy saving methods and alternative energy technologies are usually aimed at reducing the woodfuel demand from forest and other sources. It is also aimed at improving livelihoods and enhancing productivity, because less time will be spent on fuelwood collection, an exercise normally performed by women and children. Woodfuel conservation technologies also aim at improving the indoor air condition by reducing the amount of indoor air pollution.

Two classes of benefits are at the core of most programs involving diffusion of improved stoves; those internal to the household – money and time saved on acquiring fuel, reduced smoke in the home and various conveniences in use and those external to the households principally pressure on forest and energy resources and reduced greenhouse gases. The main direct beneficiaries are women and people in the middle and lower levels of society (Eckholm, 1982).

There are many woodfuel conservation technologies in the country but the research study concentrates on the adoption of three technologies namely;

2.2.1 Improved Firewood cooking stove (*Jiko Kisasa*)

This is an improved type of stove which is more efficient in wood use. Firewood saving is mainly due to the fact that the fired clay liner ensures heat is retained in the stove over a long time. The fired ceramic liner provides the thermal insulation to minimize heat loss (GTZ/PSDA, 2007). The stove can be fixed in the kitchen and is commonly known as *maendeleo Jiko* or *Jiko Kisasa* (Fig. 2.2) or can be portable by being enclosed in metal below commonly known as *Kuni mbili jiko* (Fig.2.3). According to a research study done in Tanzania, a household using three stones stove consumes around 2880 kg/year of firewood. According to the study, through the use of improved firewood stove consumption is reduced to 1728 kg/year/household, annual saving is around 1152 kg/household (equivalent to more than 20 trees/year) TaTEDO, (2005). The adoption of woodfuel saving technologies would go a long way in ensuring sustainable use of the forest resources as the fuelwood demand will decrease, it also reduces the time a woman spend in fetching firewood therefore releasing her to be involved in other productive activities.

Currently the uptake of the fuelwood improved stove is estimated at 5% Muchiri, (2008) and yet majority of the rural people in Kenya use firewood as their main source of fuel. This has implication on sources of the biomass and ends up causing encroachment to forests in search of fuelwood impacting negatively on forest conservation. It also does mean that many people in the rural households especially women and children are exposed to indoor air pollution which is detrimental to their health thus the need for adoption of the energy saving technologies.

Fig. 2.2: ***Jiko Kisasa*** **with a traditional pot**

Source: Miles (2007)

Fig. 2.3: ***Kuni Mbili*** **jiko**

Source: Majid (2006)

2.2.2 Improved Charcoal wood stove (Kenya Ceramic Jiko)

The Kenya Ceramic Jiko (KCJ) is one of the successful stove dissemination projects in Africa. The KCJ is made up of a metal cladding with a wide base and a ceramic liner. At least 25 per cent of the liner base is perforated with holes of 1.5 cm diameter to form the grate. The stove has three pot rests, two handles, three legs and a door. The door is used to control the airflow. The standard model weighs about 6 kg, which means it can be carried around easily (KENGO, 1991; Karekezi and Kithyoma, 2002, Coelho et. al 2004).

The stove is suitable for cooking and space heating. The KCJ helps to direct 25-40 per cent of the heat from the fire to the cooking pot. The traditional metal stove that the ceramic Jiko replaces delivers only 10-20 per cent of the heat to the pot, whereas an open cooking fire yields efficiencies as low as 10 per cent (Kammen, 1995).

The KCJ (Figure 2.4) stove was developed through a design process spearheaded by the Ministry of Energy. The jiko stove easily found acceptance among urban stove producers who were initially offered free training and marketing support by KENGO, working with the ministries of Energy, Agriculture and Environment and Natural resources. KCJ is purchased mostly due to its ability to reduce cooking time, produce high quality meals, reduce charcoal consumption, minimize accidents, and ease of cleaning and maintenance. Its physical appearance is not a major concern or reason for a family to buy or not to buy the stove. There are many sub-quality versions of the KCJ on the market which do not have the tensile strength and resilience of the original model, nor do they have a liner with as much resistance to cracking and breakage (DFID, 2000).

Fig 2.4: Kenya Ceramic Stove
Source: Majid (2006)

Although most producers and dealers of the jiko stove have been men, many women in small urban areas have benefited immensely from the technology, significantly improving their standards of living through gains in time and income (Okello, 2005).

Reductions in fuel use associated with the KCJ and other improved stoves have been examined in a number of countries. In Tanzania, annual fuel consumption for traditional charcoal stove was found to be around 1080 kg/year/household while for improved charcoal stove it was around 370kg/year/household (annual charcoal saving is 710 kg/household which is equivalent to around 60 trees) (TaTEDO, 2005)

In Rwanda, the savings with improved charcoal stoves were even greater. There, consumption of charcoal dropped to 0.33 kg per person per day from 0.51 kg per person per day. This means that in a year a family could save about

394 kg of charcoal worth 6,310 Rwanda Francs (Ksh. 7,232) (Smith et. al, 1994).

In Kenya charcoal use among a sample of families using the KCJ fell from 0.67 kg to 0.39 kg/person/day. This totals over 600 kg of charcoal/year for an average family, and a savings of over $US 64.7/year i.e Ksh.5590 Karekezi and Ranja, (1997); Coelho et al, (2004). Other tests done in Kenya indicated an average decline in daily charcoal consumption from 0.7 kg to 0.4 kg per person with an improved stove Jones (1989), adding up to a total yearly saving of 613 kg per family Smith et al. (1993). This would save on the money used for purchase of charcoal and thus help in improving the family living standards. It would also reduce demand for charcoal thus saving the forests trees, shrubs and herbs and thus promoting environment conservation.

According to Johnson et al. (2007) up to the equivalent of 10 tonnes of carbon dioxide may also be saved per household per year with an improved stove. This would reduce the GHG emission to the atmosphere and thus assist in mitigating against global warming and climate change

2.2.3 Fireless cooker (foodwarmer)

This is an insulated basket, container or box that is specially designed to complete the cooking that has been done partially on conventional cooking technologies. It is also a food warmer for it keeps food hot for upto eight (8) hours after cooking (Owino, 2003).

Almost anything that can be boiled or steamed may be cooked in the fireless cooker with a great saving of the cook's time and labor as well as with an economy of fuel. There is a saving of work because the food does not need to be watched, it will neither burn nor boil over. Cooking utensils do not wear out so rapidly when used in a cooker as when used over a fire, and the kitchen is neither hot nor filled with odors.

The cooking nature of the fireless cooker only allows for cooking of foodstuffs that do not need stirring during the cooking process (Taulo et. al, 2008).

Figure 2.5: Fireless cooker (food warmer)

A fireless cooker operate on the principle of thermal insulation where by food is brought to a boil then transferred into a carefully insulated basket or box to complete the cooking process using the trapped heat. According to Mugo and Poulstrup (2003) a fireless cooker reduces consumption of woodfuel by about 40%, thus by households adopting this technology in combination with the KCJ or *Kuni mbili* stoves then a huge amount on woodfuel saving would be realized and this would tremendously reduce pressure on the diminishing woodfuel sources. This technology does not only assist in woodfuel saving but can also be used in saving other conventional forms of energy for cooking e.g. LPG or even electricity.

2.3 Adoption of wood fuel energy conservation technologies

According to Makame (2006), poor quality of the improved stoves, costs, information and education about the stoves were found to be the major factors for failure to adopt improved charcoal stoves in urban Zanzibar.

Elvira (2008) reported that people base their decisions to buy a device on actual prices and do not have a good knowledge about the operational cost. While Dupont (1998) in a study found out that both US and Thai ranked the price of a technology as an important determinant for the adoption of the energy efficient appliances.

Another factor that also does limit adoption is information. According to Bhattacharya and Cropper (2010) technology diffusion is limited by unavailability of information and they proposed that the best sources of information are the people who have already adopted the technology.

China is one of the countries that has had a successful improved stove program where by early 90s it had disseminated 120 million improved stoves to the rural areas. According to Ramakrishna (1991) and Smith et. al. (1993) the success of China was attributed to the design and implementation of the program which included;

- Program concentrating efforts on areas of greatest need and selecting pilot counties with biomass fuel deficits.
- Direct contracts between the central government and the county bypassing much bureaucracy. This arrangement generated self-sustaining rural energy companies that manufactured, installed, and serviced stoves and other energy technologies.

- Local rural energy offices were in-charge of technical training, service, implementation, and monitoring for the programs.
- Chinese improved stoves were not only suitable for fuel savings but also, designed for convenience and attractiveness, highlighting the lessons learned from problems in early programs that stressed fuel savings.
- Stove adopters paid the full cost of materials and labor. The government only helped producers through stove construction, training, administration, and promotion.

Stoves that are mass-produced by a group of artisans or a small factory will be disseminated far more quickly than custom-built models whose construction and installation may depend on the availability of trained technicians or installers (Smith, et al. 1993).

A study carried out by Evans (1987) found out that stoves which are primarily designed to reduce the quantities of fuel-wood used can only be expected to be successful (i.e. adopted readily by local women) in areas where there is an acute fuel shortage, namely rural areas with an ecologically degraded environment and for poor households in peri-urban and urban areas where fuel costs are high.

2.4 Research Gaps

There is a knowledge gap relating to the adoption levels of improved firewood stoves, improved charcoal stoves and the fireless cooker in both rural and urban areas of Kenya.

Research on social economic factors influencing acquisition and use of the same technologies in Kenya is scarce and thus the need to concentrate on the same in this study.

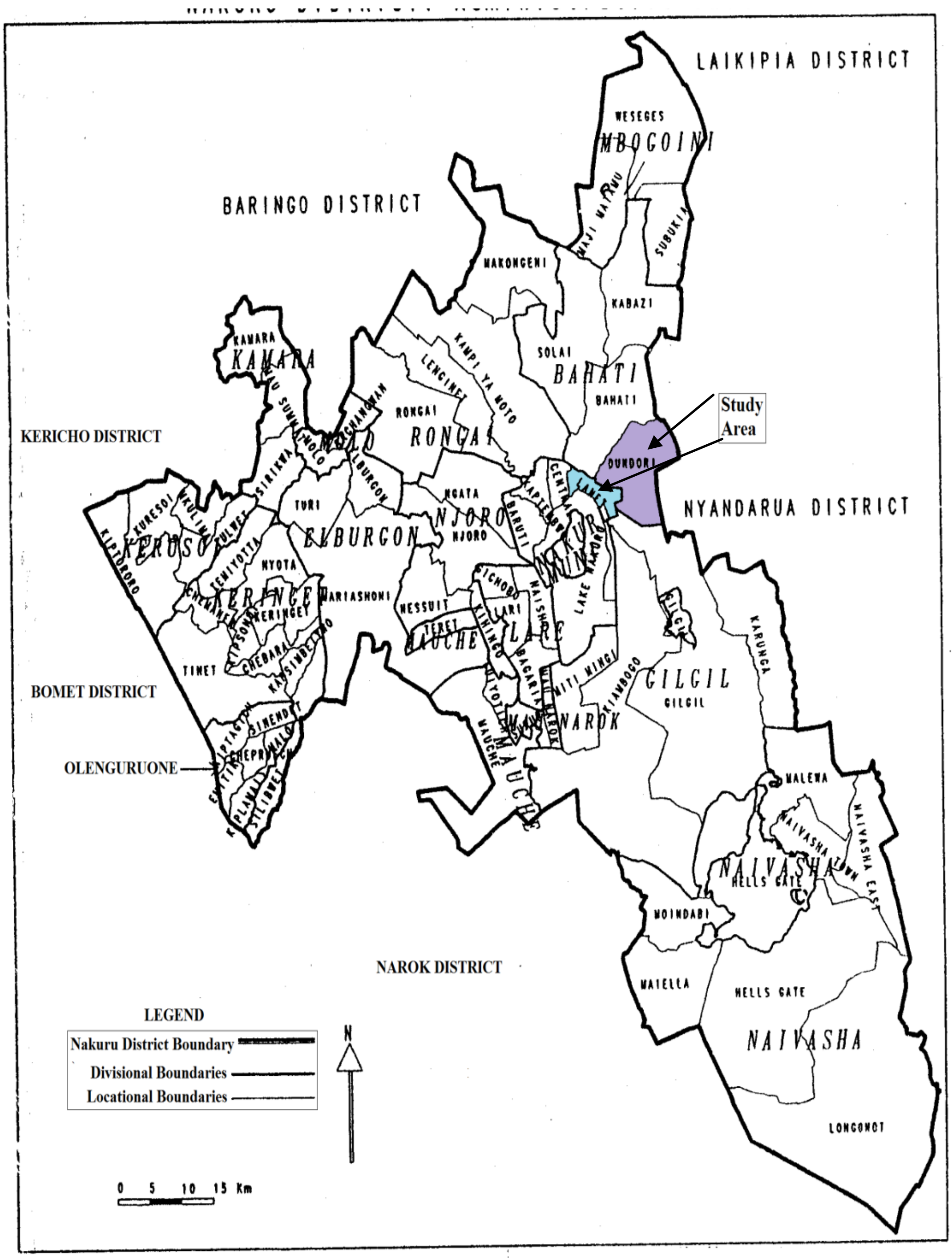
There is also limited literature relating to people's perception on weather changes and the need to conserve the environment.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Area of study

Lanet division is one of the 7 newly created divisions in the new Nakuru municipality District. It has an estimated population of 58,000 (2006 estimates-Ministry of planning, 2006) and the number of households is 9,482. The Division lies 0^0 17’ 0” South of the Equator and 36^0 4’ 0” East. There are several shopping centres with many commercial activities going on. Small scale farming is also practiced in some parts of Lanet location which is a peri-urban area. The division has a mean temperature of 26.7 ^{0}C. It has a bimodal pattern of rainfall with the long rains coming between April and June while the short rain comes in October-November.

Dundori Division is a newly created division of the Nakuru North District. It was formerly part of Nakuru District. The Division borders Lanet division to the West, Bahati division to the North, Nyandarua District to the East and Gilgil Division to the South. It lies 00 12’ 0” South of the Equator and 360 16’ 0” east. The division has a population of 60,800, (2006 estimates-Ministry of planning) while the number of households is 10,119. This is mostly an agricultural area with medium to high potential for agriculture. The temperature range is 12 ^{0}C - 29 ^{0}C. The Division receives a bimodal pattern of rainfall amounting to 1400 mm. The division also has a government forest (Dundori forest) that has been a source of woodfuel for the community for a long time.



Prepared by CBS, 1999 Population Census

Figure 3.1: Map of Nakuru County showing the study area

Source: CBS (1999)

3.2 Sampling Methods

3.2.1 Study Population

The population was taken as the total number of households in the two divisions which was 19,601 (2006 estimates-Ministry of planning).

3.2.2 Sampling procedure

Purposive sampling was used to select the districts and the divisions for the study. Nakuru Municipality District and Nakuru North Districts were selected and one division in each of the districts was selected. These were Lanet Division and Dundori Division respectively. The two Districts belonged to the same district (Nakuru District) before 2007. They were chosen because Nakuru town is the headquarters of the expansive Rift valley Province and according to Milukas (2003) Nakuru reliance on biomass fuel (Charcoal) is significantly greater than Nairobi. He further stated that Nakuru demand for charcoal exceeded the regional capacity to provide long term sustainable supply. Thus a study on how energy saving technologies have been disseminated and adopted by the households in Nakuru was necessary. Nakuru District is also part of the Mau ranges and in the recent past and even currently this region has raised international environmental concern due to the destruction of the forest which is a one of the five water towers in Kenya. Dundori forest is one of the catchment areas for Lake Nakuru and there is need for its conservation thus the need to study on one of the options of minimizing woodfuel demand and therefore assist in conservation of the environment by proposing options in order to improve uptake of these technologies.

Cluster and Simple Random sampling were used to select the sublocations to be used in the study. The Urban Sub-locations were grouped together to form a cluster and also the Sub-urban sublocations were grouped together in Lanet Division. In Dundori Division, the rural sublocations were clustered together and the Sub-urban sublocations were also grouped together to form a cluster. Simple random sampling was used to select the sub-locations to involve in the study. Systematic random sampling was used to select the households to involve in the study in each Sub-location. According to Schaffer et al. (1979), a systematic sample is frequently spread more uniformly over the entire population and provides more information about the population than an equivalent amount of data contained in a simple random sample.

The sample size (n) was calculated using the Fishers formula as recommended by Mugenda and Mugenda (Mugenda and Mugenda , 1999):

$$N=\frac{Z^2(p)(q)}{d^2}$$

Where:

- Z refers to the confidence limits of the study results, i.e 95% where Z = 1.96
- P refers to the proportion of the population who have acquired and using the woodfuel energy conservation technologies. Estimation (0.5)
  - Q = (1-p) refers to the proportion of the population who have not acquired nor using the energy conservation technologies. Estimation (0.5).

- D refers to the desired precision of the estimates (within a range of plus or minus 5%)

So, using the equation above, one get:

$$N = \frac{(1.96^{2})(0.5)(0.5)}{0.05^2} = 384$$

(Fisher et al, 1983)

A sample of 384 households (1.96% of the total population) was selected. Fisher formula ($n= Z^2pq/ d^2$) for selecting a sample of a population above 10,000 was used to get the sample size (Mugenda and Mugenda, 1999: RHRC 2004). A sample of 198 households in Dundori and 186 households from Lanet Division were systematically randomly selected for this study. This was done as a proportion to the households in each Division.

Table 3.1: The study sampling frame

	Division	
	Lanet (Urban Households)	Dundori (Rural household)
Total	9,482	10,119
Sample	186	198
% of Total	1.96%	1.96%

All the household in a certain locality (village/estate) were first numbered then the starting point was chosen randomly by use of table of random numbers and then every *nth* household on the right hand side along the road/street was chosen next until the number required in that area was completed. For example where in a certain village the number of household was 300 and only 10 household were required, it meant that after the first household had been chosen randomly by use of random numbers then every 30th household would be selected for interview so that at the end of the study in that area, total number of household interviewed would be 10.

3.3 Primary Data collection

3.3.1 Research tools

The study collected data from heads of the households (male or female). Both questionnaire and interview schedule were used to collect data on information pertinent to woodfuel saving technologies utilized in the homestead and respondents perception on weather changes and the need to conserve the environment.

3.3.1.1 Semi-structured Questionnaire

The questionnaire was semi structured and were administered by means of personal interviews in order to encourage the respondents to participate and to allow probes, clarification by the interviewer as observed by Peil et al (1982). The open ended questions were used to allow the respondents to give their own opinions (sample in Appendix 2). Closed questions were presented with a series of choices and allowed the respondents to choose one answer. The questionnaire was used to gather information on educational level, gender status, number of children, income level, types of energy saving devices in use, source of fuel wood and other information important for the study.

Likert scale, developed by Renis Likert in 1930s was used to gather information on the level of awareness of weather changes and the need for environmental conservation. Likert (1932) proposed a summated scale for the assessment of survey respondent's attitudes. Individual items used as in Likert's sample scale had five response alternatives: Strongly Agree Agree, Neutral, Disagree, and Strongly Disagree. It provided an ordinal level of measure of a respondent's attitude. Interview with other stakeholders in the energy sector were conducted e.g supplier of the technologies, DAEO, and NGOs.

3.3.1.2 Field Observation

Field observation was also used to verify the type of woodfuel technologies in use by households as well as the type of technologies being promoted by the NGOs and artisans operating in the study area.

3.3.1.3 Photography

Photography was used in data gathering. Areas affected by unsustainable use of woodfuel were photographed as well as the types of woodfuel energy saving technologies being promoted in the study area.

3.3.2 Secondary data collection

Secondary data was sought from annual reports of relevant ministries, NEMA, journals and books relevant to the area of research.

3.3.3 Piloting of questionnaire

The semi structured questionnaire was pretested beforehand by piloting in order to gauge its reliability in gathering the required data. A sample of 20 households was selected randomly outside the area of the study and involved in filling the questionnaire. The number 20 was chosen for pre-test because according to Kathuri and Pals (1993) it is the smallest number that can yield meaningful results on data analysis in a survey research. The required corrections were made on the questionnaire/interview schedule before being administered to the households involved in the study.

3.4 Data analysis

Data was analyzed using the Statistical package for social science (SPSS) computer software version 11.5. Data analysis consisted of both descriptive and analytical components with a variety of statistical tools to describe the study population. SPSS was preferred because it is easy to use and accepts a wide range of data manipulation to give desired values and is also readily available as compared to other statistical packages.

3.4.1 Descriptive statistics

Descriptive statistics was used to analyze the characteristics of the population studied. According to Trochim (2006) descriptive statistics are used to describe the basic features of the data in a study providing simple summaries about the sample and the measures. Means, standard deviation, Frequency tables, bar charts and percentages were used. These were used to describe demographic data such as age, education, employment status, number of dependent etc.

3.4.2 Inferential statistics

According to Smith (2011) inferential statistics are used to make inferential statements about a population. It makes use of random sampling techniques to make sure the sample is representative. Independent sample two tailed t-test (significance level of 0.05) was used to test whether there was any significant difference in the level of adoption of woodfuel saving technologies in the two divisions. A t-test is used to test whether there are any significant differences between two means derived from two samples at a specified probability level (Mugenda and Mugenda, 1999).

The Pearson correlation–coefficient was used to measure correlation for independent variables and dependent Variables in the interval or ratio scale, Spearman correlation–co-efficient was used to measure correlation involving ordinal variables while multiple regression analysis was used to determine the social economic factors that influence adoption of woodfuel conservation technologies. Similar method of analysis was used by Faham and others in analyzing factors that influence forest dwellers participation in reforestation and development of forest areas (Faham et al, 2008).

Descriptive statistic e.g use of Bar graphs, tables and percentages was used to analyze the Likert scale questions. Spearman correlation has also been used to analyze the responses of various statements.

3.5 Operational definition of variables

Dependent variable

Acquisition of the Technologies - This is the number of woodfuel energy conservation Technologies possessed by a household. Was either 0, 1, 2 or 3.

Rate of usage of Technology – Rating how often a technology was being used in a household

Independent Variable

Education level- Level of education attained by the head of the household

Age- Number of years the respondent has lived.

Income- Combined earnings of the Household from different sources per month.

Employment status- Where one gets his income from, e.g self employed, informally employed, unemployed or not employed

Number of dependent- Number of people related or unrelated who depend on the income from the household.

Cost of the energy saving technology- The price of the energy efficient technology acquired by the household.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter is presented in an attempt to answer the research questions in sub section 1.4 and respond to the objectives initially set out in the study. The results in this section originated from the questionnaire responses, the researcher's own observations and also through relevant literature search.

4.2 Socio- economic details of the study area

4.2.1 General social economic characteristics of the respondents

This study was carried out in Nakuru County. Dundori Division represented the rural population, while Lanet Division represented the urban population. Generally the study area was composed of low and middle income earners and a small proportion of high income earners. The rural people were mostly engaged in farming activities while majority of the urban respondents were employed in the urban area and others were small scale traders.

One of the objectives of the study was to find out which socio-economic factors influence adoption of woodfuel saving technologies. The independent variables considered were level of education, income of the household, employment status, cost of woodfuel devices, number of dependants, age of the respondent, knowledge about the technology, house ownership and house type as well as gender of the respondent. Both correlation and multiple regression analysis were used to determine the factors.

4.2.2 Gender of the Respondent

A majority of the respondents (73%) were female, while the rest (27%) were male (Table 4.1). However, the rural population interviewed comprised of 70% female and 30% male; compared to 76% female and 24% male in the urban population. There were more females respondents in both the urban and the rural respondents as most times women are the ones who are left at home and involved in domestic chores while men move out daily in search of income to meet the needs of the family. Thus women are well versed with problems associated with use of fuelwood and type of energy efficient technologies in use for cooking and heating activities. Due to involvement in the domestic chores, women and children are also the most affected by indoor air pollution by use of energy inefficient stoves (Muchiri, 2008).

Table 4.1: Gender proportions of the respondents in Dundori and Lanet Divisions

	Division of respondent					
	Dundori		**Lanet**			
	Sex of the Respondent		Sex of the Respondent		Total	
	Count	**%**	**Count**	**%**	**Count**	**%**
Male	59	29.8%	45	24.2%	104	27
Female	139	70.2%	141	75.8%	280	73%

There was a very weak positive correlation between the gender of the household head and the number of woodfuel saving technologies with Spearman's Rho Correlation value (r_{rho} = 0.046; n=384, p=0.05) (Table 4.7). Female headed households had acquired more woodfuel energy saving technologies as compared to the male headed households (Table 4.7).

4.2.3 Age of Respondents

The survey revealed that a majority of the respondents (26%) are aged between 26 to 33 years (Table 4.2). The overall majority of respondents (70%) fall between 18 to 41 years of age. Rural Dundori accounted for 64%, while the urban Lanet accounts for 75% of respondents in that age bracket. The urban respondents were composed mainly of young people since many of them had migrated to the urban areas in search of income as compared to the rural area where the older generation retire after active live in the urban areas during their younger age.

Table 4.2: Age categories of the respondents in Dundori and Lanet Divisions

	Dundori Age of the respondent		**Lanet** Age of the respondent		Total	
Age (yrs)	n	%	n	%	n	%
18-25	34	17.2%	51	27.4%	85	22.3
26-33	52	26.3%	45	24.2%	97	25.3
34-41	41	20.7%	45	24.2%	86	22.5
42-49	19	9.6%	28	15.1%	47	12.4
50-57	10	5.1%	14	7.5%	24	6.3
58-65	19	9.6%	3	1.6%	22	5.6
>66	23	11.6%			23	11.6

There was a very weak correlation between the age of the respondents and the number of woodsaving technologies a household was able to acquire with a Pearson's Correlation value (r = 0.018, n=384, p=0.05) (Table 4.7). Younger household heads had acquired more woodfuel saving technologies, unlike older household heads, who had acquired fewer technologies. The youth were more adaptive to new ideas compared to the old. In a study carried out in Kathiani, Kenya, Karanja (1999) found out that the age bracket 26-36 years had adopted more energy saving technologies as compared to those over 45 years. She attributed her findings to the fact that middle age respondents are in their reproductive and productive years and this age group had adopted energy conservation technologies for effective performance of both reproductive and productive activities.

4.2.4 Marital Status of the Respondents

Most of the respondents (79%) were married, 13% were single, 6% were widowed, while 2% were separated (Table 4.3). In Dundori, majority of the respondents (76%) were married; compared to 82% of respondents from Lanet. Both residential categories had 13% single and 2% separated. Rural areas had 9% widowed while urban Lanet had 3% widowed. The marital status of the respondents can influence acquisition and use of a technology because there is usually need for consultation before a decision is made unlike in the case of female headed household where a woman makes decision on her own.

Table 4.3: Marital status of the respondents in Dundori and Lanet Divisions

	Division of respondent					
	Dundori		**Lanet**		**Total**	
Marital status	**N**	**%**	**n**	**%**	**n**	**%**
Married	150	75.8%	152	81.7%	302	78.8%
Single	26	13.1%	24	12.9%	48	13%
Separated	5	2.5%	4	2.2%	9	2.4%
Widowed	17	8.6%	6	3.2%	23	5.9%

4.2.5 Education status of the respondents

A Majority of the respondents had attained primary (40%) and secondary (39%) levels of education (Table 4.4). Overall, about 53% of the respondents had acquired at least secondary education. However, in Dundori, only 45% had acquired at least secondary education, compared to about 61% in Lanet. In Dundori, only 6% had college education, while in Lanet 17% and 6% had acquired college and university education respectively. This implies that the educated tend to migrate to the urban areas in search of employment while the less educated stay in the rural areas and get involved in menial jobs.

Table 4.4: Educational level of the respondents

	Dundori		**Lanet**		Total	
Level of education of respondent	n	%	n	%	n	%
None	20	10.1%	7	3.8%	27	7%
Primary	90	45.5%	65	34.9%	155	40%
Secondary	77	38.9%	71	38.2%	148	39%
College	11	5.6%	32	17.2%	43	11%
University	-	-	11	5.9%	11	3%

There was a positive correlation between the level of education of the household head and the number of woodfuel saving technologies acquired (Table 4.7) with Spearman's Rho Correlation value (r_{rho} = 0.232, n=384, p=0.01). The higher the level of education of the respondents, the more the number of woodfuel saving technologies they purchased/ owned.

Education level of the respondents tends to influence adoption of technologies as learned people usually adapts to new ideas faster than those who have not been to school. According to Hirok and Ashok (2010), people with higher education level have better access to information and knowledge that is beneficial in their domestic activities. They also tend to have higher analytical capability of the information and knowledge necessary to implement new technology and realize the expected result. Hence the higher education level allows households to make efficient adoption decisions Rahn & Huffman, (1984) and be the early adopters who can take advantage of new technology and profit from it Gardner and Rausser, (2001).

Cotlear (1990) argues that formal, non-formal and informal education may provide specific or general knowledge, which provides the benefit and uses of new technology. The result of this study shows that majority of the potential adopters (53%) had been through secondary schools. A study conducted by Taulo et al, (2008) in Malawi revealed that education had a positive influence on the adoption of the fireless cooker. Households with one or both parents with some formal education accepted the fireless cooker technology more readily.

The findings of this study agree with those of Karanja (1999) who found out that many of the non adopters of energy saving technologies were those with no education while majority of the adopters had been either through primary (36%) or secondary school (37%). In this study about 26% (Table 4.5) of those without formal education had not adopted any energy saving technology and this means they were using energy inefficient technologies which tend to consume more woodfuel and release more pollutants to indoor air as well as to the atmosphere. The proportion of the respondents with two energy saving technologies seems to increase with increase in education level. The ability to make better choices on type of technology to use seems to increase with educational level.

Table 4.5: Number of Technologies acquired against level of Education

	Level of education of respondent				
Number of technologies acquired	**None**	**Primary**	**Secondary**	**College**	**University**
	%	%	%	%	%
0	25.9	11.0	3.4	9.3	
1	70.4	84.5	90.5	65.1	81.8
2	3.7	3.9	6.1	23.3	18.2
3		0.6		2.3	

4.2. 6 Employment Status of the Respondents

Majority of the respondents (54%) were unemployed (Table 4.6). Still, a large number (34%) were self-employed. Only a small percentage (9%) was formally employed (Table 4.6). Majority of the rural population (64%) were unemployed compared to 42% of the urban population. Only 7% of the rural population was formally employed, compared to 12% of the urban population.

About 41% of the urban population was self-employed, compared to only 27% of the rural population. About 5% of rural and 2% of urban population were in the informal sector (Table 4.6).

The respondents who were formally employed meant that they had a guaranteed salary at the end of every month and thus there was a likelihood of acquiring the energy saving technologies. The findings of the high rate of unemployment in both urban and rural might be misleading due to the fact that even where the respondents mostly female reported that they were unemployed they still had their husbands working and thus guaranteed of some income at the end of the month.

Table 4.6: Employment Status of the Respondents

Employment status of respondent	Dundori		Lanet		Total	
	n	%	n	%	n	%
Formally employed	13	6.6%	23	12.4%	36	9%
Informally employed	4	2.0%	9	4.8%	13	3%
Self –employed	54	27.3%	76	40.9%	130	34%
Unemployed	127	64.1%	78	41.9%	205	54%

4.2.7 Average monthly household incomes

Majority of the respondents (33%) fall in the income bracket of Kshs. 5,001 and Ksh.10, 000 (Figure 4.1). Still, 25% earn a monthly income of Kshs. 10,001 to 15,000; while 20% earn less than Ksh. 5,000. Only 3% of the population earns an income above Ksh.100, 000 per month.

However, income earnings varied between the urban and the rural households (Figure 4.1). Majority of the rural respondents earned Ksh. 5,001 – 10,000 (39%) and less than Ksh.5, 000 (35%). A majority of the urban respondents (40%) earned a monthly income of Ksh.10,001 – 15,000, about 27% earned Ksh. 5,001 – 10,000, and only 3% reported earning over Ksh. 100,000.

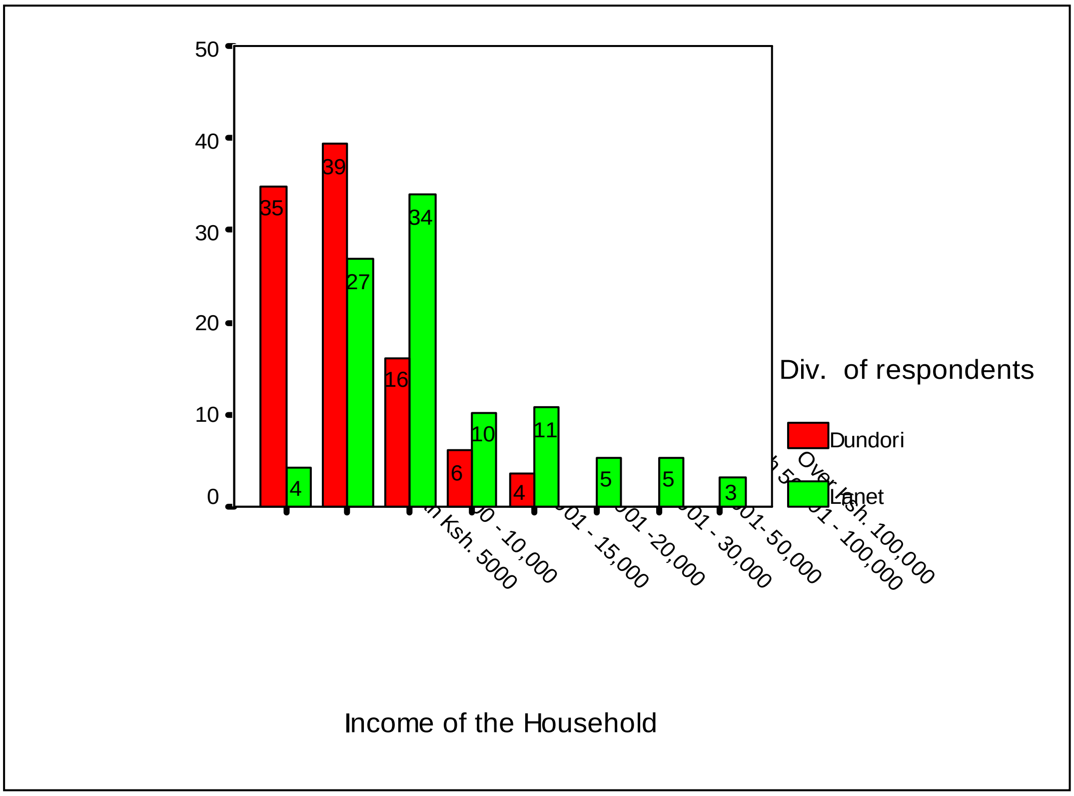


Figure 4.1: Average Monthly Household Income

There was a positive correlation between the average monthly household income and the number of woodfuel saving technologies with Pearson's Correlation value (r = 0.230, n=384, p=0.01) (Table 4.7). The higher the level of monthly income of the respondents, the more the likelihood of purchasing woodfuel saving technologies.

Household income can be used as a proxy to working capital because it determines the available capital for the investment in the adoption of technologies and it is a means through which the effect of poverty can be assessed. According to the World Bank (2003), poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income. Household income has a bearing on the socio-economic status of family.

According to GTZ, (2008), the low level of income of the households depending on biomass fuels is a major barrier to increasing the dissemination of improved stoves. For poor households stoves represent a high initial investment cost which prevents them from purchasing the product.

Income level plays a role in determining whether one acquires a new technology or not. The lower the level of income the lower the adoption of any technology while the higher the level of income, the higher the level of acquiring and usage of a new technology. This is because most of the new technologies have a cost implication and only those with money are able to adopt the technology faster.

Table 4.7: Correlation coefficient values of social economic factor compared to the number of woodfuel conservation technologies acquired

	Number of devices acquired **r**	**n**	**p-value**
Number of devices acquired	1		
Gender of the Respondent	-0.046	383	0.05
Level of education of respondent	0.232	383	0.01
Income of the Household	0.230	383	0.01
Number of dependants per household	-0.196	383	0.05

House ownership	-0.042	383	0.05
Type of house	0.156	383	0.01
Cost of Improved firewood stove	-0.284	10	0.05
Cost of Improved charcoal stove	0.296	343	0.01
Cost of fireless cooker	-0.479	19	0.05
Age of the respondent	0.018	383	0.05
Information on Improved firewood Stove	0.022	383	0.05
Information on Improved charcoal Stove	-0.001	383	0.05
Information on fireless cooker	0.183	383	0.01

4.2.8 Multiple regression analysis of Social economic factors influencing adoption of wood fuel conservation technologies in Nakuru County.

A multiple regression model was established that incooperated thirteen identified independent variables to predict the number of energy saving technologies acquired per household. A stepwise method was used in order to include in the model only those variables that explain additional variance, Karl (2006). The result of the multiple regression is presented in Table 4.8.

Table 4.8 indicates that among the independent variables that have significant correlation with the dependent variables; Cost of improved firewood stove, cost of the improved charcoal stove, cost of the fireless cooker and the number of dependants have entered to regression equation by 4 steps.

The four variables could explain 40% (see Adjusted R Square Value in step 4 of Table 4.8) of the variation in the adoption of the energy saving technologies. The regression equation is as follows:

Y= β_0 (Costant) + β_1 (cost of improved firewood stove) + β_2 (Cost of Improved charcoal stove + β_3 (Cost of Fireless cooker) + β_4 (Number of dependants per household) + ε_o (error term)

Table 4.8: Multiple regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.48	0.23	0.23	0.37
2	0.56	0.32	0.31	0.35
3	0.62	0.39	0.38	0.33
4	0.64	0.40	0.40	0.33

1 Predictors: (Constant), Cost of fireless cooker

2 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove

3 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove

4 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove, Number of dependants

When analysis of Variance was done the F statistics was found to be 63.905 with a significance value of less than 0.05 (Appendix 4.1). This results indicate that the overall model was statistically significant (F = 63.905 p = 0.000).

This means that the independent variables considered play an important role in explaining the variation in the dependent variable (acquisition of woodfuel saving technologies). This is also supported by the t-values of all the four independent variables being more than 3.0 where 'Cost of the fireless cooker had t-value of -11.385, Cost of improved firewood stove (t-value -6.6587), cost of improved charcoal stove (t-value 7.161) and the Number of dependants had a t value of -3.365 (Table 4.9)

Table 4.9: Multiple Regression Coefficients

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		

(Constant)	0.917	0.049		18.602	0.000
Cost of fireless cooker	-0.001	0.000	- 0.454	- 11.385	0.000
Cost of Improved charcoal stove	0.001	0.000	0.286	7.161	0.000
Cost of Improved firewood stove	- 0.001	0.000	- 0.265	- 6.658	0.000
Number of dependants per household	-0.027	0.008	- 0.135	-3.365	0.000

4.2.9 Number of dependants per household

Most of the respondents had 4 dependants (22%) while other respondents had 5 dependants (20%); 3 dependants (17%) and 6 dependants (14%).

Majority of the rural and urban respondents had between 3 and 6 dependants (Figure 4.2). About 21% of the rural and 23% of the urban respondents had 4 dependants; 17% of rural and 22% of the urban had 5 dependants; 16% of rural and 18% of the urban had 3 dependants; while 14% of rural and 13% of urban had 6 dependants.

The study found out that the households with many dependants had acquired less energy saving technologies as compared to those with few dependants. About 50% of those with 11-14 dependants and 29% of those with 8-10 dependants had not adopted any form of energy saving technologies as compared to only 8% of those with 5-7 dependants and 5% of those with 0-4 dependants (Fig 4.2). The finding shows that the opposite happens for those who had adopted one energy saving technology where their proportion increases from those with highest number of dependants (50%) to those with the lowest number of dependants (87%). Only those with the least number of dependants were able to acquire 2 or more energy saving technologies.

There was a negative correlation between the number of dependants in the household and the number of woodfuel saving technologies acquired with a Pearson's Correlation value ($r = -0.196$, $n=384$, $p=0.01$) (Table 4.7). The higher the number of dependants per household, the less was the likelihood of affordability by the household of such technologies holding other factors equal. Many dependants meant that more money was required to meet the basic needs thus acquiring of improved cookstoves was secondary.

This findings tally well with those of Karanja (1999) who found out that a family size of 1-3 and 4-6 children seemed to have adopted more energy saving technologies as compared to a family size of 7-9 and 10-12. She attributed low adoption of energy saving technologies by large families to strained budget to cater for the large family and thus their preference of the inefficient wasteful mode of cooking (open fire). This means that large families can end up becoming poor managers of environmental resources and thus the need for awareness creation of the benefits even to the large families when energy saving technologies are adopted.

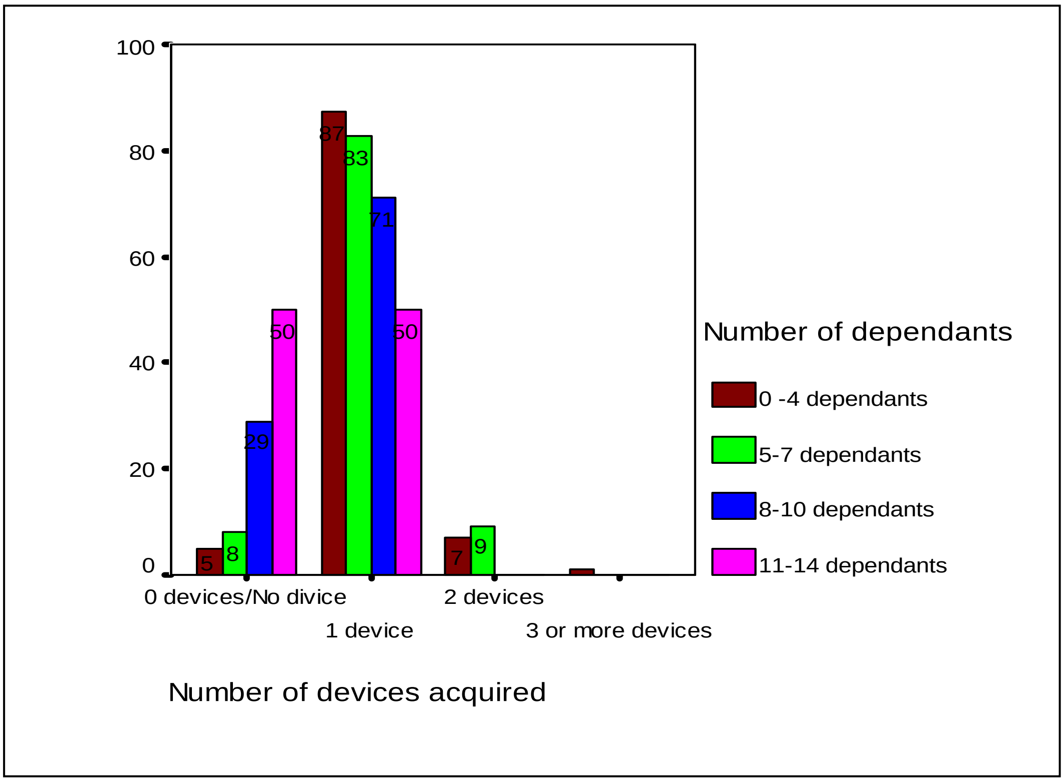


Figure 4.2: Number of dependants per household against number of technologies adopted.

The regression analysis p-value for the independent variable *dependants per household* against the number of devices acquired was 0.000 and a t-value of - 3.365 (Table 4.9). This means that number of dependants per household does influence acquisition and use of energy saving technologies. The more the dependants the less the acquisition and use of woodfuel saving technologies. This could also be due to the type of stove in the market such that they are small and medium in size thus unable to carry large pots (sufurias) to cater for a meal of a large family.

In a study by Taulo et al (2008) it was found out that a greater percentage (61.5%) of adopters of fireless cookers had small household size (4-6).

Households with 10-12 members had the lowest percentage of adopters (10%). The low adoption amongst the bigger household sizes was attributed to the design of the fireless cooker where a specific pot size could be used.

4.2.10 House ownership

About 54% of all the respondents interviewed had rented the houses they occupied and only 46% own the houses they live in. Majority of the rural respondents (58%) owned the houses they live in; compared to only 34% of the urban population. About 42% of the rural and 66% of the urban respondents had rented the houses they lived in. There was a very weak correlation (r—0.042, p=0.05) between the ownership of the house and the number of energy saving technologies adopted.

4.2.11 Type of House

A Majority of the respondents in the two divisions stayed in stonewalled houses (46.1%) followed by mudwalled houses (31.3%), timber walled (17.2%) while the rest lived in ironsheet walled houses (Table 4.10). When a correlation was done where the categories were turned to be a dummy variable (i.e. 0 - semi permanent and 1-Permanent) it was found out that the r- value was 0.156 meaning there was some correlation where those with permanent houses had a likelihood of having more energy saving technologies. This could be due to the fact that those with permanent houses were also likely to be the same as those with higher income and thus able to adopt the energy efficient technologies. Also majority of the urban households were living in permanent houses and the adoption of energy efficient stoves was quite high due to the restriction in use of fuelwood in those houses.

Table 4.10: Type of house of the respondents

	Dundori		Lanet		Total	
Type of house	Count	%	Count	%	Count	%
Mud walled/ ironsheet roofed	82	41.4%	38	20.4%	120	31.3%
Timber walled/ Ironsheetroofed	57	28.8%	9	4.8%	66	17.2%
Stone walled/ ironsheet roofed	57	28.8%	120	64.5%	177	46.1%
Stone walled/ tile roofed	1	. 5%	12	6.5%	13	3.4%
Others	1	.5%	7	3.8%	8	4.3%

4.2.12 Cost of the woodfuel energy conservation technology

There was a moderate negative correlation between the cost of the fuelwood improved stoves and the number of devices a household was able to acquire with Pearson's Correlation value of r = -0.284, n=10, and p=0.05 (Table 4.7) There was similar findings when one compared the cost of fireless cooker and the number of devices acquired by household with a correlation coefficient of -0.479, an n value 19 and p value being 0.025 (Table 4.7). The higher the cost of the technology, the less was the likelihood of affordability by households hence not acquired.

There was a significant positive correlation between cost of KCJ and the number of devices acquired (r- 0.296, n-343 and p-value of 0.01) (Table 4.7).

Thus cost of KCJ could be used to predict adoption or acquiring of these technologies due to the fact that the cost of this stove is relatively low ranging between Ksh.100-300 with the mean price being Ksh.150. The positive correlation could be attributed to the perception in the market that the improved stoves which are very cheap are of very low quality and thus might not last long. Thus the lower the price for this energy saving technology the less likely to be adopted. The Ksh 300 for a better quality stove is still within the reach of many households in Nakuru. These cookstoves were readily available in most shops both in the urban and the rural areas. Thus it was relatively affordable by both the low income earners as well as the high income earners.

When multiple regression analysis using the stepwise method was done, it was found out that the cost of the three technologies were good predictors for the adoption of these technologies where the cost of improved charcoal stove (t-value 7.161 and sig. p-value-0.000) had a positive influence while the cost of improved fuelwood stove (t-value - -6.658 and sig. p-value-0.000) and the fireless cooker (t-value - -11.385 and sig. p-value-0.000) had a negative influence (see Table 4.9). Thus the higher the cost of the improved fuelwood stove and fireless cooker the less likely the household were able to acquire the technologies. The cost of the fireless cooker ranged between Ksh. 950 - 2,200 while the cost of improved fuelwood technologies ranged from Ksh. 400 – 3000. These prices were high, for many households had limited sources of income and would rather use the traditional methods of cooking than adopt new technologies.

From the multiple regression analysis, the independent variables that seemed to be good predictors of adoption of the energy conservation technologies identified were; cost of fireless cooker, cost of the improved charcoal stove (e.g KCJ and rocket stoves), cost of the improved fuelwood stoves (e.g *Kuni mbili*, and *maendeleo Jiko*) , and the number of dependants per household. According to Barnes et. al, (1994), the price of stoves can be a significant barrier to their adoption. Improved woodfuel stoves are typically about twice as expensive as the local traditional stoves while some traditional stoves are free e.g the three stone fire. Surveys reveal that in most of Africa, middle-income families have adopted improved stoves far more quickly than poor families (Jones 1989). Other social economic factors had a significant positive correlation (Table 4.7) such as level of education (r-value, 0.232, $p< 0.01$), Income of the household (r-value-0.230, $p< 0.01$), information on fireless cooker (r-value 0.183, $p< 0.01$) and the type of house (r-value – 0.156, $p< 0.01$), but these independent variables overall contribution to the multiple regression model using the stepwise method was not significant.

4.3 Levels of adoption of woodfuel conservation technologies in Dundori Division (Rural) and Lanet Division (Urban)

4.3.1 Type of fuels used in Nakuru County

Majority of the rural respondents in Dundori (68%) reported always using firewood as the main source of fuel for cooking and heating (Table 4.11). Another (52%) of rural respondents reported using charcoal on a daily basis. Electricity (99%), cooking gas (89%) and kerosene (68%) were never used by the rural respondents. Thus the main energy mix in the rural area was firewood/charcoal, firewood/crop residue or firewood/charcoal/crop residue. This meant that biomass was the main source of fuel in the rural area of Nakuru County. Thus the demand for firewood and charcoal was high and putting alot of pressure on the main sources of this form of fuel e.g forests and woodlands.

Table 4.11: Usage of various fuels in Dundori Division

	Fuel type						
	Electricit y	Gas	Kerosene	Charcoa l	Firewood	Crop residue	Other fuel
Freq. of use	%	%	%	%	%	%	%
N.used	99.5	88.9	68.2	5.6	17.7	32.3	50.8
R. used		0.5	1	2.5	0.5	1.5	
S. used	0.5	9.6	28.8	40.4	13.1	66.2	.3
A. used		1	2.0	51.5	68.7		.3%

N-Not, R-Rarely, S-Sometimes, A-Always

On the other hand, a majority of the urban respondents (85%) in Lanet division of Nakuru District reported always using charcoal as their main source of cooking and heating (Table 4.12). About 62% of the respondents reported that they never used firewood at all while 23% sometimes used it, while 10% reported always using it. Kerosene was reported to be sometimes used by about 52% of the respondents in the urban division for cooking and heating water unlike in the rural area (28.8%).

The high rate of charcoal use by households in the urban areas has implication on woodfuel demand since most of the charcoal comes from the surrounding forests like Mau and also the woodlands near the study area. According to a study carried out by World Bank, (1994) there is a linkage between urban fuel demand and rural deforestation. According to a study done by Kirubi (2002) urban households can cause more deforestation than the rural household due to the fact that majority of the urban household uses charcoal unlike the rural household who use firewood and charcoal. Also majority of the charcoal supplied to urban areas comes from wet wood mostly cut from young trees.

This affects the regeneration rate of the forests making its conservation unsustainable. Thus the need for adopting energy conservation technologies in order to reduce demand for woodfuel , conserve the country's forests, saving on money used for woodfuel and eventually promote environmental sustainability.

Table 4.12: Usage of various fuels in Lanet Division

	Fuel type									
	Electricity		**Gas**		**Kerosene**		**Charcoal**		**Firewood**	
Freq. of use	n	%	n	%	n	%	n	%	n	%
N.used	177	95.5	142	76.3	66	35.5	2	1.1	115	61.8
R. used	2	1.1	2	1.1	2	1.1	2	1.1	8	4.3
S. used	3	1.6	25	13.4	96	51.6	23	12.4	44	23.7
A. used	4	2.2	17	9.1	22	11.8	159	85.5	19	10.2

N-Not, R-Rarely, S-Sometimes, A-Always

Although used at different amounts, it is evident that charcoal and firewood are the main sources of fuel for the rural population, while charcoal is the main source of fuel for the urban population in Nakuru County. This means that the demand for firewood and charcoal is quite high in these areas such that unless mechanisms are put in place to reduce demand for woodfuel, people will continue to encroach on forests and woodlands remaining in Nakuru County and the surrounding areas in search of these forms of fuel. This would reduce the forest cover as has happened in Mau forest and Dundori forest and therefore increasing land degradation, causing changes in the rainfall pattern as well as increasing the mean temperatures as has been witnessed in the last decade (MET, 2009).

Majority of the population, 93% in Dundori and 97% in Lanet buy woodfuel. About 2% of Dundori respondents reported getting firewood directly from Dundori forest. Most of those who buy in Dundori location do so from the Kenya Forest Service.

4.3.2 Woodfuel saving technologies

Woodfuel saving technologies are used by both the rural and urban populations in Nakuru County. The findings of the study showed that there was no significant difference in the levels of adoption of the three woodfuel conservation technologies when considered together. An independent Sample t-Test showed there was no significant difference in the number of woodfuel saving technologies owned between the sample mean of the rural and the urban population which was at 95% Confidence level, the t-Test value was -1.563 with 382 Degrees of Freedom and an associated p Value of 0.119 (Table 4.14). This can be attributed to the fact that rural areas had more improved firewood stoves which tended to cancel out the more fireless cookers among the urban dwellers of Lanet Division.

Table 4.13: Mean and standard deviation of the number of devices acquired by households in Lanet and Dundori Division.

	Division of respondent	N	Mean	Std. Deviation	Std. Error Mean
No. of devices acquired	Dundori	198	.96	.477	.034
	Lanet	186	1.03	.359	.026

Table 4.14: Independent Samples t-Test on the Number of technologies.

	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confi. Interval of the Difference	
						Lower	Upper
No. of devices acquired	1.56	382	.119	-.07	.043	-.153	.017

A majority of Nakuru population owned one woodfuel saving technology. About 93.5% of the urban population and 81.8% of the rural population owned improved charcoal cookstove *(*KCJ) (Table 4.15)). About 12% of the rural population and 5% of the urban population did not own a woodfuel saving technology. Thus the dissemination of the improved cookstoves is quite high in Nakuru County especially the improved charcoal stove (e.g KCJ). According to the implementation scenario in the integrated assessment (IAP) of energy policy prepared by UNEP in collaboration with the Government of Kenya, the target of 100% adoption in urban areas by the year 2030 is achievable (UNEP, 2006).

Due to the high adoption of the KCJ, the demand for charcoal can be assumed to be lower as compared to areas where the adoption level is low. This is because the energy efficient stoves use less charcoal than the traditional stoves (metallic jiko) leading to more conservation of the forest, improving indoor air condition and thus better health for the woman and children as well as saving on fuel expenditure and time spent in search of woodfuel. According to Johnson et al. (2008) the equivalent of upto 10 tonnes of carbon dioxide may be saved per household per year with an improved stove depending on fuelwood renewability.

About 7% of rural and 8% of the urban population owned 2 such devices (Figure 4.3).

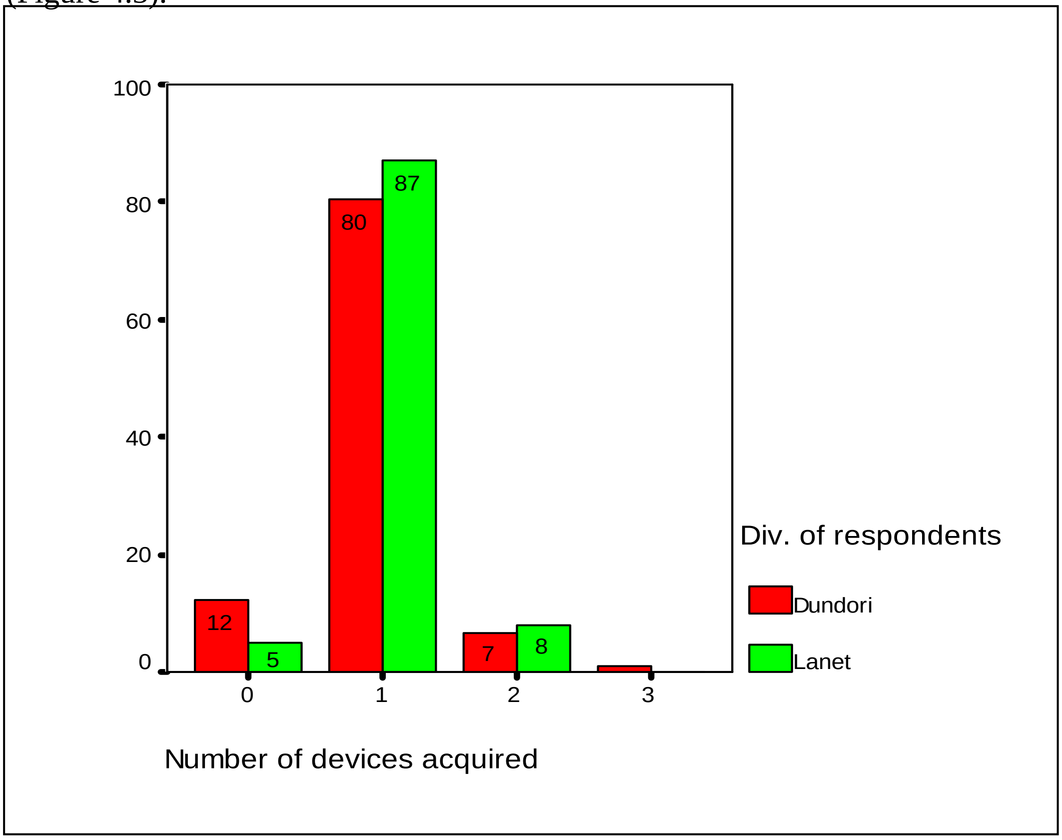


Figure 4.3: Number of woodfuel energy conservation device acquired.

The least acquired device in Dundori division is the fireless cooker where only 1.53% had it as compared to 8.06% in Lanet Division (Table 4.15). This can be attributed to lack of knowledge concerning the device where 67% of the household in Dundori stated that they had not heard about the device, while it was 50% in Lanet Division. The study also found out that there was a positive correlation between the respondents having information on the fireless cooker and the acquisition of the energy saving technologies (r-value-0.183) (Table 4.7).

The improved firewood stove is the least acquired technology (1.08%) (Fig. 4.4 and Table 4.15) among urban households. This can be explained as being due to the fact that a majority of the urban households rarely use firewood as a fuel in their domestic activities. The adoption of the improved firewood stove is quite low in the rural area and yet most of the rural households depend on firewood for their kitchen activities. This could be due to several factors including the cost of the technology which is relatively high compared to the improved charcoal stoves, unavailability of the stoves in many of the market centres as well as there being very few artisans involved in making of these stoves.

There was only one NGO (SCODE) involved in making of these stoves in the Division. The limited adoption has implication in terms of more trees being cut for firewood thus increasing deforestation, soil erosion and land degradation due to clearing of woodland in order to get firewood. Though the dissemination of the improved firewood stoves is low in relation to the improved charcoal stove (KCJ), it is still higher (9.18%) than the national average of less than 5% (Muchiri, 2008).

The study also found out that some of the respondents in the rural areas who did not have the improved fuelwood stoves had modified their traditional three stone stoves in order to minimize usage of firewood by re-arranging the three stones such that firewood was fed from only one side.

Table 4.15: Frequency of Woodfuel saving technologies in the two divisions

Type of Device	Dundori Division	Lanet Division
Improved charcoal stove	81.80%	93.55%
Improved firewood stove	9.18%	1.08%
Fireless cooker	1.53%	8.06%

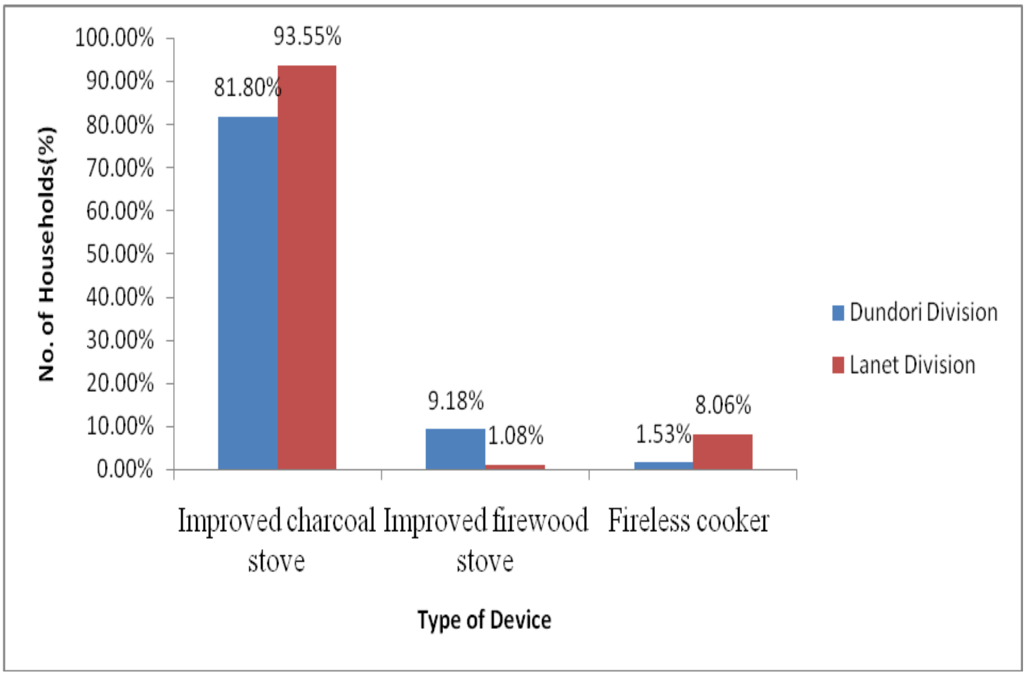


Figure 4.4: Type of woodfuel saving technologies owned

The trend in adoption agrees with a report by UNEP (2006) that the urban communities have over the past decades adopted (and will continue to adopt at a higher rate) the fuel-saving KCJ charcoal stoves. Over 85 per cent of urban households used these stoves in year 2002 compared to 47 per cent in year, 2000 and 13 per cent in year 1997. According to Xander et al. (2009), in urban areas, where wood is often purchased, users are motivated to use stoves that save money. In rural areas where fuel is scarce or in refugee camps, people similarly see the value of fuel-saving stoves, which help them reduce long or dangerous trips to collect wood

4.3.2.1 Improved charcoal stove (KCJ)

An independent sample t-Test showed that the difference between the sample mean of the rural and the urban population was 0.000, with a 95% Confidence level, the t-Test Statistic was –2.746 with 382 degrees of freedom and an associated p value of 0.006 (Table 4.17). The critical value of t is 1.960 since a two tailed test is applied, thus there is a significant difference in the means of the two samples. Therefore one can conclude that the adoption of the improved charcoal stoves (KCJ) is higher in the urban area than in the rural area of Nakuru.

A majority of the respondents in the urban division of Lanet (84%) always used the improved charcoal stove- also known as *Kenya ceramic jiko*; compared to 51% in Dundori (Figure 4.5).

The rate of usage is higher compared to the findings of Owino (2006) who found out that the usage in Nairobi of KCJ was 73%. About 31% of the respondent in Dundori reported to sometimes using the improved charcoal stove, while only 16% reported to have never used it. On the other hand, about 7% of the respondents in Lanet division were either using the improved charcoal stove sometimes while others had never used it at all. The high level of acquisition and use of the KCJ in both urban and rural areas of Nakuru County is vital for minimization of charcoal demand and thus decrease the rate of deforestation, improve indoor air conditions and ensure environmental sustainability. Thus the demand for charcoal could be said to be less compared to areas where adoption is low and therefore this may lead to more forest being conserved leading to sustainable environment. Currently there are organizations that are promoting adoption of energy saving technology under the clean development mechanism in order to benefit from carbon trading.

In Kenya, there is a voluntary Carbon market developing independently of government policies and guidelines and is slowly attracting businesses. There are now more than half a dozen carbon trading companies located in Kenya. They have registered over 50,000 tonnes of carbon from community projects such as tree planting, brick building, methane capture from slaughter houses and energy efficiency in hotel industry as of August 2007 (DANIDA, 2007).

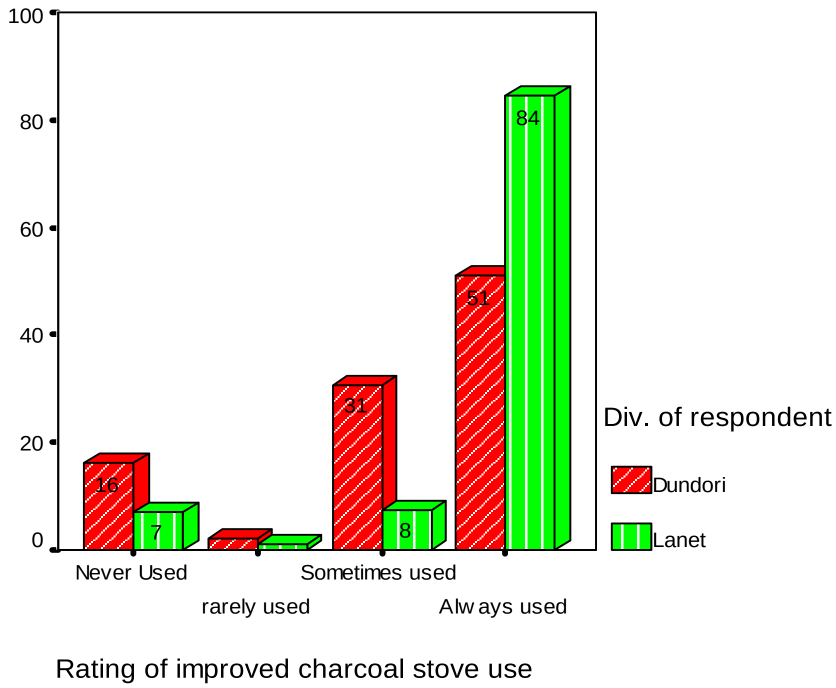


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Figure 4.5: Comparing the Rating of Improved Charcoal Stove Use Rural and urban areas of Nakuru

Only about 9% of respondents in the urban areas always used metallic stoves while 5% of the rural areas always used it (Fig. 4.6). This difference where it seems as if the rural had lower frequency of usage could be due to the fact that fewer households used charcoal as the main fuel for cooking and heating in the rural area as compared to the urban areas.

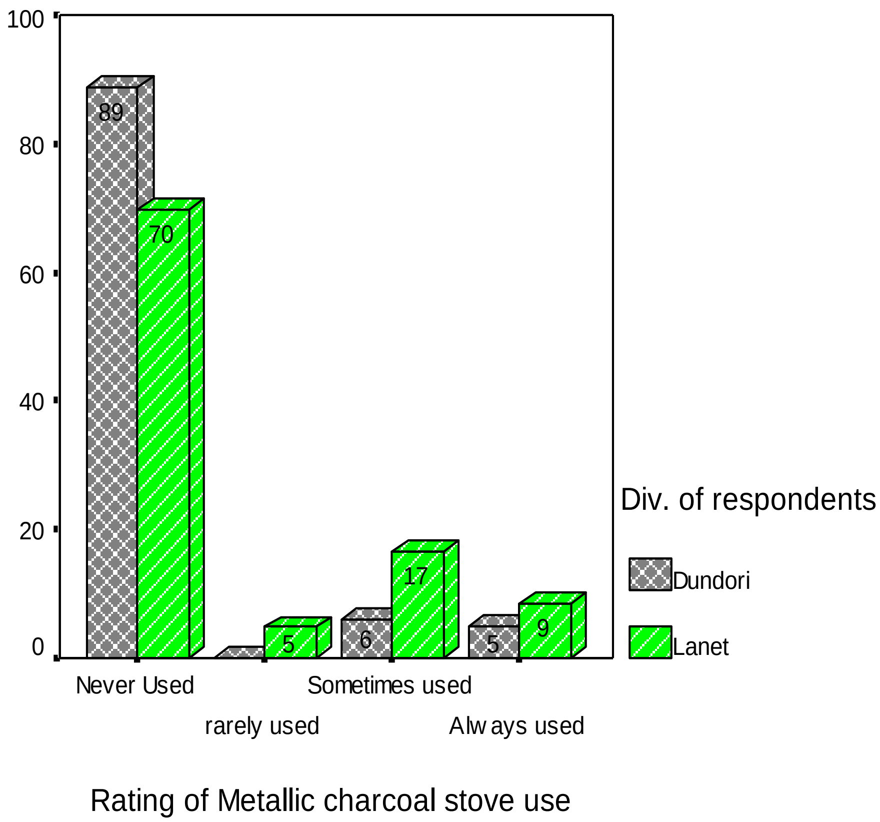

Figure 4.6: Comparing the Rating of Metallic charcoal Stove Use

4.3.2.2 Improved Firewood Stove (Kuni Mbili or Upesi jiko)

An independent Sample t-Test done showed that the difference in the acquisition and use of improved firewood stove between the sample mean of the rural and the urban population was 0.000, with a 95% Confidence level, the t-Test Statistic value was 3.726 with 382 Degrees of Freedom and an associated p Value of 0.000 (Table 4.17). Thus the conclusion in this case is that there is a significant difference in the mean number of *Kuni mbili* devices acquired between the rural and the urban areas of Nakuru whereby there are significantly more improved firewood stoves in the rural than in the urban area.

A majority of the respondents (98%) in Lanet Division reported that they had never used improved firewood stoves, compared to 89% of the respondents in Dundori division (Figure 4.7). However, about 10% of the rural respondents in Dundori reported always using the improved stove also known as *jiko kisasa* or *kuni mbil*i compared to less than 1% in Lanet division.

Though the acquisition and use of *kuni mbili* stove is higher in rural than in the urban areas, the adoption is still quite low compared to the number of households who are using firewood especially in the rural area as their main source of fuel for cooking and heating purposes. The findings are much lower than those of Karanja (1999) in a study done in Kathiani where the use of fuelwood saving stoves was 43.4% compared to 9.8 % in Dundori. Thus a lot still needs to be done to increase the uptake of this technology in the rural areas of Nakuru County. This low use of the improved stoves means that majority of the people in the rural areas use the traditional three stone stove which is poor in energy efficiency and causes more trees to be cut in order to meet the high demand. The cutting down of trees escalates soil erosion, land degradation and leads to increase in albedo thus changing the weather conditions of the area.

The finding are in agreement with Openshaw (1982) and also Jones (1989) who stated that there was low adoption of the improved wood stove in Kenya. They attributed the low adoption to women not having the time or the tools to cut the wood in small pieces to fit into firewood stoves with physically restricted fire box.

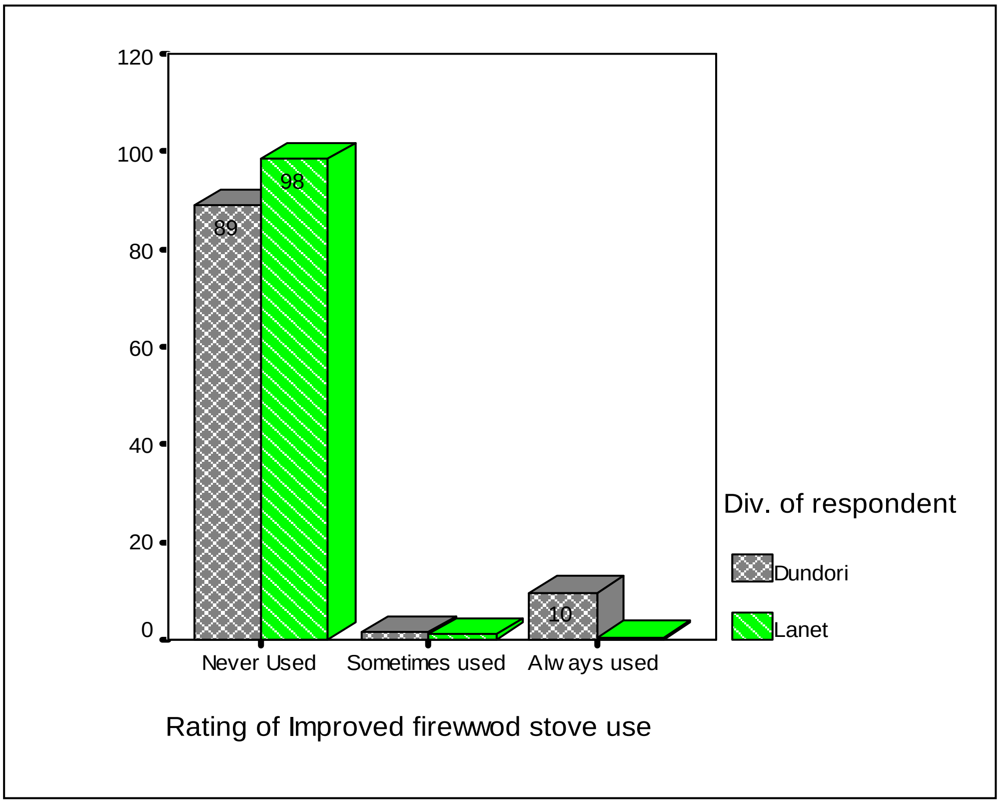

Figure 4.7: Comparing the rating of improved firewood stove Use

4.3.2.3 Adoption of Fireless cooker

An independent Sample t-Test done showed that there was a significant difference between the sample mean of the rural and the urban population in the acquisition and frequency of use of the fireless cooker at 0.000, with a 95% Confidence level, the t-Test Statistic value was -2.634 with 382 Degrees of freedom and an associated P Value of 0.009 (Table 4.17). Thus the acquisition and usage of fireless cookers is significantly higher in Lanet division (urban) than in the rural area (Dundori division)

A majority of the rural respondents (99%) reported that they had never used a fireless cooker/food warmer compared to 90% of the urban respondents (Figure 4.8). Only 6% of the respondents in Lanet division reported using the fireless cooker frequently compared to less than 1% of the respondents in Dundori division.

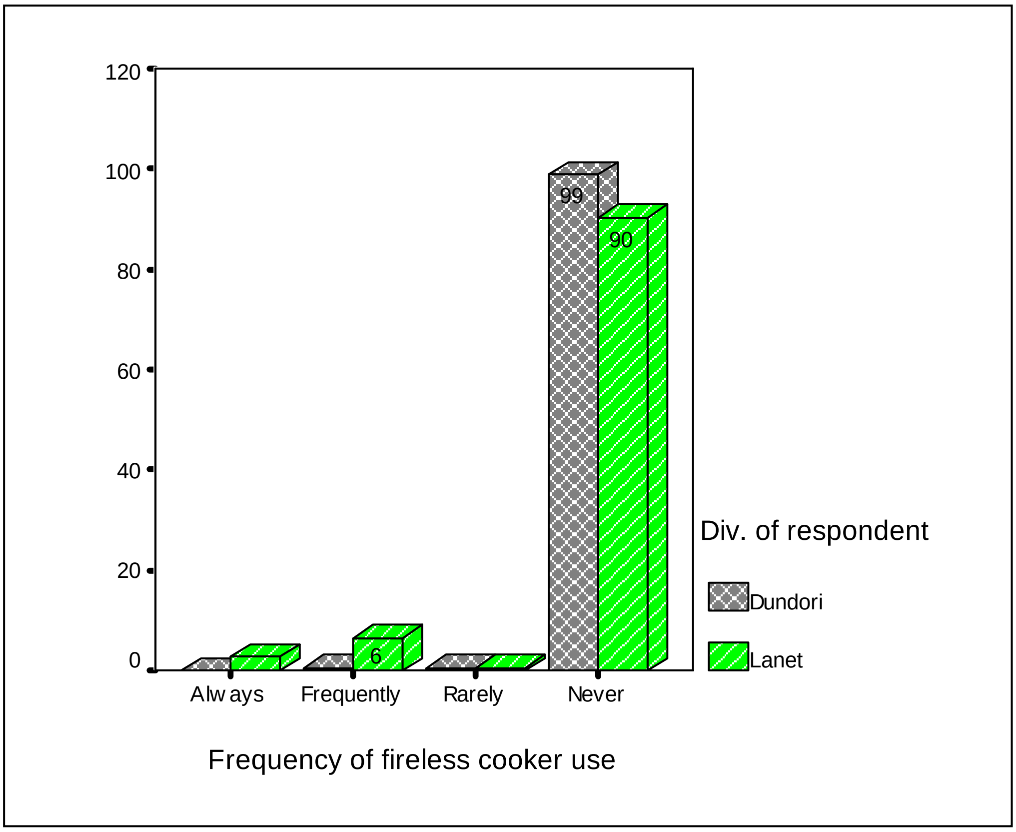

Figure 4.8: Comparing the rating of fireless cooker use

The low acquisition of fireless cooker by rural households can be attributed to the fact that most of the respondents were unaware of the technology as only 33% in Dundori and 53% in Lanet had ever heard about the technology. This findings of very low adoption in the rural area seems to tally with those of Taulo et al (2008) in a study done in the rural districts of Malawi where the adoption rate was 1.1%. UNEP (2006) had projected a 10% adoption of the fireless cookers by the year 2010 from 3% in 2004 in the rural areas of Kenya. This has not been achieved and thus the need to readdress the hindrance to this target being achieved. This technology if accepted by the household would help in saving time for the woman, releasing her to be engaged in other domestic chores or income generating activities instead of spending much time cooking. It will also reduce duration of exposer to indoor air pollutants as the food being cooked is heated on fire for a relatively shorter time. Taulo et. al (2008) attributed the low adoption of the fireless cooker to several factors such as household size, extension work, marital status as well as education level.

Table 4.16: The mean and standard deviation of devices acquired in Lanet and Dundori division

	Division of respondent	N	Mean	Std. Deviation	Std. Error Mean
Number of KCJ	Dundori	198	.85	.359	.026
	Lanet	186	.94	.246	.018
Number of Improved Fwood stove	Dundori	198	.096	.295	.021
	Lanet	186	.011	.103	.008
Number of fireless cooker	Dundori	198	.025	.157	.012
	Lanet	186	.086	.281	.021

Table 4.17: Comparing adoption of the energy saving technologies in Nakuru The Independent Samples t-Test

	t	df	Sig. (2-tailed)
No. of KCJ	-2.749	382	.006
No. of *Kuni mbili* stoves	3.726	382	.000
No. of fireless cooker	-2.634	382	.009

4.4 Awareness level of households on weather variability and need for environmental conservation

This study also sought to find out the extent to which respondents were aware of weather variability in their surrounding some of which could be attributed to unsustainable use of biomass energy and the need to conserve the environment.

4.4.1 Household's perception on weather variability

A majority of the respondents in Dundori (81.31%) and Lanet (68.82%) agreed to the statement that rainfall amount had been decreasing for the last ten (10) years (2000-2009) (Table 4.18). Only less than 4% of the total sample disagreed with the statement. This was in agreement with the weather data obtained from meteorological station Nakuru which showed that there had been a decrease in the amount of rainfall between 2001-2009 at the mean rate 42.6 mm per year (Appendix 4.2).

A majority of the respondents in both the rural (79.8%) and the urban (68.28%) areas either disagreed or strongly disagreed with the statement that the mean temperature had been decreasing for the last 10 years (Table 4.18) while 17% of Dundori and 25.8% of Lanet respondents agreed with the statement. In other words the majority of the households perceived that the mean monthly temperature has been increasing for the last 10 years. This agrees very well with the finding from the meteorological department Nakuru whose records showed that there was an average mean increase in temperature per year between 2000-2009 of 0.198 ^{0}C. It also means that more people in the rural area had better perception of the changes in temperature as compared to those in the urban areas. This could be due to the immediate impacts of deforestation that had taken place in Dundori forest within the division.

There was not much difference in the respondents' perception of the changes in the rainfall pattern as majority of the respondent both in Dundori (95.45%) and Lanet (97.85%) either agreed or strongly agreed to the statement that the rainfall pattern had changed for the last 10 years (Table 4.18). The findings agrees with those of Walubengo (2007) who found out that the majority of people in Njoro Division (Nakuru County) were of the opinion that the rainfall pattern had changed where the rain came when not expected and when it came it was torrential..

In a study done by Ovuka and Sven (2000), in Murang'a it was found out that a majority of those interviewed said that there was a decreasing trend in rainfall and in the number of storms. They also stated that the rain periods started later than normal and the rains were less reliable during the period under study upto the late 1990s.

Table 4.18: Levels of Awareness of weather changes in Nakuru

			Rainfall amount has decreased				
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Division of resp.	Dundori	%	16.16	81.31		2.53	
	Lanet	%	24.19	68.82	2.69	3.76	0.54
			Average temperature has decreased				
Division of resp.	Dundori	%	2.02	15.15	3.03	68.69	11.11
	Lanet	%	3.76	22.04	5.91	36.56	31.72
			Rainfall pattern has changed				
Division of resp.	Dundori	%	14.14	81.31	0.51	4.04	
	Lanet	%	27.96	69.89	0.54	1.61	

The study found out that a majority of the households were very much aware about the weather parameters such as rainfall pattern and amount as well as temperature changes. The high level of awareness could be attributed to the vigorous campaign by the government through the Kenya Meteorological department in 2009 to sensitize people concerning changes in weather and the need to conserve the water catchment areas. The weather changes has implication on biomass supply as the rate of renewability of this source of energy might be interfered with and thus the need to support conservation efforts to ensure sustainable supply of this very important form of energy which majority of the people of this country depend upon.

According to the Provincial Meteorological Officer Rift Valley Province Mr. Ramtu, the weather changes especially the increase in the mean temperature and the decrease in rainfall amount can be attributed to the deforestation of the forests especially the Dundori, Bahati as well as the Mau. There is thus a greater need to ensure forested area are conserved due to the meteorological function that they play, assisting in moderation of the weather conditions and as a source of woodfuel.

There were strong correlation in the responses on items relating to weather characteristics (Appendix 4.3) such that those who agreed to the statement that rainfall pattern has been changing were also likely to state that the amount of rainfall has been decreasing for the last 10 years (r-0.516, p value-. 000) while they also disagreed with the statement that the mean temperature has been decreasing for the last 10 year (-0.252 p value .000).

4.4.2. Awareness on the woodfuel-related factors that can affect weather pattern.

Most of the respondents (55%) agreed that cutting down of trees for firewood affects the weather patterns of their surrounding areas. Another 42% strongly agreed to this statement; and it was only about 3% (Fig. 4.9) of the respondents who disagreed. About 4% of those in Lanet (urban) disagreed with the statement that cutting down of trees affect the weather pattern as compared to 2% in the rural area of Nakuru

Cutting down of trees from forest or woodland leads to degradation of the land, and eventually the land becomes bare thus increasing the albedo. Increase in the albedo can end up increasing the mean temperature of the surrounding area and eventually interfering with the evaporation -condensation process thus affecting the rainfall formation. Many of the respondents were aware of the fact that forest assist in moderation of the weather conditions of an area.

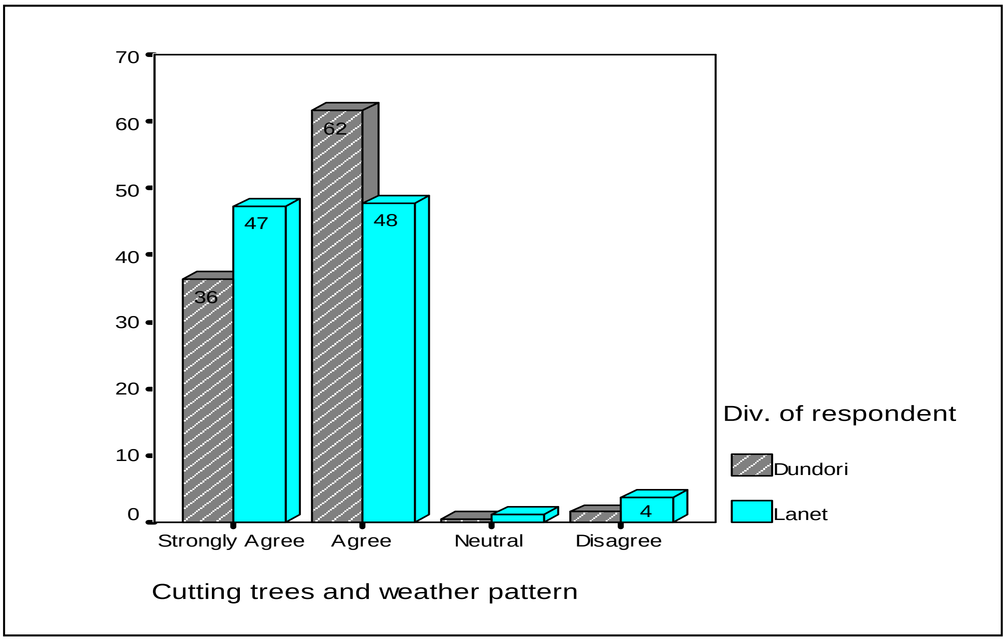

Figure 4.9: Cutting down trees for firewood affects the weather patterns

4.4.3 Ratings on the need for environmental conservation

Majority of the respondents (70%) strongly agreed that they would need to plant trees in order to conserve the environment, while 27% agreed to the same. This implies that majority of the respondents are aware of the role of trees in environmental conservation.

About 50.2 % of the respondents strongly agreed while 47.1% agreed with the statement that pollution of the natural environment can be reduced by use of charcoal instead of firewood. About 42% disagreed with the statement while 7.8% did not have an answer to the statement (Fig 4.10). The finding means that many of the households were not aware of the greater harm charcoal making and use has on the natural environment as one has to use more biomass to make charcoal than when using the fuelwood directly. Majority of them could have been right if it was in reference to indoor air pollution as charcoal is a more cleaner form of fuel as compared to fuelwood. According to Bhattarai (1998) the average conversion ratio of charcoal is 5:1 which means that 5 kg of air dried fuelwood when burnt produces one kilogram of charcoal. Thus there is need for public awareness creation on issues relating to the pollutants emitted by different types of fuels and the impacts each type of fuel use has on the natural environment so that households can make informed decisions on what fuel to use.

Many of the respondents strongly agreed on the importance of planting trees (almost 100%) in order to mitigate against weather changes and thus promote environmental sustainability as households will be assured of continuous source of woodfuel. Thus the need to encourage the planting of trees in form of woodlot or on boundary planting as well as involve the local communities in managing forests in their area.

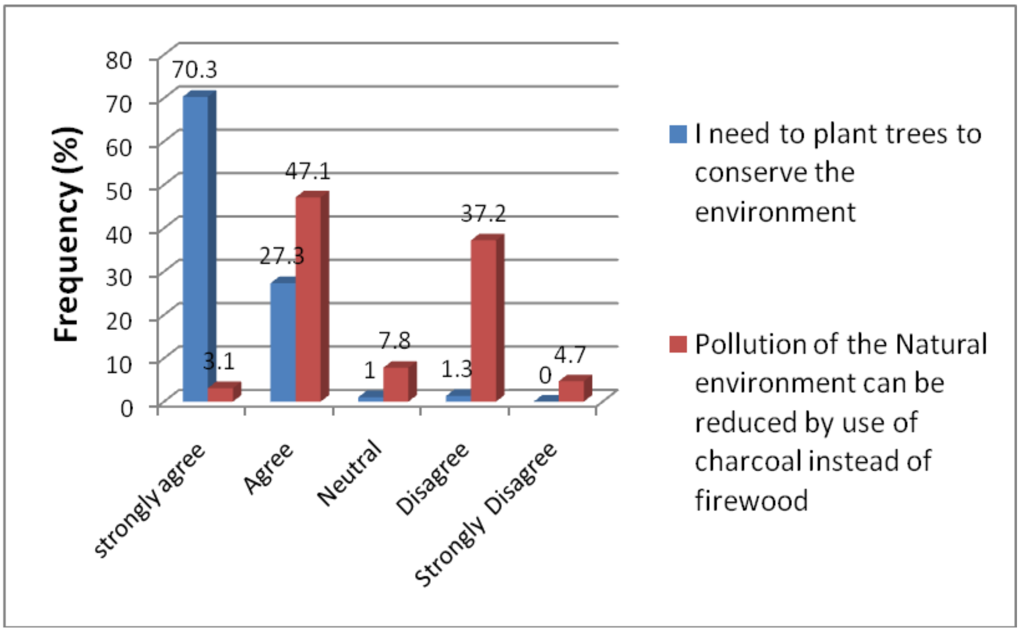

Figure 4.10: Ratings on what should be done to conserve the environment

4.4.4 Initiatives relating to energy efficient technologies dissemination and environmental conservation in the study area.

4.4.4.1 Role of NGOs (SCODE)

Sustainable Community Development is one of the major NGO which was involved in promotion of energy efficient stoves and other renewable forms of energy technologies. It was based within Nakuru County in Bahati division neighbouring the study area.

According to one of its managers the NGO is a Kenyan development organization which was registered in 1996 as an NGO. Its mission is to enable the poor to improve their quality of life by adopting technologies and approaches that are environmentally friendly and contribute towards sustainable development.

The NGO is involved in the promotion of renewable energy technologies such as:

> Biogas generation, Solar PV systems, Solar vegetable drying panels, Improved cookstoves such as KCJ, *Kuni mbili*, *Maendeleo* liners and Rocket stoves.

Plate 1: Improved modified Kuni Mbili stove, Rocket stove and Maendeleo liners made by SCODE

The organization implemented an improved cookstove dissemination enterprise development project that aimed at delivering 22,500 stoves to households within the study area and also in other parts of the country. It had also been involved in training users and installers on effective use of the improved cookstoves to save energy reduce indoor air pollution and build capacity of organized groups to continue acquiring and using the improved stoves beyond the project period. The organization was involved in producing good quality and durable stoves though relatively expensive compared to those produced by local artisans.

Currently they are also involved in doing repair and maintenance works for those households whose stoves needs repairs in terms of installing good quality liners. They reported that there were many poor quality stoves in the market as it was evidenced by the huge number of stoves brought to them whose inner ceramic liners were broken.

Their approach of extension was *demand driven* where organized groups in need of help would go to them for whatever assistance that they needed e.g training, installation of liners or purchase of the improved cookstoves. They also worked in collaboration with relevant ministries e.g Ministry of Agriculture through the extension department. From the study findings NGO's impact in the study area was low especially in terms of dissemination of the fuelwood improved stoves and other renewable technologies such as biogas digesters installation.

4.4.4.2 LANAMEDUBA

This is a community based project funded by community environment facility under the World Bank whose goal was to restore and sustainably manage the upper-Lake Nakuru catchment and its natural resources for improved socio-economic development of the people.

It had been involved in restoring the catchment value by increasing forest/tree cover- including development of integrated management plans for Dundori and Bahati forests, providing adjacent forest communities with alternative income sources through initiation of nature-based micro-enterprises, promoting sustainable land use practices for enhanced farm productivity and enhanced soil and water management measures, enhancing good governance and management of forests and land based natural resources through advocacy and capacity building and collaboration among different stakeholders.

The CBO had been involved in distributing improved cookstoves to those involved in forest conservation activities in order to reduce demand on woodfuel and also trained on how to use them.

According to one officer who worked for them, the creation of awareness on energy saving initiatives and offering of alternative livelihoods had enabled the community to be an integral part of conservation. The organization initiated a project to plant 200,000 trees in more than 60 acres of Bahati and Dundori forests. Those member of the community involved in re-afforestation efforts were also provided with seedlings to plant in their own farms as a way of promoting agroforestry as well as establishment of woodlots among the households in Dundori Division. It was reported by the Dundori divisional agricultural extension officer that already the community in Dundori Division had been provided with 2 acres of land and bee hives where they were apiculture as a way of promoting nature based micro-enterprises.

This is quite a commendable initiative in which if all the surrounding community would embrace, it would go a long way in assisting in forest and environmental conservation in the study area. The NGOs impact was already starting to be felt through the diffusion of the improved cookstoves as the researcher found out while collecting the data.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the findings of the research study, the most commonly used form of fuel by households in Nakuru County was woodfuel. Charcoal was mostly used in the urban areas (85.5%), while in the rural areas firewood was mostly used (69%). The other forms of fuel used by households in the study area were kerosene (7%), LPG (5%) and electricity (1.1%). Crop residue was not always used in the County since it was mostly a seasonal type of fuel, with about 42% of respondents using it sometimes in the rural areas.

Most of the respondents in the urban division of Lanet in Nakuru County had acquired the improved charcoal cookstove (93.5%) as compared to the rural parts of County (81%). Majority of those who had acquired the cookstoves commonly known as *Kenya ceramic jiko* (KCJ) also often used it in their daily cooking activities though its use was more common in the urban (84%) than the rural areas (51%). It was found out that the level of adoption of KCJ was significantly higher among the urban households as compared to the rural households with a t-test value of -2.746 and a p value of 0.006 at 95% confidence level.

The adoption of the firewood cookstoves (e.g *Kuni mbili* and *Upesi jiko*) was found to be very low with only 9.18% of rural and 1.08% of the urban households having acquired it. The difference in adoption of the improved firewood stove was significantly higher in rural as compared to urban households with a t-test value of -3.726 and a p value of 0.000 at 95% confidence level.

Adoption of fireless cookers was very low in both Lanet (8.06%) and Dundori areas (1.53%). The difference in acquisition and use of fireless cooker was significant with a t-test value of -2.634 and a *p* Value of 0.009 at 95% confidence level. Cost was one of the major factors contributing to low adoption as well as lack of information relating to the technology.

Some of the factors identified that could influence adoption of woodfuel conservation technologies were income of the household (r – 0.230), level of education of the heads of the household (r-0.230), number of dependants (t-value -3.365), cost of fuelwood stoves (t value -6.658), cost of the KCJ (t - value 7.161) and the cost fireless cooker (t value -11.385). It was also found out that majority of the respondents in the rural areas (67%) had never heard of a fireless cooker. This could also be a factor that influenced its adoption

From the study it was found out that a majority of the respondents (89%) in the study area recognized that there had been weather changes. Majority of the respondents were in agreement that cutting down of trees could negatively affect the weather,

Majority of the respondents perceived the use of charcoal as a better option for natural environmental conservation as compared to use of firewood. This implied that those respondents who used charcoal did not think that it has greater negative impacts on the natural environment as compared to firewood especially when considering the charcoal making process and thus would encourage switching to charcoal as a better option yet this might not be the solution.

5.2 Recommendations and Policy implications

- There is need for aggressive campaign in dissemination of improved stoves (*maendeleo* stoves and *Kuni mbili*) technology in order to reduce pressure on forest and other woodlands surrounding Dundori division.
- An energy centre needs to be established in the Nakuru County which can act as the focal point for dissemination of energy efficient technologies.
- It is important to build capacity of field extension staff in the energy sector ministries e.g Ministry of environment, Ministry of energy, Ministry of forestry and wildlife as well as ministry of agriculture in order for them to acquire the necessary skills to assist in promoting adoption of energy efficient technologies.
- There is need for standardization in the design and making of energy efficient stoves so that quality may not be compromised in expense of quantity in order to make more money. Compromise of quality may make households revert back to metallic stoves which lasts longer but are energy inefficient.
- One of the major factors identified by this study that influences adoption is the cost of the technologies especially the improved fuelwood stove and the fireless cooker whose costs negatively influences adoption. It is recommended that the government and other donor agencies can look for ways in which production of these technologies can be subsidized.

- The number of households using other forms of energy (e.g solar energy, biogas) was negligible despite the fact that in the study area there are many dairy farmers especially in the rural areas and also solar energy is readily available. The main constraints might be information as well as the initial cost of installing these forms of technologies, thus there will be need for concerted effort to promote the use of these cleaner forms of energy in the area. This will exceedingly reduce demand on woodfuel as people switch to these alternative forms of renewable technologies and therefore save the forests and woodland, reduce women drudgery, reduce indoor air pollution and eventually improve the local environment.

- The government needs to streamline the making and distribution of charcoal as a fuel since it is being used by a majority of the Kenyans, both in the urban and the rural areas.
- Awareness level on weather changes in the study area and the need to plant trees as a way of environmental conservation was quite high thus initiatives promoting planting of trees in forms of woodlot, agroforestry or as hedges in farms should be encouraged. Re-afforestation and afforestation efforts in the area should be given full support by the government which aims at increasing the countries forest cover to 10%. If considered and supported such initiative will make households self reliant in woodfuel since majority of the household indicated they depended on purchasing woodfuel to supplement these scarce resource.

5.3 Areas for further research

There is a need for detailed study on the:

- Sources of woodfuel (charcoal and firewood) both in urban and rural areas.
- Comparative study on the amount of pollutants emitted by traditional stoves and improved stoves using different types of woodfuel.
- Adaptation mechanism by households in relation to woodfuel shortage in the light of climate change.

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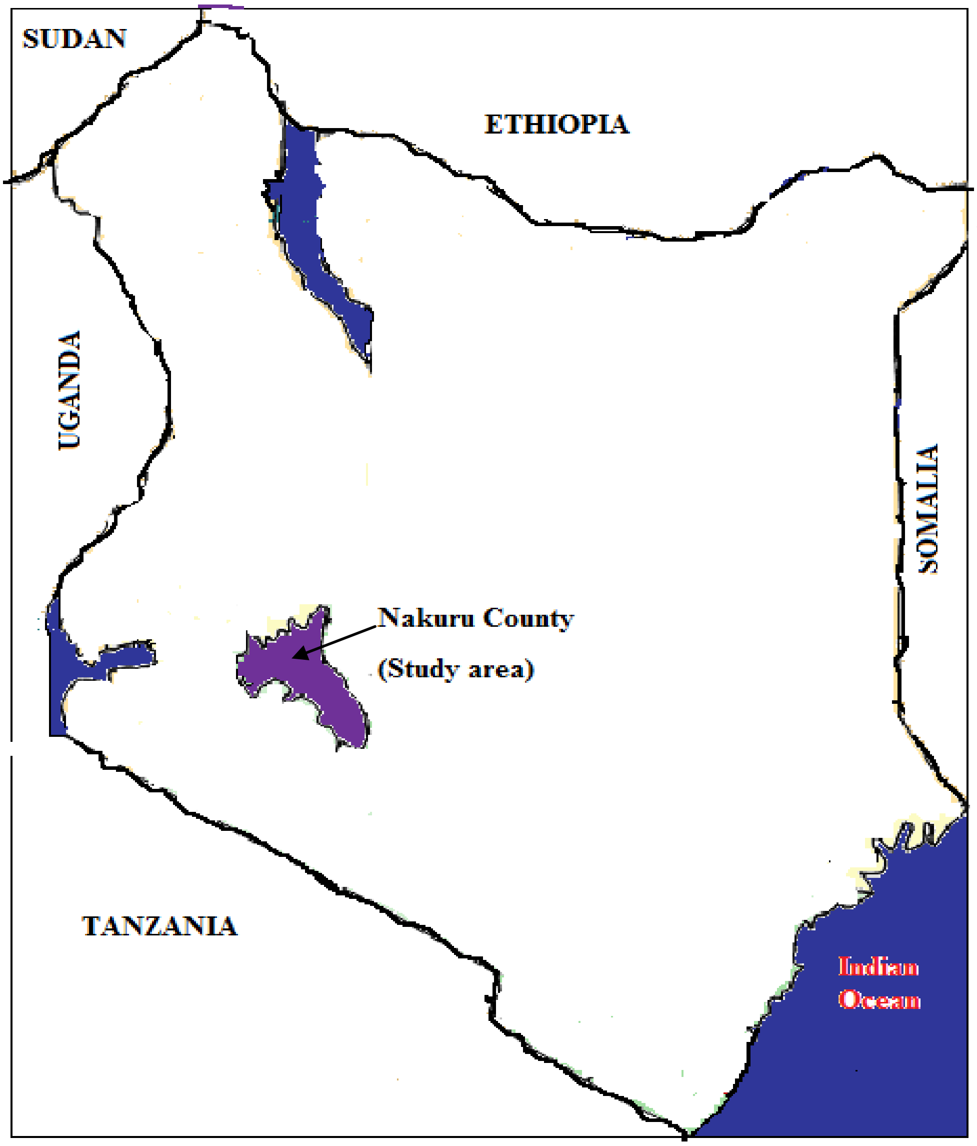
APPENDICES

APPENDIX 1



Map of Kenya showing the study area.

Source: Modified from www.bushdrum.com

APPENDIX 2.0

QUESTIONNAIRE FOR THE HEAD OF HOUSEHOLD RESPONDENTS

No……………….

Division…………..

Location………….

Sub location………..

Please fill the following questionnaires as frankly as possible (Tick √) where appropriate.

1. Gender 1. ☐ Male 2. ☐ Female
2. Area of residence 1 ☐ Urban 2 ☐ Suburban 3 ☐ Rural
3. Age bracket 1. ☐ 18-25 2. ☐ 26-33 3. ☐ 34-41 4. ☐ 42-49
   5. ☐ 50-57 6. ☐ 58-65 7. ☐ 66 and over
4. Level of education
   ☐ None ☐ Primary ☐ Secondary
   ☐ College ☐ University
5. Marital status
   ☐ Married ☐ Single ☐ Separated
   ☐ Widowed ☐ Divorced
6. Indicate your employment status
   ☐ Formally Employed ☐ Informally employed
   ☐ Self –employed ☐ Unemployed

7. Indicate average household income per month

☐ Less than Ksh.5,000 ☐ Ksh.5001- 10,000 ☐ Ksh10, 001-15000

☐ Ksh. 15,001- 20,000 ☐ Ksh 20,001- 30,000

☐ Ksh. 30,001- 50,000 ☐ Ksh. 50,001- 100,000 ☐ Over 100,000

8. Indicate the number of people who depend on this income……………….

9. Indicate whether the house is rented or owned

☐ Rented ☐ Owned

10. Indicate the type of the house.

☐ Grass thatched, ☐ Timber House Iron sheet ☐ Stone House

☐ walled, Iron sheet roofed. ☐ Stoned walled, tile roofed

☐ Others………………………….

11. Rate the following energy fuels that you mostly use in your Kitchen activities

Indicate 1 Not used, 2. Rarely used, 3. Some times used 4. Always used .

☐ Electricity ☐ Gas ☐ Kerosene ☐ Charcoal

☐ Wood fuel ☐ Crop residue

☐ others (specify)……………………………………………

12. Indicate the source of your Charcoal

☐ Buying ☐ Forest ☐ Woodlot

☐ Others, Specify………………………………………………

13. Indicate the source of your Firewood

☐ Buying ☐ Forest ☐ Farm ☐ Woodlot

☐ Others specify…………………………………………………….

14. Have you ever heard of the following energy conservation devices?

Improved firewood stove (Kuni Mbili, Upesi Jiko) ☐ Yes ☐ No

Improved charcoal jiko(KCJ) ☐Yes ☐No

Fireless cooker ☐Yes ☐ No

15. If yes from who did you get the information?

☐ Government extension workers ☐NGOs ☐ Traders

☐ Women group ☐ Others(specify)

…………………………………………………………………

16. Do you know of any promoters of woodfuel conservation technologies in this division? ☐ Yes ☐ NO

If Yes name one promoter…..…………………………………………….

17. Which of the following woodfuel energy conservation devices have you acquired for your kitchen?

Device	**Source**	**Cost/unit**
Improved firewood stove	…………………	……………….
Improved charcoal jiko	…………………	…………..
Fireless cooker	……………………	……………

If you possess the outlined devices in Question 16, **Answer** questions 17-21

18. How long does the improved woodfuel stove last?

☐1yr ☐2yrs ☐3yrs ☐4yrs

☐Others (specify)…………………………

19. Between the traditional 3 stone stove and the improved firewood stove, which is easier to use? ……………………………………………..

20. Between the metallic stove and the improved charcoal stove (KCJ), which is more convenient to use?

………………………………………………………..

21. Is there any difference in the woodfuel consumption between the traditional stoves and the improved stoves?

☐ Yes ☐ No

If yes what is the difference?

....

22. How often do you use a fireless cooker?

☐ Always ☐ Frequently ☐ Rarely ☐ Never

23. Rate the following energy fuels devices that you mostly use in your Kitchen activities

Indicate **1** for Never used, 2. Rarely used 3.Used sometimes, 4. Always used.

☐ Electric cooker ☐ gas cooker

☐ Paraffin stove ☐ improved charcoal stove(KCJ)

☐ Improved Firewood stove (*Kuni Mbili* *or upesi Jiko*)

☐ Three stone

☐ Others

(specify)………………………………………………………………………………

……………………………………………………………………………………….

QUESTIONS ON PERCEPTION ON WEATHER CHANGES AND THE WILLINGNESS TO BE INVOLVED IN ENVIRONMENTAL CONSERVATION

Please circle the number that best describes your feelings about woodfuel use and climate change on the following statements.

1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

1. The rainfall pattern in Nakuru has been changing for the last 10 years.

1 2 3 4 5

2. The average temperature in Nakuru has been reducing for the last 10 years.

1 2 3 4 5

3. The average amount of rainfall in Nakuru has been decreasing for the last 10 years.

1 2 3 4 5

4. Rivers are drying up because of weather changes

1 2 3 4 5

5. Cutting down of trees for firewood affects the weather pattern.

1 2 3 4 5

6. Pollution of the environment can be reduced by use of charcoal instead of firewood.

1 2 3 4 5

7. I need to plant trees to conserve the environment

1 2 3 4 5

APPENDIX 3.0

COPY OF INTRODUCTION LETTER BY HOD (ENVIRONMENTAL SCIENCE) –KENYATTA UNIVERSITY.

KENYATTA UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCES
P.O. Box 43844 Nairobi – Kenya Tel: (254)(2) 810901-12 Ext 57223

September 11, 2009

TO WHOM IT MAY CONCERN

RE: PAUL KURIA NJOGU

This is to confirm that Mr. Paul Kuria Njogu is a registered student in the Department of Environmental Sciences, Kenyatta University, Registration Number N50/10692/2007. He is a post graduate student pursuing a Master of Environmental Studies degree programme.

As a university requirement, he is expected to carry out research work in order for him to complete his degree programme. Please accord him the necessary assistance

Thank you,

KENYATTA UNIVERSITY
CHAIRMAN, DEPARTMENT OF
11 SEP 2009
ENVIRONMENTAL SCIENCES
P.O. Box 43844 - 00100, NAIROBI

PROF JAMES B KUNG'U
CHAIRMAN, DEPARTMENT OF ENVIRONMENTAL SCIENCES

JBK/mn

APPENDIX 4.1

SUMMARY OF ANOVA TEST FOR INDEPENDENT AND DEPENDENT VARIABLES

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.363588	1	15.364	113.069	0.000
	Residual	51.633794	380	0.136		
	Total	66.997382	381			
2	Regression	21.148287	2	10.574	87.408	0.000
	Residual	45.849095	379	0.121		
	Total	66.997382	381			
3	Regression	25.872454	3	8.624	79.269	0.000
	Residual	41.124929	378	0.109		
	Total	66.997382	381			
4	Regression	27.071341	4	6.768	**63.905**	0.000
	Residual	39.926041	377	0.106		

1 Predictors: (Constant), Cost of fireless cooker

2 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove

3 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove

4 Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove, Number of dependants per household

- Dependent Variable: Number of devices acquired

APPENDIX 4.2:

AMOUNT OF RAINFALL BETWEEN 2000-2009 IN NAKURU COUNTY

YEAR	AMOUNT OF RAINFALL
2000	609.8
2001	1214.4
2002	1013.7
2003	1110.6
2004	891.7
2005	885
2006	973.7
2007	1217.3
2008	826.7
2009	706

Source: Kenya Meteorological weather data-2009

APPENDIX 4.3:

CORRELATIONS ON AWARENESS OF WEATHER CHANGES ITEM RESPONSES

			Rainfall amount has decreased	Rainfall pattern has changed	Average temp. has decreased
Spearman's rho	Rainfall amount has decreased	Correlation Coefficient	1.000	516(**)	-.252(**)
		Sig. (2-tailed)	.	.000	.000
		N	384	384	384
	Rainfall pattern has changed	Correlation Coefficient	.516(**)	1.000	-.204(**)
		Sig. (2-tailed)	.000	.	.000
		N	384	384	384
	Average temp. has decreased	Correlation Coefficient	-.252(**)	-.204(**)	1.000
		Sig. (2-tailed)	.000	.000	.
		N	384	384	384

** Correlation is significant at the 0.01 level (2-tailed).