Kenya's Water Towers Protection and Climate Change Mitigation and Adaptation (WaTER) Programme

Component 4: Science to Inform Design of Community-Level Actions and Policy Decisions

Baseline Survey Report on Energy Sources in Mt. Elgon and Cherengany Ecosystems

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(KEFRI)

Baseline Survey Report on Energy Sources in Mt. Elgon and Cherengany Ecosystems

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We also appreciate the contributions made by the communities of Mt. Elgon and Cherangany Sub-counties for their cooperation during the baseline survey, key informant interviews and Focus Group Discussions.

Affirmation

We affirm that this baseline survey report consists of the findings of the study that was undertaken through gathering information on the baseline on energy sources in the counties of Bungoma, Nandi, West Pokot, Kisumu, Kakamega and Uasin Gishu which is among the eleven counties in which the project is being implemented.

The development of this report has been guided by the Terms of Reference, provided by KEFRI and contributions of individuals and community through key informant interviews, focus group discussions and individual respondents during the study.

This Baseline Survey Report remains the property of KEFRI. Information and data collected must be used only with their consent.

List of acronyms and abbreviation

EC	Ecosystem Conservator
FGDs	Focus Group Discussions
KIIs	Key Informant Interviews
KPLC	Kenya Power and Lighting Company
KWS	Kenya Wildlife Service
LPG	Liquefied Petroleum Gas
NGOs	Non-Governmental Organizations
CBO	Community Based Organizations
GDP	Gross Domestic Product
GoK	Government of Kenya
HH	Households
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
UNEP	United Nations Environment Programme

EXECUTIVE SUMMARY

This Study was based on Component 4 which is on: “Science to inform design of community-level actions and policy decisions”. This EU funded project is expected to support Kenya to reduce poverty through enhancing the productivity and resilience to climate change of Kenya’s water sources. The project is a community Initiative Partnership between the Government of Kenya (GoK) and EU. The Project is being implemented in Mount Elgon and Cherangany Hills Ecosystems.

The ability of Kenya's water towers to continue providing critical ecosystem services, in a sustained manner to adjacent communities and beneficiaries further afield is being threatened by deforestation and land degradation. Deforestation had reduced Kenya’s forest coverage from 10% in the 1960s to 3% in the 1980s (Vison 2030), however, the government initiatives in re-afforestation has increased it to the current 6.9%. Deforestation costs the Kenyan economy an estimated KES 5.8 billion per year (UNEP, 2012). An estimated 50,000ha lost between 2000 and 2010, has resulted in cumulative negative effects amounting to KES 3,652million/year, more than 2.8 times the cash revenue of deforestation (UNEP 2012a). The contribution of forests to Gross Domestic Product (GDP) is estimated at 3-3.6% excluding environmental services and contributions to other sectors (UNEP, 2012).

The baseline survey was undertaken in 6 out of the 11 targeted Counties. The criteria of choosing the Counties were based on the Counties homogeneity to the ecosystem while the households were selected using simple random sampling. The baseline survey aimed at generating baseline data on energy sources and potential energy interventions among communities in the study area.

The socio-economic and livelihood profile of the households indicate that the average gross monthly household income from below KShs. 5,000 to those earning above KShs 40,0000 with majority (22.2%) earning between KShs 20,0001 and KShs. 30,000. In terms of formal education, of all the household heads who completed primary education, 60.2% were males, while 39.8% were females, among those who finished secondary school education 88.4 % of the household heads were males while 11.6% were female, 82.6 % of household heads completed college were males

while 17.4% females, 83.3% of those who have completed university were males while 6.7% were female. This implies that more of the males are literate as compared to the females. The type of housing for the households were surveyed. In overall, majority of the respondents (48%) were having mud walled houses.

The study identified firewood, charcoal, electricity, paraffin, solar, LPG gas as energy sources utilized in Mt. Elgon and Cherengany ecosystems. Other sources identified included saw dust, crop residues (Maize stalk, maize cobs) and biogas. The main source of energy for majority (91%) of the households was firewood and charcoal (52%).

The situation on preferred source of energy (firewood and charcoal) over the past five years had improved as indicated by 50% of the respondents, 30% indicated no change, while 20% indicated that the situation had worsened.

The tree species used for firewood and charcoal in order of preference were *Ecalyptus Sp, Grevillea robusta, Cupressus lusitanica, Markhamia lutea, Mangifera indica, Persea Americana, Acacia mearnsii, Pinus patula, Croton macrostachyus, Albizia coriara, Psidium guajava, Jacaranda mimosifolia, Ficus sycomorus, Acacia Sp, Euphorbia tirucali.*

Of all the households surveyed across the Counties, 62% sourced firewood from existing exotic trees from the farm while 45% sourced from indigenous trees from the farm. 47% purchased charcoal from sellers while 29% sourced charcoal from either existing indigenous trees on farm or exotic trees from the farm.

Charcoal production in all the Counties is still done using the traditional earth kiln. The low adoption of the improved charcoal conversion technologies may be linked to low awareness on improved methods of charcoal production as indicated by 96% of the households in all the Counties.

Majority (79%) of the households still use the traditional three (3) stones for cooking. A number of initiatives on the introduction of improved cook stoves were noted in all the counties studied.

However the adoption rate is still low as some households indicated lack of knowledge on their use and high cost of purchase as reasons for low adoption rates.

Several energy intervention initiatives are currently going on, including tree planting, introduction of improved cook stoves and use of alternative sources of energy. Despite the initiatives to ensure energy sustainability, fuel wood energy is still not economically and environmentally sustainable in the Counties surveyed. More deforestation has been experienced in these Counties mainly due to population increase and need for income. To reduce further deforestation due to high demand of firewood and charcoal, the following possible intervention measures are suggested to ensure sustainability within the study area.

- Promote integration of wood fuel production on farm
- Promote use of improved charcoal production technologies and sensitization on charcoal rules
- Promotion of improved cook stoves with higher energy efficiency
- Promote use of alternative sources of energy
- Strengthen of existing energy centres

1.0 INTRODUCTION

Kenya is endowed with significant amount of renewable energy resources, which include: hydropower, geothermal, biomass, solar, wind, among others. Biomass, petroleum and electricity are the main sources of energy in Kenya accounting for 74.6%, 19.1% and 5.1% respectively (Kiplagat, 2011).

Kenyan communities use several energy sources which include firewood, charcoal, Liquid petroleum gas (LPG), paraffin (Kerosene), electricity and agricultural and sawmill wastes. However, the major energy source is wood fuel which contribute to 70% of the National energy demand where over 90% rural households use it inform of firewood or charcoal (MoE, 2002; Kituyi, 2002). Besides being the standard cooking fuel for the majority of Kenyan households, fuelwood is also an important energy source for small-scale rural industries such as tobacco curing, tea drying, brick making, fish smoking, and bakeries, among others. However, despite its importance, the available data is scarce and uncertain which is mainly due to the fact that it is handled in the informal sector and does not pass through monetized economy like in the case of liquefied petroleum gas (LPG), kerosene and electricity which are alternatives to wood energy (Githiomi *et al* 2011).

Firewood is increasingly supplied from private smallholder lands and farm woodlots. Charcoal, on the other hand, is mainly an urban fuel, 82% of urban households depend on it as part of their energy mix, compared to 34% of households using charcoal in rural areas (GTZ 2007). Wood fuel is not only an important source of household energy but its use relates to public sector interests such as environment, public health, rural development and employment. It provides income to over 3 million people (ESDA, 2005; Republic of Kenya, 2002a).

Charcoal is produced inefficiently using traditional earth kilns whose efficiency range between 10–13%, yet higher recoveries of between 30-40% have been achieved using brick kilns. Biomass comes from various forest formations such as closed forest, woodlands, bush lands, wooded

grasslands and, farms with natural vegetation and mixtures of native and exotic trees, industrial and fuel wood plantations, and residues from agricultural crops and wood-based industries. However, although there are apparently large wood volumes available from the various vegetation types, not all of it is accessible for energy. Accessibility depends on a number of factors such as legal issues, environmental issues, ownership, and objectives of management, distance, and infrastructure (GTZ 2007).

Although there are several bio-digesters installed in Kenya, most of them operate below capacity or are currently in disuse due to management, technical, socio-cultural beliefs or economic problems. Biogas is widely used in institutions due to their high potential of waste utilization for biogas generation.

Large areas of Kenya's forest resources are not accessible due to legal or environmental restrictions, ownership, management issues, distances or infrastructure. Fuel wood demand for the country is projected at 30.4 million tons per year while its supply is projected at 53.4 million tons per year, representing a deficit of 19.6 million tons (MOE, 2002 report). The massive deficit in fuel wood supply has led to high rates of deforestation in both exotic and indigenous vegetation resulting to adverse environmental effects such as desertification, land degradation, droughts and famine among others. It is in an effort to reduce these problems that PSDA through collaboration with other Development Partners initiated "*Promotion of Improved Energy Stoves*" in January 2006.

Petroleum fuels are the most important source of commercial energy in Kenya, and are mainly used in the transport, commercial and industrial sectors. The country relies entirely on imported petroleum products (Ministry of Energy, 2004).

The major sources of electricity are hydro, geothermal and thermal power. The installed power capacity, in June 2005, was 1155.0 MW. The breakdown was: hydropower at 677.3 MW, oil thermal power at 344.2 MW, geothermal power at 128 MW, and wind power at 0.4 MW (KPLC, 2005).

The high number of biomass energy consumers in Kenya is as result of the rapidly increasing populations, urbanizations, high poverty levels and relatively high prices of alternative energy

sources such as Liquid petroleum gas (LPG) and electricity. Due to the high demand of wood as a source of energy for cooking and heating by rural communities, it is important to have its sustainable production and utilization assured to avoid scarcity which may lead to over-exploitation of natural resources leading to environmental degradation. Other negative factors to scarcity of firewood as source of energy in the rural poor communities includes increased collection time and health effects for women and children as result of walking long distances and carrying heavy loads, increased use of agricultural residues leading to loss of soil fertility and food insecurity among others.

The first national energy policy (Sessional Paper No. 4 of 2004 on Energy), which came into effect in 2004, contains specific measures to be undertaken by the government aimed at promoting the use of renewable energy. This policy was developed in response to service delivery survey of August 2002 which indicated a number of policy gaps within the Energy sector including lack of clarity on renewable energy, petroleum, geo-exploration and rural electrification. Moreover, new challenges in the now liberalized economy required new policy measures. This policy sets out the national strategies for the short-term, medium-term and long-term that will ensure adequate, quality, cost effective and affordable supply of energy to meet the development needs while protecting the environment. (Kiplagat, 2011).

Important aspects of energy policy include climate change and energy security, energy reliability, energy affordability, and market competitiveness for businesses, industries and households. (Stigka, 2014). There has been increasing demand for energy and associated services to meet social and economic development and improve human welfare and health. All societies require energy services to meet basic human needs including lighting, cooking, space comfort, mobility and communication to serve productive processes. Since around 1850, global use of fossil fuels; coal, oil and gas has increased to ensure energy supply, leading to rapid growth in carbon dioxide emissions (IPCC, 2011).

1.1 Study objectives

The main objective of this assignment was to generate baseline data on energy sources and potential energy interventions among communities in the study area. Specifically, the survey was to:

a) Determine and map out energy sources used by the communities in the project areas;
b) Explore possible and potential energy interventions within the communities in the project areas;
c) Identify and characterize dominant tree species preferred for energy use in the counties
d) Assess cross-cutting issues related to energy and impact on them-Livelihoods, shelter and education;
e) Determine energy preferences for communities in the project areas

1.2 Scope of work

The areas covered included Mt. Elgon and Cherengany Ecosystems where the assignment entailed the following;

a. Hold planning meetings with the project team and other stakeholders;
b. Desk review of available secondary data to gain an understanding of the ecosystems, other similar project and survey designs on surveys of similar nature;
c. Designing of the survey and the data collection tools for review by the KEFRI project team;
d. Data collection through HH interviews, Focus Group Discussions and Key Informant Interviews;
e. Data Analysis and Reporting

1.3 Terms of reference

a) A desk review of the available secondary data especially regarding documents published on energy sources in the ecosystem; which will provide background information for designing the study and questionnaires.

b) Design of the baseline study and develop questionnaires which will be reviewed and approved by the project team. Questionnaires will then be field-tested and revised as necessary.
c) Undertaking focus group discussions with communities
d) Data collection in both ecosystems
e) Conduct data cleaning, entry and analysis
f) Write the final report

METHODOLOGY

1.4 Study area

The baseline survey on energy sources was conducted in Mt. Elgon and Cherangany Hills Ecosystems. The study area covers 11 counties (Busia, Kisumu, Siaya, Bungoma, and Trans-Nzoia in Mt. Elgon; and Elgeyo Marakwet, Pokot West, Uasin Gishu, Kakamega, Vihiga and Nandi in Cherangany.

1.1.1 Mt. Elgon Ecosystem

Mt. Elgon is one of Kenya's five main water towers with an estimated watershed population of over 1.5 million. Mount Elgon's forest ecosystem covers an area of 236,505ha to the Kenyan side and overlaps with Trans-Nzoia and Bungoma counties (KWS 2011). It was gazetted in 1932 (Ongugo *et al*, 2001) and receives high rainfall, designating it as one of the Kenya's five "water towers" supporting a huge population (van Heist, 1994).The ecosystem comprises of forest resources contributing to socio-economy e.g. firewood, poles or timber, water and fodder. In addition, Mt. Elgon hosts the headwaters of the Nzoia River which provides hydrological services to a range of economic sectors including irrigated agriculture with an estimated watershed population of over 1.5 million.

Mt. Elgon vegetation can be zoned into four: open woodland, tropical moist forest, bamboo and afro-alpine zone (Figure 2). The forest is divided into three management units namely: the natural forest reserve, the commercial exotic plantations and the national park.

2.1.1 Cherangany Hills ecosystem

The Cherangany ecosystem is an important water catchment area and it is one of Kenya's 'Water Towers'. It serves as a watershed between the Lake Victoria and Lake Turkana basins. The Cherangany Hills cuts across four administrative districts in Rift Valley Province that is Trans-Nzoia, West Pokot, Marakwet and Lelan. Spatially, the location of Cherangany Hills is defined by 35° 26''

East and 1^{0}16'' North at an altitude range of 2000-3365m above sea level (CHFESp 2015). Cherangany Hills forest ecosystem comprises of a number of forest blocks (12), cutting across three counties, Trans-Nzoia, Elgeyo Marakwet and West Pokot, on the Western ridge of the Great Rift Valley (Figure 1). It covers an area of 120,000 ha, forming the upper catchment of Nzoia, Kerio and Turkwel rivers (KFWG & DRSRS 2004).

1.5 Sampling procedure

Purposive sampling in the two ecosystems was done based on household population in Mt. Elgon and Cherangay ecosystems (2009 population census data). 6 Counties (Kisumu, Bungoma, Kakamega, Pokot West Uasin Gishu and Nandi) out of the 11 counties were sampled based on homogeneity to the ecosystem (Figure 1).

The sample size was computed using;

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})}$$

Where *Population Size = N*

Margin of error = e (e is percentage, put into decimal form)

*Z-score = z (*The z-score is the number of standard deviations a given proportion is away from the mean).

Table 1: Sample size per county in Mt. Elgon and Cherangany ecosystems

Ecosystem			CL-95% ME-3.5%		
	County	Household population	% HH Distribution per county	Number of HH	No. of sub-counties
Mt. Elgon	Kisumu	226719	17	67	7
	Bungoma	321628	24	95	10
	Kakamega	355679	26	105	11

	Pokot West	93777	7	28	3
Cherangany Hills	Uasin Gishu	202291	15	60	6
	Nandi	154073	11	46	5
	Total	**1354167**	**100**	**401**	**42**

The Confidence level (95%) and margin of error (3.5%) was used to calculate the sample size of the whole population in Mt. Elgon and Cherangany hills ecosystems.

With different (%) household distribution in each of the counties within the ecosystems, a sample of 400 households representing the population was randomly sampled (Table 1). However, a total of 415 households were interviewed during the survey (Table 2). 10 households per sub-county were randomly sampled in the 42 sub-counties of the ecosystem.

Table 2: Number of households interviewed per Sub-County

No.	County	Sub-Counties	Number of Households interviewed
1	West Pokot	North Pokot, South Pokot and Central Pokot	24
2	Bungoma	Sirisia,Mt. Elgon, Kanduyi, Bumula, Kabuchai, Webuye and Bokoli	87
3	Kakamega	Lugari, Lukuyani, Malava, Alurambi, Navakholo, Mumias, Mumias East Matungu, Butere, Kwisero, Shinyalu and Ikolomani	124
4	Kisumu	Nyakach, Seme, Kisumu East, West and Central, Nyando and Muhoroni	77
5	Nandi	Emngwen, Mosop, Nandi Hills, Aldai, Tinderet, and Chesume	42
6	Uasin Gishu	Soy, Moiben, Ainabkhoi, Kaseret, and Kesses	61

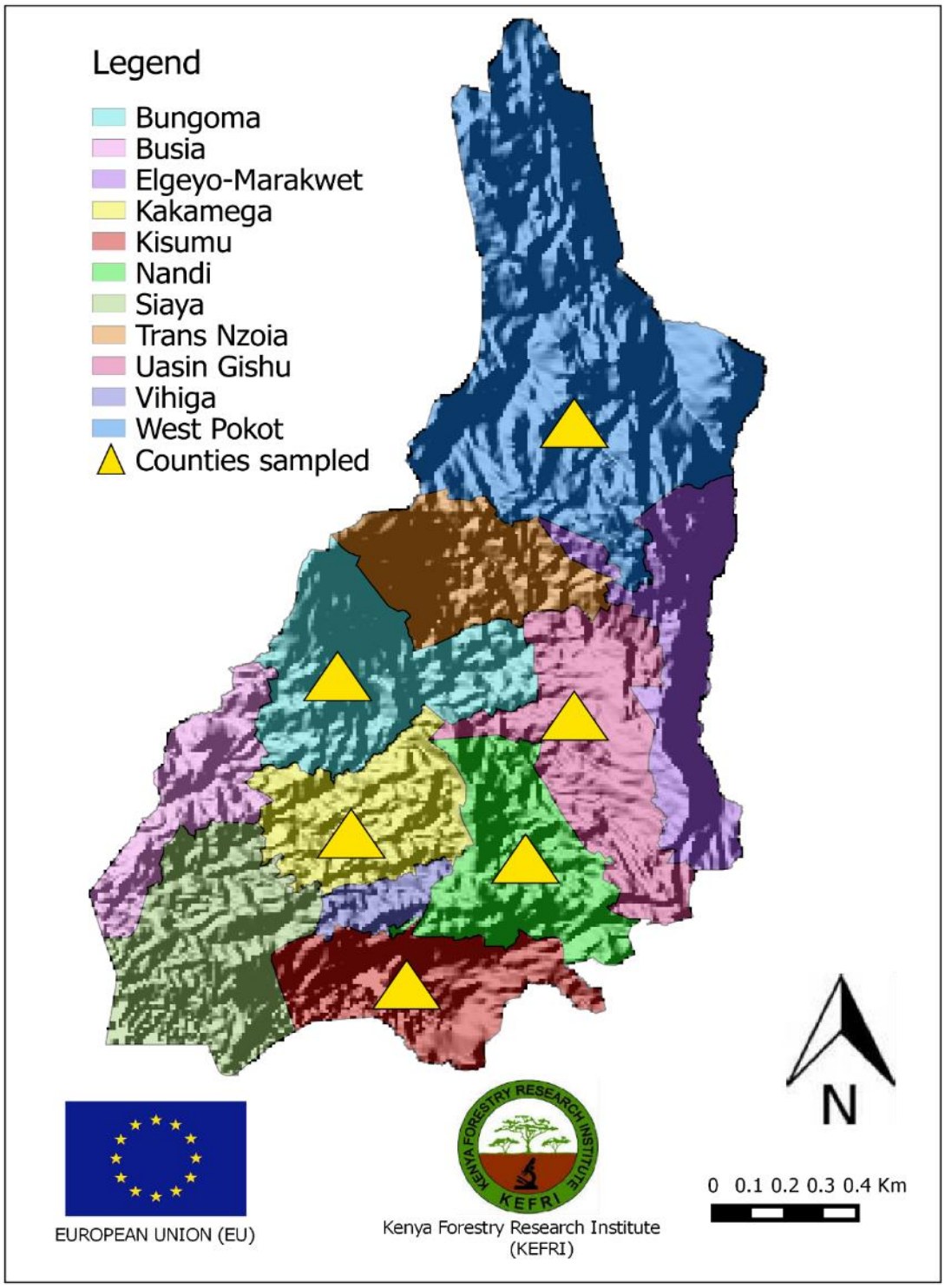


Figure 1: Counties sampled in Mt. Elgon and Cherangany ecosystem

1.6 Data collection tools

Household surveys, FGDs and KIIs were conducted in the ecosystem. A combination of qualitative and quantitative tools was developed for energy baseline data collection activities.

These included household survey questionnaires (Appendix 1), Key Informant Interview guide (Appendix 2) and Focus Group Discussions guide (Appendix 3) to provide information on different variables of energy study.

3.1.1 Household survey questionnaire

At the household level, household heads and children (18 and above) were interviewed on energy access and use. The information gathered in this survey were sources of energy commonly used for heating and lighting, labor, supply and consumption of charcoal and firewood, the cooking technologies used and the social, economic, environmental aspects of energy use.

4.1.1 Key informant interviews (guiding questions)

The Key informants targeted were officials of KFS (Ecosystem Conservator), Extension Officers (Ministry of Agriculture, Energy and Environment), Local Administration and NGOs.

The guiding questions captured information on main sources of energy, quantities of wood energy supplied from the forest, charcoal production techniques and energy interventions in the county.

5.1.1 Focus Group Discussions (guiding questions)

FGDs were held at the sub-county/village level. The representatives of CFA, CBO, and user groups were interviewed to provide information representative of community energy access and use.

Using guiding questions, the information captured was on the most preferred energy sources, intervention measures to ensure environmental sustainability, types of cook stoves used by households, social, economic, environmental and health concerns of access and use of different sources of energy.

1.7 Data analysis and reporting

The baseline survey data was analyzed using SPSS and MS excel. The qualitative data was processed to into a narrative account, capturing the topical themes Key Informant and FGDs guide to corroborate quantitative data.

The quantitative data was coded, classified and analyzed and presented in tables, graphs and texts.

1.8 Assessment approach

6.1.1 Preparation and planning

At the commencement of the project, the consultancy held an inception meeting with KEFRI team, in which the consultants presented the inception report.

Specifically, the objective of the meeting was to;

- Harmonize the consultants and clients understanding of the objectives and scope of the assignment;
- Build a consensus on the assignments methodology;
- Agree on the logistical arrangements to execute the project within the given time frame;

7.1.1 Development of data collection tools

A combination of qualitative and quantitative data collection tools were developed for the study. Household survey questionnaire was developed for the household survey, while KII and FGD guides were developed for Key Informant Interviews and FGD interviews respectively.

8.1.1 Recruitment of and training of research assistants and enumerators

A team of research assistants with experience in community based development projects were hired and trained as facilitators.

The training focused on:

a) Understanding of the data collection tools (Household questionnaire. KII and FGD Guides);
b) Understanding of PDA (Personal Digital Assistant-a software for data collection)
c) Sample frame and methodology and
d) Administering the questionnaires.

After the training, the household collection tool was pre-tested on site prior to actual data collection.

9.1.1 Data checks-Data collection, cleaning, analysis and reporting

Strict supervision was done by the consultants, coordinators and supervisors to ensure that quality data on energy was collected. Daily reporting was conducted to address any data gaps experienced by the enumerators in the field. Post collection data cleaning with logical checks was done prior to analysis.

RESULTS AND DISCUSSIONS

A survey on the energy sources was carried out amongst communities in Mt. Elgon and Cherengany Hills ecosystems. A total of 415 households, 288 from Mt. Elgon and 127 from Cherengany Hills ecosystems, were interviewed. The Counties surveyed were Kakamega, Bungoma and Kisumu in Mt. Elgon Ecosystem while in Cherengany Hills ecosystem, Nandi, West Pokot and Uasin Gishu Counties were covered. The results of the survey are presented below.

1.9 Household Information

10.1.1 Gender of household Respondent

From the 415 respondents interviewed, 75.3% of the respondents were male-headed while 24.7 % of the respondents were female (Figure 2). The variation in gender of the household heads per County also follows the same trend as shown in Within the family, women are the most affected group by fuel wood issues since they devote a lot of their time to fuel wood gathering and cooking tasks as opposed to being involved in other income generating activities. Charcoal production and marketing on the other hand tend to be more male dominated task.

Table 3. Even though the higher percentage of respondents was males, women are chief producers and consumers of energy at the rural level and they hold most potential for driving sustainable development.

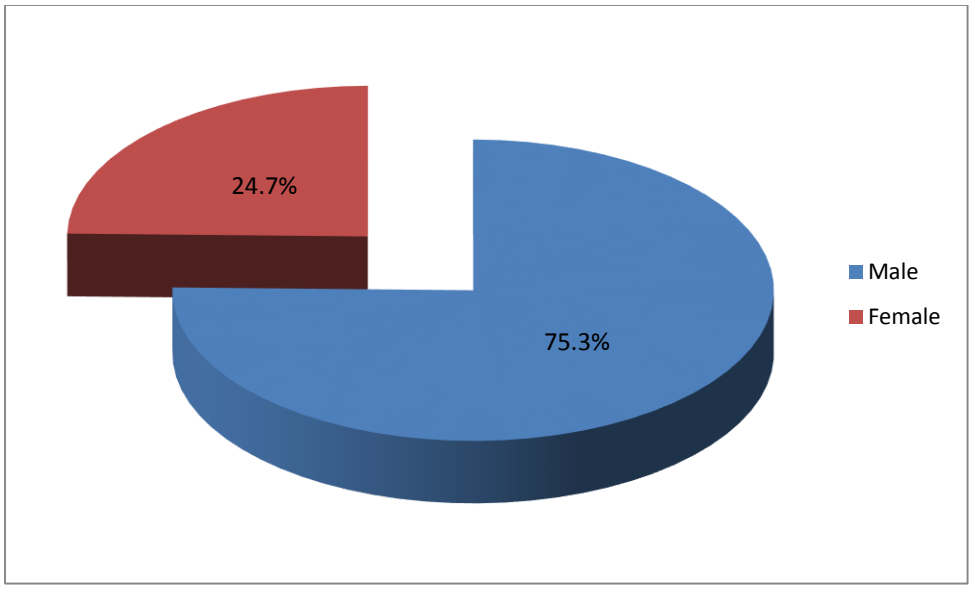


Figure 2: Male and female household heads in the ecosystems

Within the family, women are the most affected group by fuel wood issues since they devote a lot of their time to fuel wood gathering and cooking tasks as opposed to being involved in other income generating activities. Charcoal production and marketing on the other hand tend to be more male dominated task.

Table 3: Gender of household heads per county

Gender	Frequency	Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Male	Frequency (n)	96	16	53	73	23	50
	Frequency (%)	77%	67%	69%	84%	55%	82%
Female	Frequency (n)	28	8	24	14	19	11
	Frequency (%)	23%	33%	31%	16%	45%	18%

11.1.1 Age of respondent

Of all the respondents interviewed, majority (29%) were between the ages 31-40 years followed by those between ages 41-50 years (26%). A similar trend is noted a cross the Counties except for Kakamega where majority (25%) of respondents were of ages 60 years and above followed by those of ages between 31-40 years and 41-50 years at 20% as shown in Table 4

Table 4: Age of respondents

Age	Frequency	Total	County					
			Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
20-30 years	Frequency (n)	57	19	2	14	3	6	13
	Frequency (%)	14%	15%	8%	18%	3%	14%	21%
31-40 years	Frequency (n)	120	25	7	20	29	14	25
	Frequency (%)	29%	20%	29%	26%	33%	33%	41%
41-50 years	Frequency (n)	107	25	5	24	27	13	13
	Frequency (%)	26%	20%	21%	31%	31%	31%	21%
51-60 years	Frequency (n)	72	24	4	9	19	8	8
	Frequency (%)	17%	19%	17%	12%	22%	19%	13%
61+ years	Frequency (n)	59	31	6	10	9	1	2
	Frequency (%)	14%	25%	25%	13%	10%	2%	3%

12.1.1 Household size

The study shows that most of the households across all the Counties are medium sized having 4 to 6 persons. Only a small percentage of the households can be classified as large with more than 10 members (Figure 3). As the family size increased, the number of households reduced.

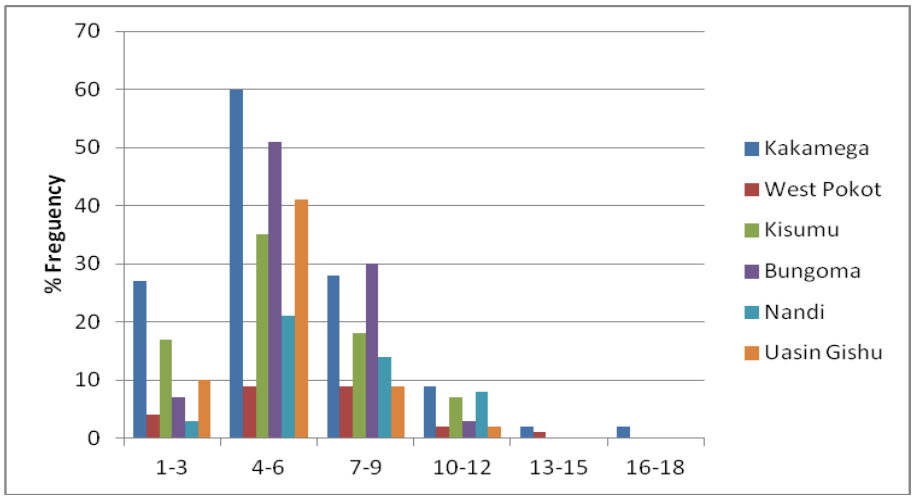


Figure 3: House hold size in the ecosystem

13.1.1 Type of housing

Overall, majority of the respondents (48%) had mud walled houses (Table 5). This was also true in the individual Counties except Kisumu and Bungoma which had 60% and 59% of the respondents respectively having cemented wall houses.

Table 5: Type housing of respondent

Type of house	Total	County					
		Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Stone walled	13%	6%	21%	8%	7%	14%	41%
Timber walled	3%	0%	0%	0%	0%	19%	5%
Cemented wall	35%	15%	8%	60%	59%	33%	23%
Mud walled	48%	79%	71%	32%	34%	33%	28%
Grass thatched	0%	0%	0%	0%	0%	0%	3%

The occupation of the household head determined the type of housing as indicated in Table 6. Household heads who were farmers were minority (57%) having mud walled houses, majority (80%) who were clerks had cemented wall houses, 70% of the respondents who were teachers had cemented wall houses.

Table 6: Type of housing and occupation of household head

Type of house	Total	Occupation of the Head of Household			
		Farmer	Clerk	teacher	Other
Stone walled	13%	12%	20%	7%	17%
Timber walled	3%	3%	0%	4%	1%
Cemented wall	35%	26%	80%	70%	42%
Mud walled	48%	57%	0%	19%	41%
Grass thatched	0%	1%	0%	0%	0%

14.1.1 Education levels of respondents

In terms of formal education, , the number of males in all the individual Counties studied at all levels of education was higher than females as shown in Figure 4.

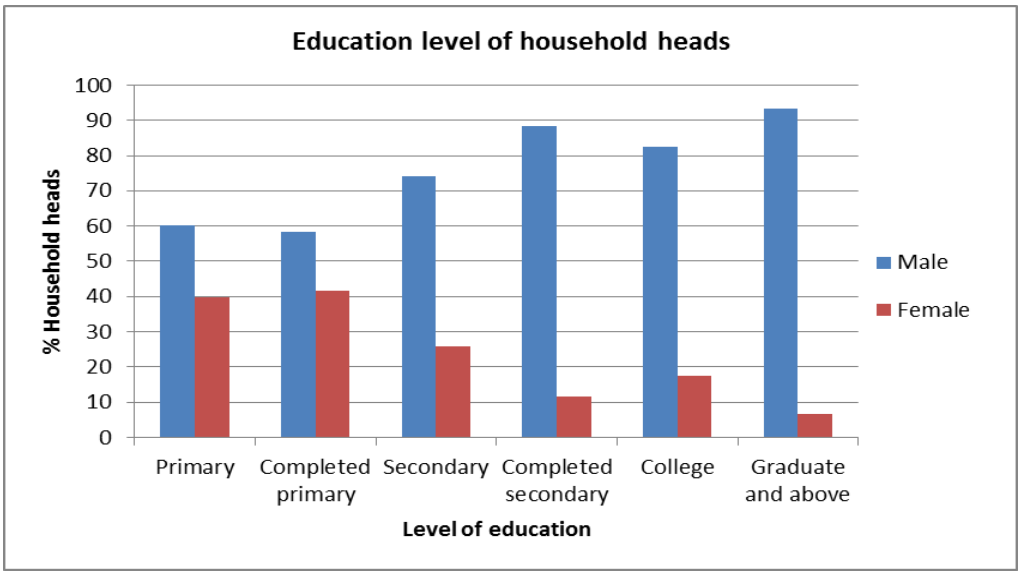


Figure 4: Household head education level at the County level

Among the household heads who completed primary education, 60.2% were male, while 39.8% were females, among those who finished secondary school education 88.4 % of the household heads were males while 11.6% were female, 82.6 % of household heads completed college education were males while 17.4% females, 83.3% of those who have completed university education were males while 6.7% were females (Figure 5). This implies that more of the males are literate as compared to the females.

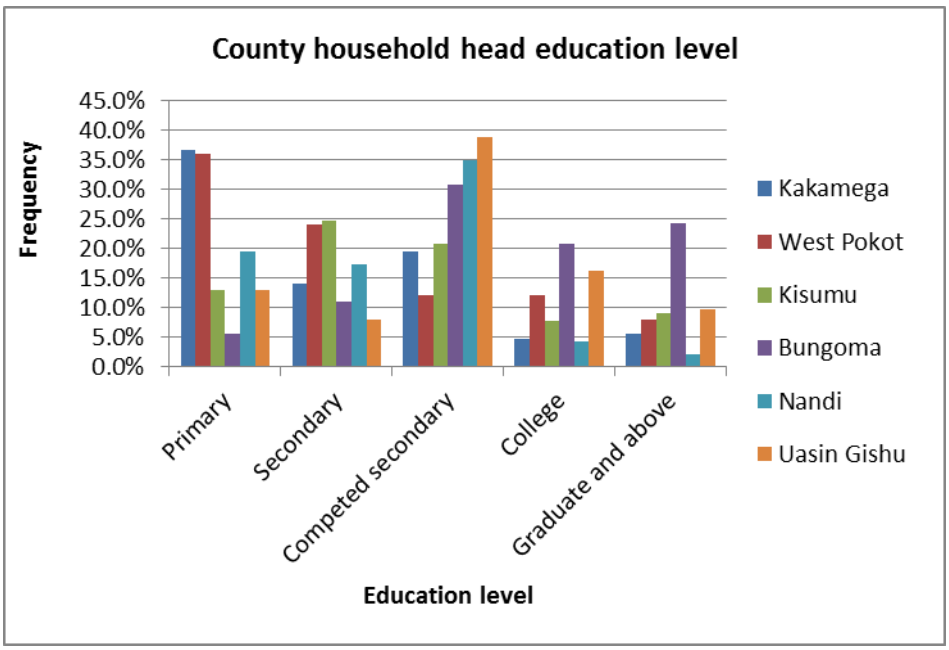


Figure 5: Level of education of household head

15.1.1 Occupation of household head

The results of analysis indicates that majority (62%) of the household heads are farmers followed by those with other occupations at 29% (Table 7). This is also similar across the individual Counties except for Bungoma County with majority (47%) having other occupations. This shows that the households derive most of their basic income through subsistence farming.

Table 7: Occupation of household heads

Occupation	Frequency	Total	County					
			Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Farmer	Frequency (n)	258	96	12	39	30	37	44
	Frequency (%)	62%	77%	50%	51%	34%	88%	72%
Clerk	Frequency (n)	10	2	0	1	4	0	3
	Frequency (%)	2%	2%	0%	1%	5%	0%	5%
teacher	Frequency (n)	27	3	3	4	12	2	3
	Frequency (%)	7%	2%	13%	5%	14%	5%	5%
Other	Frequency (n)	120	23	9	33	41	3	11
	Frequency (%)	29%	19%	38%	43%	47%	7%	18%

16.1.1 Average household income

Majority (22.2%) of the households had an average monthly of income between KShs. 20,001and KShs. 30,000 with households having monthly income between KShs. 30,001 and KShs. 40.000 constituting the lowest proportion of only 9.2% as shown in Figure 6 below.

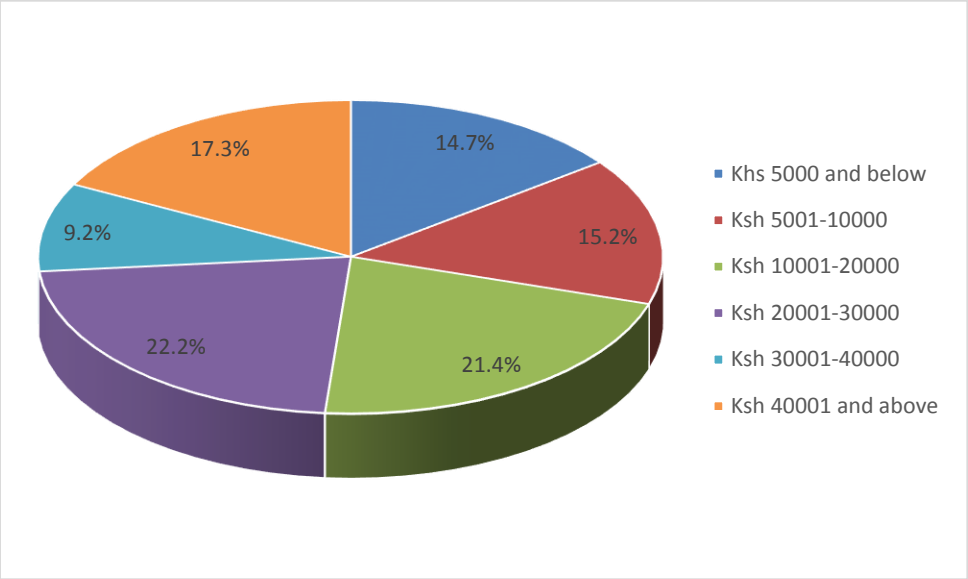


Figure 6: Average household income

1.10 Sources of energy

The sources of energy identified under the study were firewood, charcoal, electricity, paraffin, solar, LPG. Other sources included saw dust, crop residues (Maize stalk, maize cobs) and biogas. The saw dust is used in specialized *jikos*. Saw dust from timber processing is most preferred because the chips are a bit larger than those from saw mills. Firewood was the main source of energy in majority of rural households. Charcoal was mostly used in the urban areas such as hotels and gas used in urban households. The parts of wood mostly used were the stumps and branches.

17.1.1 Energy sources Preference

Of all households surveyed across all the six Counties, 91% of the households used firewood, 52% use charcoal, while none (0%) used electricity for heating as shown in Figure 7.

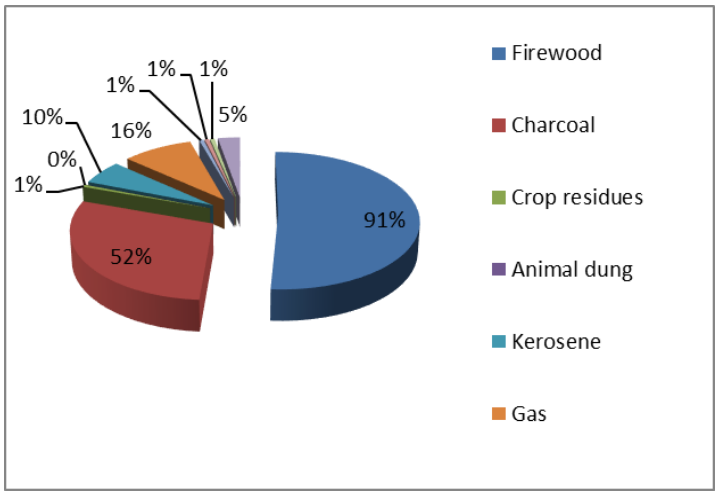


Figure 7: Overall preference of sources for heating

Firewood was the most preferred source of energy for heating and cooking with only a slight percentage variation among the Counties as shown in Figure 8 with West Pokot (100%), Nandi (100%), Kakamega (98%), Kisumu (83%), Bungoma (86%) and Uasin Gishu (84%). From the group discussions, charcoal was also used but mostly in urban areas. West Pokot County produced a lot of charcoal but most of it (90%) is sold to towns like Kisumu, Eldoret, Nairobi, Kitale and Bungoma which confirms why the County uses firewood more for heating/cooking. Energy prices are a major determinant of the choice of fuel type a household chooses. Firewood was the most preferred source of energy among the households because of its availability, familiarity and most importantly, because it costs much less as compared to other energy sources.

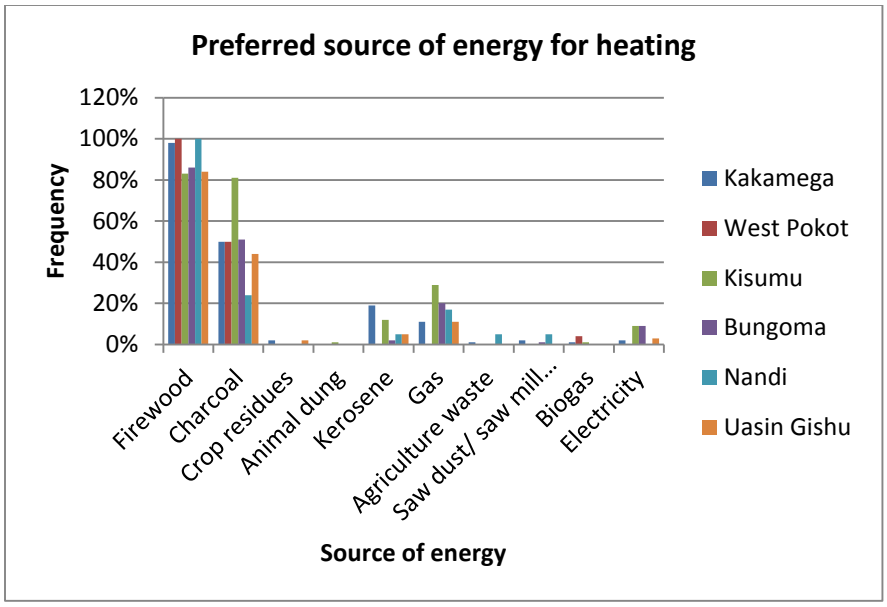


Figure 8: Most preferred energy sources for heating

Of the households surveyed across all the Counties, kerosene was the most commonly used source of energy for lighting (47%). This was followed by electricity (42%) and solar (24%) as shown in Figure 9.

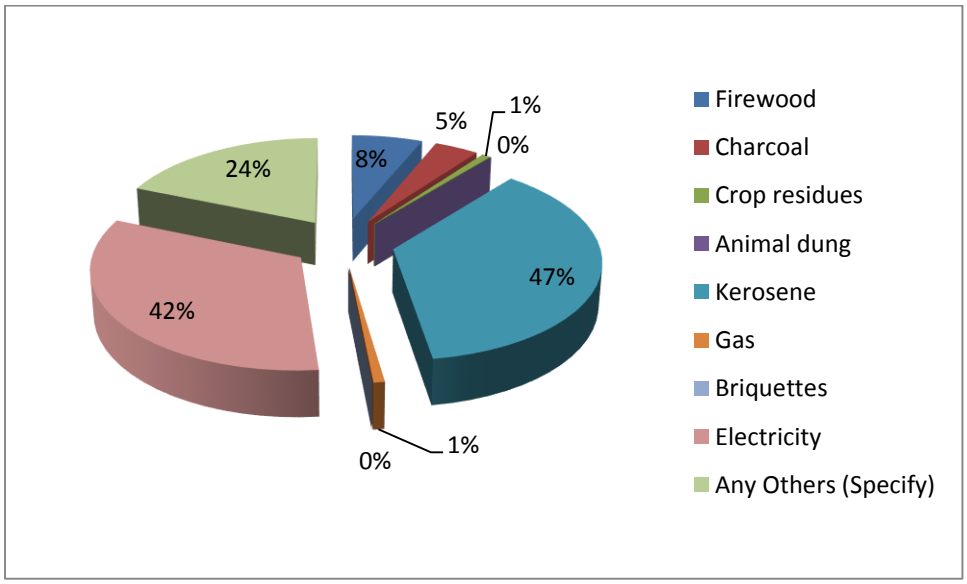


Figure 9: Overall preference of energy source for lighting

Within the Counties, kerosene was commonly used for lighting in Kakamega (65%) and West Pokot (54%) compared to 19% and 25% of respondents respectively using electricity (19%) as shown in Figure 10. The use of electricity could be attributed to the Rural Electrification programme and likely effect to improved connections for lighting. In Kisumu (59%), Nandi (55%) and Bungoma (53%) Counties, electricity was commonly used compared to Kisumu (39%), Nandi (33%) and Bungoma (34%) using kerosene for lighting.

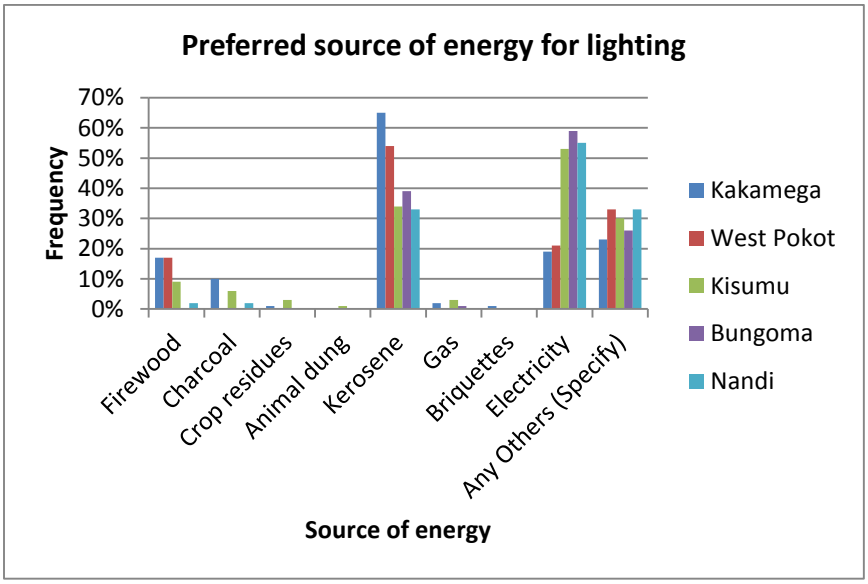


Figure 10: Source of energy commonly used as energy for lighting

18.1.1 Relationship between the level of education, income and type of household homes to energy sources

There is no considerable relationship among the education levels, type of household homes and energy sources used (Figure 11 and Figure 12). Level of income plays a bigger role in the type of energy used as those with a stable source of income are faster to adopt energy alternatives but this is also to a lesser extent (Figure 13) as households with monthly income of over KShs.40,000 have majority (86%) still preferring firewood for cooking. This could be explained by ease of accessibility of firewood, its familiarity and most importantly, because it costs much less as compared to other energy sources.

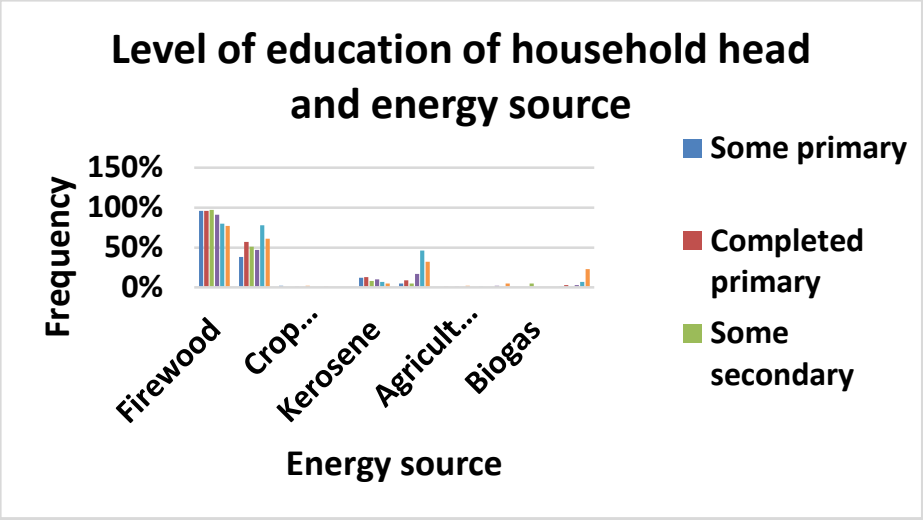


Figure 11: Level of education and energy source

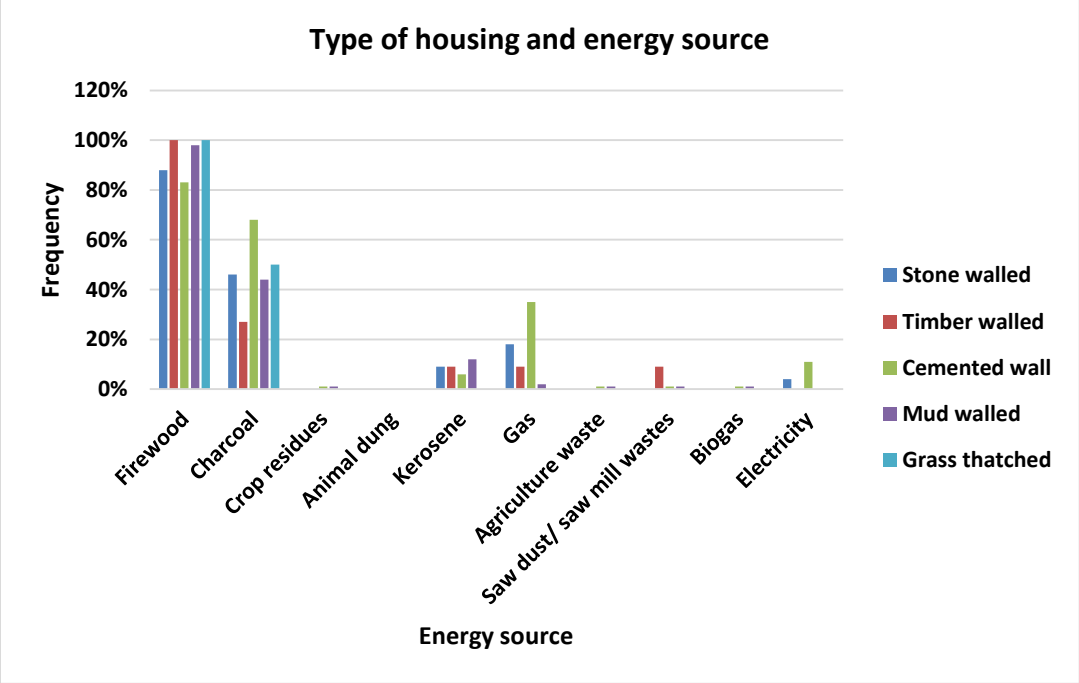


Figure 12: Type of housing and energy source

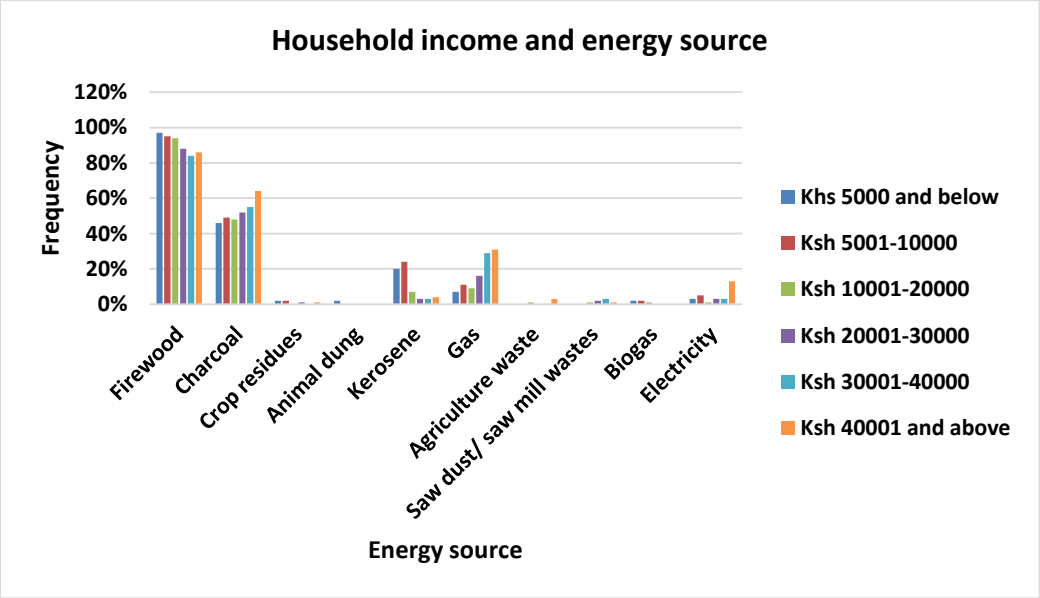


Figure 13: Household income and energy source

19.1.1 Situation on the preferred source of energy

On average across all the Counties surveyed, 50% of the respondents indicated that the situation on preferred source of energy (firewood and charcoal) over the past five years had improved, 30% indicated no change, while 20% indicated that the situation had worsened. (Figure 14).

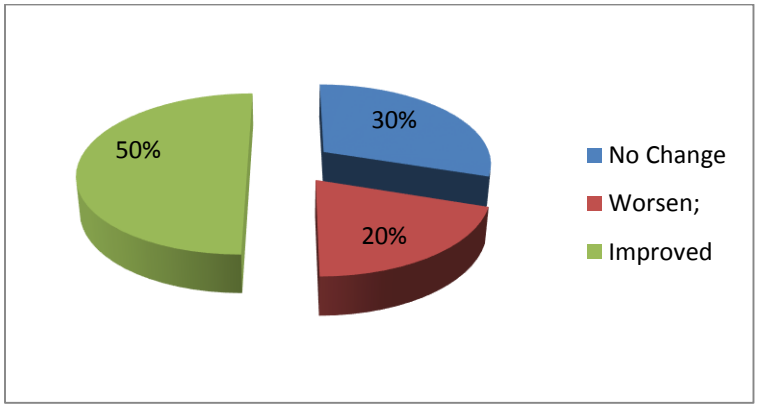


Figure 14: Situation on preferred sources of fuelwood over the past 5 years

However, the change differed by County surveyed with majority of respondents (Figure 15) in Kakamega (37%), Nandi (13.6%) and Uasin Gishu (25%) Counties stating that the situation had worsened. In Bungoma County, majority (26.7%) felt that the situation improved while 25.2% had

seen no change. In Kisumu majority (25.2%) indicated that there was no change. The slight improvement witnessed could be as a result of the awareness created on farm tree planting by KFS which has led to the establishment of household woodlots.

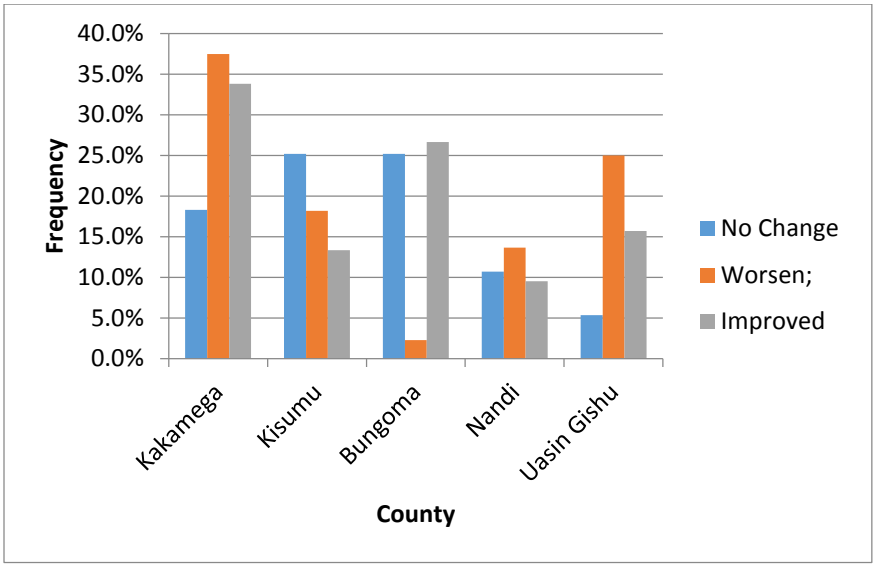


Figure 15: Change in preferred source of energy within the counties over the past five (5) years

The average number of meals cooked by households per day were 3, the average minimum number of meals were 2 while the average maximum were 4 meals per day. In Kisumu county, the minimum meals cooked per day was 1, while in Nandi county, the maximum number of meals cooked were 8 (Figure 16). The expected maximum number of meals is usually five, however, the high number of 8 meals observed in some households could be attributed to households with polygamous marriages where the household head has 2 or more houses to fend for.

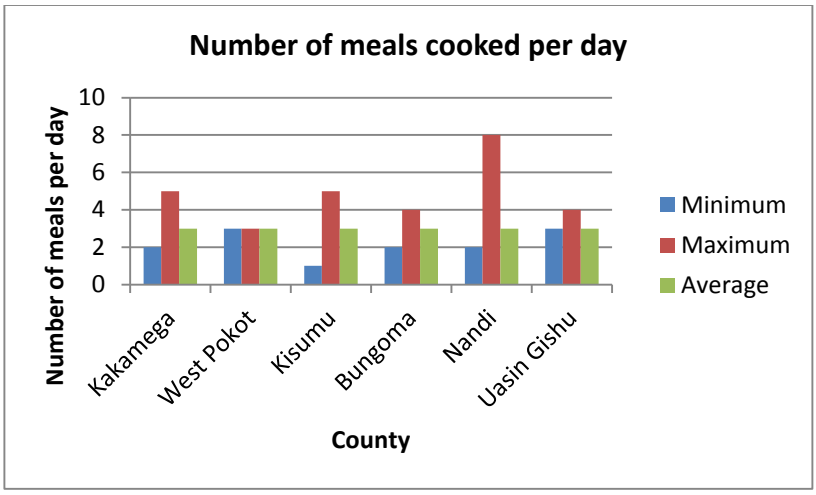


Figure 16: Number of meals cooked per day

The maximum number of hours that energy was used as source of light was 13 hours in Kakamega, the minimum was 1hour in West Pokot, Bungoma and Uasin Gishu (Figure 17)

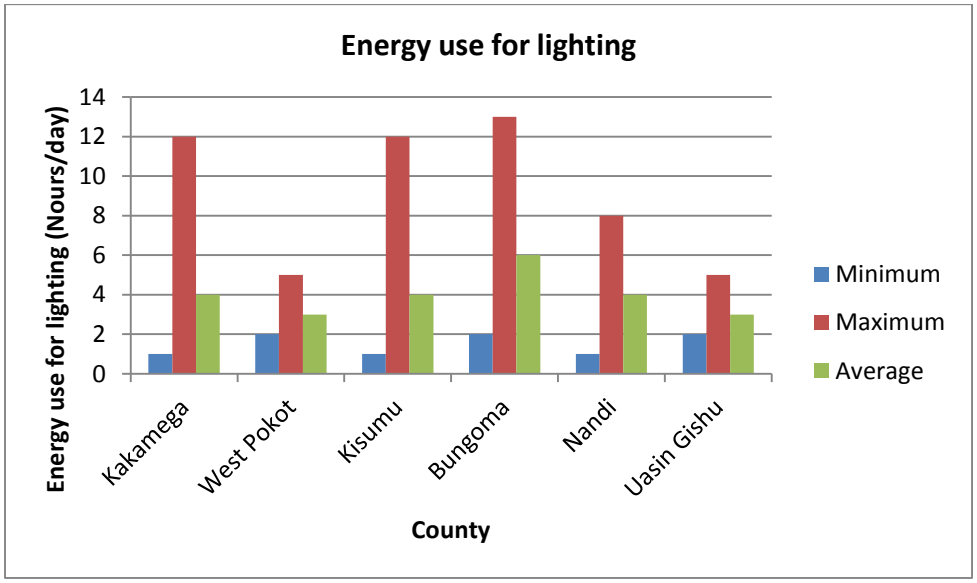


Figure 17: Number of hours energy is used per day for lighting

20.1.1 Tree species preference for firewood and charcoal

The tree species in order of preference were *Ecalyptus Sp, Grevillea robusta, Cupressus lusitanica, Markhamia lutea, Mangifera indica, Persea Americana, Acacia mearnsii, Pinus patula, Croton*

macrostachyus, Albizia coriara, Psidium guajava, Jacaranda mimosifolia, Ficus sycomorus, Acacia Sp, Euphorbia tirucali. The dominant and most preferred species per County tree species and reasons for preferences are summarized in (Table 8). The preference was based on the short time period the species took to grow, ease of processing compared to the indigenous species. Both indigenous and exotic species were preferred for charcoal and firewood. However, exotic species were dominant, and most preferred to indigenous species (

Table 9, Appendix 4). This could be explained by the fact that communities attach more value to indigenous species as opposed exotic species and therefore they were not cutting them for firewood. The species most available in Bungoma, Kakamega and Nandi are Eucalyptus. Eucalyptus was also the 2nd dominant species in all the other 3 counties. Despite earlier findings indicating preference to indigenous tree species for firewood and charcoal, the trend seems to be shifting to exotic tree species owing to the on farm tree planting initiatives being undertaken in the Counties under study to curb deforestation (which has led to destruction of most indigenous tree species). This has provided alternative tree species like Eucalyptus with high growth rate, high density and high calorific value.

Table 8: Preferred indigenous and exotic species and reasons for preference in the ecosystem

Species	Frequency (%)	Plant type	Reasons for preference
Ecalyptus Sp.	18.50	Exotic	Easily/locally available, Produces branches good for firewood, burns well and retains heat, Easy to split, Cheap to acquire, early maturity, easily grows (coppice) after cutting, Faster to grow, grows tall and produces branches, Economical to use
Grevillea robusta	12.20	Exotic	Can be used as a source of timber, charcoal, firewood and shade, easily available and economical, Burns with high heat intensity (Produces more heat), doesn't produce a lot of smoke, dries faster, matures faster, easy to split, easy to light, produces high quality charcoal
Cupressus lusitanica	10.66	Exotic	Easy to propagate, grow and matures faster, Branches dry fast, Burns with ease; good flame; Cheap to acquire, produces less smoke and ash, Easy to cut and split

Markhamia lutea	7.35	Indigenous	Easily accessible, burns for long, dries faster, Produces high quality charcoal and firewood that light faster, easy to intercrop, easy to split, grows faster,
Mangifera indica	4.28	Exotic	available and produces firewood and charcoal of high quality , burns for long, dries quickly, easy split, the branches are easy to lit, produce less smoke when dried well
Persea americana	3.63	Exotic	available, burns for long, dries fast, early maturity, easy to split, It is easy to maintain, produces quality of charcoal
Acacia mearnsii	3.39	exotic	Best for Charcoal and fuelwood; burns for long time, Grows and matures faster to produce marketable firewood and charcoal, Cheap and easy to acquire, High market demand for its charcoal and firewood which produces less smoke, Easy to harvest and process and lights easily, the seedling are more available compared to others so that make the farmers grown them
Pinus patula	3.39	Exotic	Easy to split, dries faster, produces less smoke, early maturity, easy to split, Firewood burns faster, it has worst charcoal so we only use it for firewood, they are Being plant purposely for timber and branches are used as firewood, they are cheap to maintain because one can grow with other crops e.g. maize, beans
Croton macrostachyus	2.99	Indigenous	Readily available; Burns for long, Easy to light; dries fast and easy to split, Matures faster, Produces high quality charcoal and timber
Albizia coriara	2.91	Indigenous	Available, Produces quality charcoal and firewood, burns for long, dries

			faster, easy to spilt, good source of heat
Psidium guajava	1.94	Indigenous	Dries faster, easily available, naturally growing, not easily consumed with fire, Easy to prune branches for firewood, Produces good quality charcoal,
Jacaranda mimosifolia	1.78	Indigenous	Easy to light, easier to spilt, easy to get, fast growing, Produces quality of charcoal and firewood
Ficus sycomorus	1.70	Indigenous	Easily available, burns for long, easy to split, Lights faster, produces firewood and quality charcoal
Acacia Sp	1.45	Indigenous	Easy to grow, has high heat intensity, Produces high quality charcoal and firewood, easy to light, has more branches which can be used fire firewood, Readily available
Euphorbia tirucali	0.89	Indigenous	dries faster, grows fast as such easy to replace, good source of heat, grows naturally, readily available

Table 9: Dominant species preferred per county for charcoal and firewood

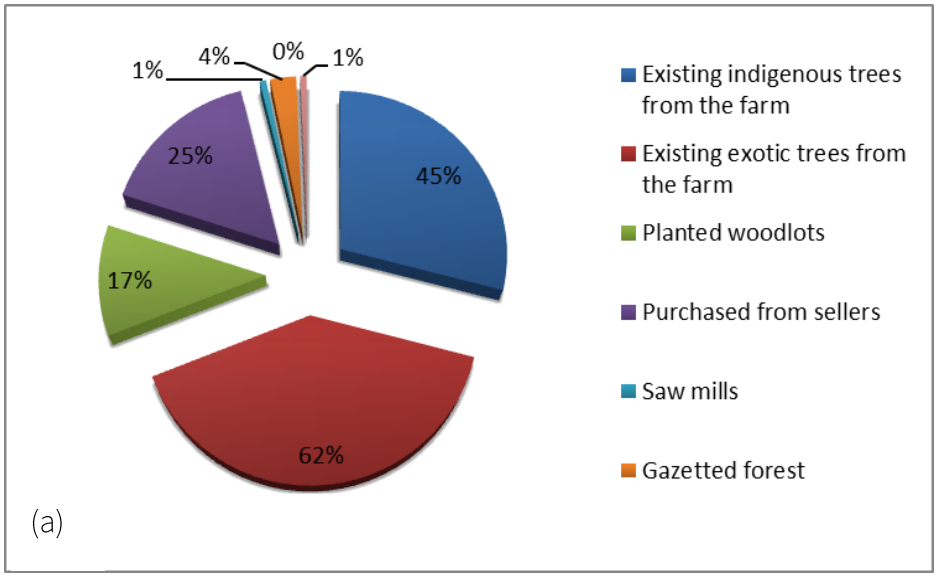
Bungoma	Frequency (%)	Kakamega	Frequency (%)	Uasin Gishu	Frequency (%)
Ecalyptus Sp.	*20.11*	*Ecalyptus Sp.*	*22.22*	*Acacia mearnsii*	*26.92*
Grevillea robusta	*17.45*	*Markhamia lutea*	*10.46*	*Ecalyptus Sp.*	*20.77*
Cupressus lusitanica	*9.47*	*Cupressus lusitanica*	*9.48*	*Cupressus lusitanica*	*20*
Ficus sycomorus	*6.21*	*Grevillea robusta*	*9.48*	*Grevillea robusta*	*15.38*
Markhamia lutea	*5.92*	*Persea americana*	*5.56*	*Acacia Sp*	*6.92*
Albizia coriara	*5.62*	*Croton macrostachyus*	*4.58*		
Mangifera indica	*5.33*	*Psidium guajava*	*3.92*		
Pinus patula	*4.14*	*Mangifera indica*	*3.59*		
Persea americana	*4.14*	*Pinus patula*	*3.27*		
Kisumu	**Frequency (%)**	**Nandi**	**Frequency (%)**	**West Pokot**	**Frequency (%)**
Markhamia lutea	*13.79*	*Ecalyptus Sp.*	*18.49*	*Cupressus lusitanica*	*25.81*
Ecalyptus Sp.	*12.01*	*Cupressus lusitanica*	*17.65*	*Ecalyptus Sp.*	*16.13*
Mangifera indica	*8.48*	*Grevillea robusta*	*14.29*	*Grevillea robusta*	*9.68*
Grevillea robusta	*7.07*	*Croton macrostachyus*	*12.60*		
Albizia coriara	*5.30*				
Pinus patula	*4.59*				
Jacaranda mimosifolia	*3.89*				
Euphorbia tirucali	*3.53*				

1.11 Energy supply, consumption and its utilization technologies

21.1.1 Sourcing of firewood and charcoal

Of all the households surveyed across the Counties, 62% sourced firewood from existing exotic trees from the farm while 45% sourced from indigenous trees from the farm (

Figure 18). 47% purchased charcoal from sellers while 29% sourced charcoal from either existing indigenous trees on farm or exotic trees from the farm.



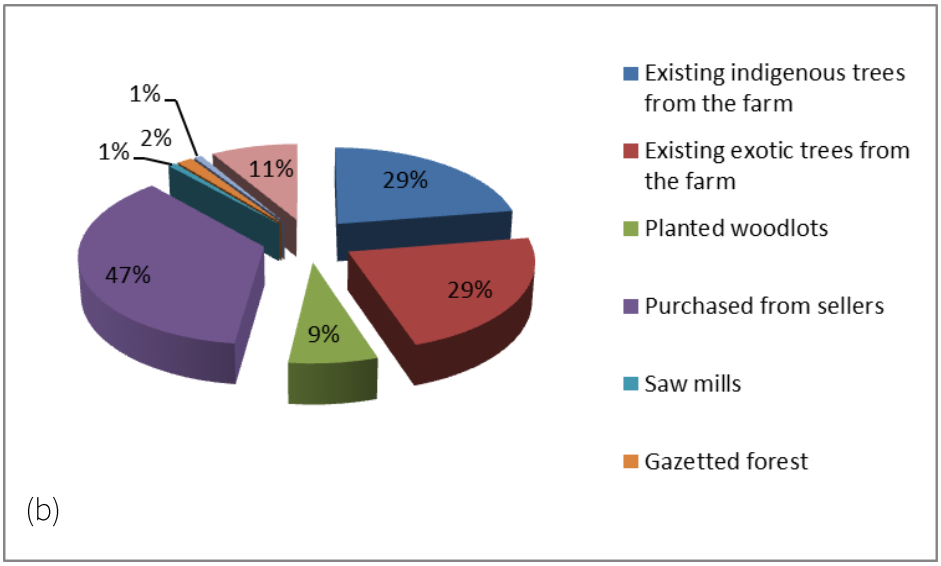


Figure 18: Sourcing of (a) firewood and (b) charcoal

(i) Sourcing of firewood

Sourcing of firewood however varied by County with majority of households from West Pokot County sourcing firewood (100%) from the existing indigenous trees on farm while 71% sourced from Existing exotic trees on farm. Majority (82%) of households from Uasin Gishu County sourced

firewood from existing exotic trees on farm. 75% of respondent from Bungoma County indicated sourcing firewood from existing exotic trees on farm while 61% sourced from existing indigenous trees on farm. In Kisumu County, 78% of the respondents sourced firewood from existing indigenous trees on farm while 47% and 42% source from existing exotic trees on farm and sellers respectively (Figure 19). The study also showed that learning institutions/Schools use fuel wood which is either sourced from own woodlots or from contracted private farms. The sourcing of fuelwood from existing indigenous and exotic tree species on farm could be attributed to the on farm tree planting initiatives being undertaken in all the counties surveyed.

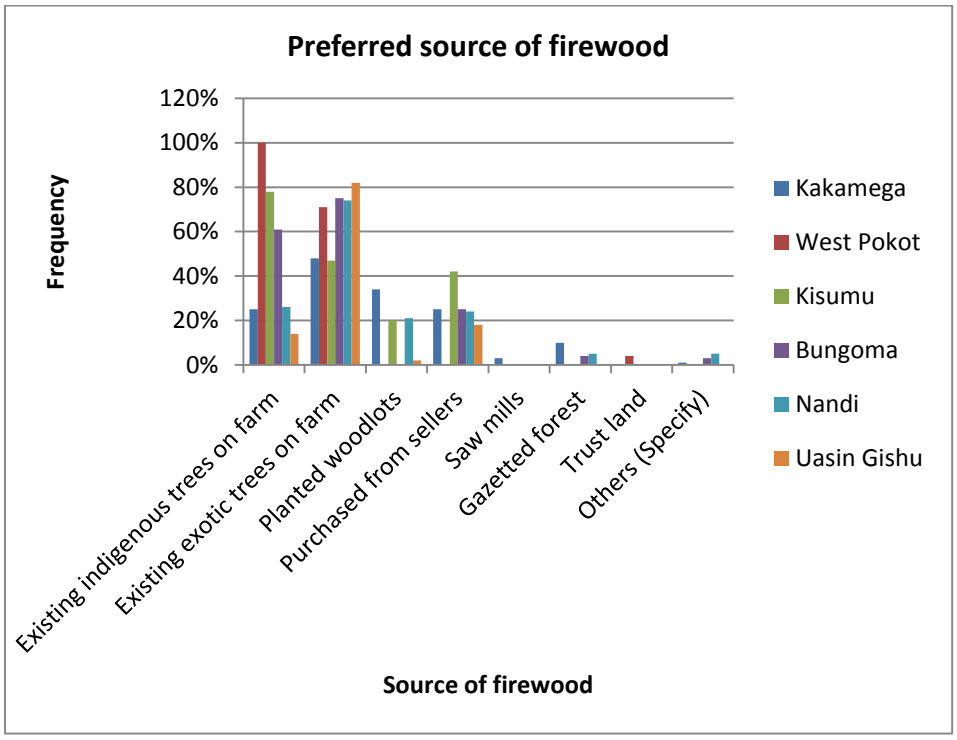


Figure 19: Most preferred sources of firewood

(ii) Sourcing of charcoal

Sourcing of charcoal also varied across the Counties surveyed with 92% of respondents in West Pokot sourcing from existing indigenous trees from the farm (Figure 20). 70% and 64% of respondents from Kisumu and Nandi Counties respectively purchase charcoal from sellers. In

Uasin Gishu County 54% sourced charcoal from existing exotic trees from the farm and 57% purchased from sellers.

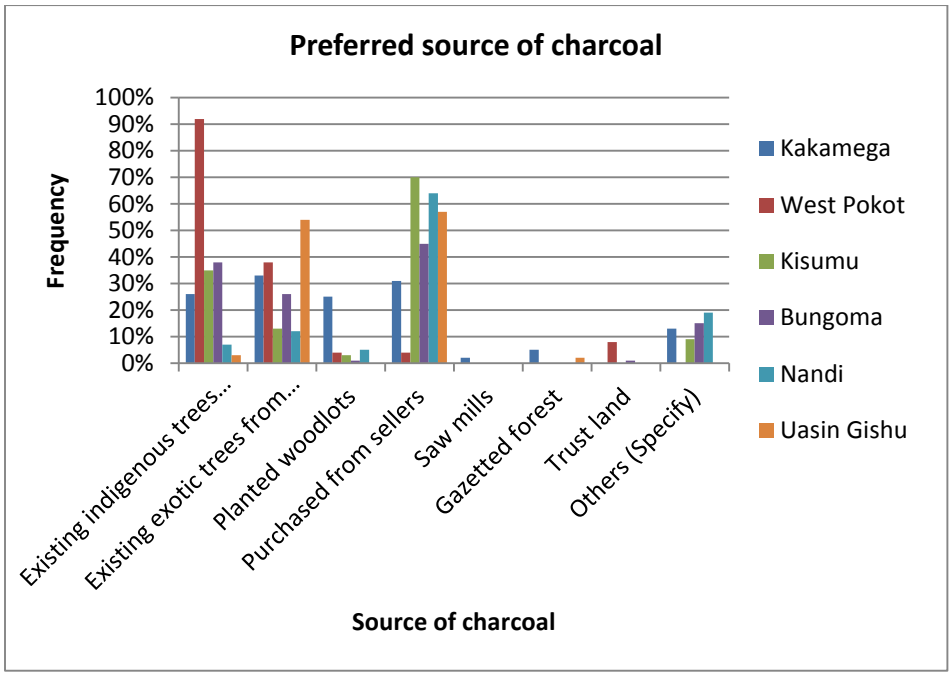


Figure 20: Most preferred sources of charcoal used

(iii) Self-sufficiency in firewood and charcoal

Majority of the households from West Pokot (71%), Kisumu (61%), Bungoma (93%) and Nandi (91%) Counties were self-sufficient with firewood except Uasin Gishu County (25%). The high percentage of self-sufficiency in firewood in all counties may be attributed to the on farm tree planting initiatives. Self-sufficiency in charcoal is however very relative with Bungoma (63%) and Kakamega (52%) Counties having more than 50% of respondents indicating self-sufficiency (Figure 21). Despite West Pokot being the main producer in charcoal, the households interviewed indicated not being self-sufficient in charcoal. This could be attributed to the fact that these households may not be producing charcoal for own use and that most (75%) of them still use the traditional 3 stone for cooking. Firewood was also the most preferred source of energy for heating

and cooking with 100% of respondents in West Pokot indicating preference for firewood while only 50% of respondents indicated preference for charcoal an indication of its use mostly used in urban areas.

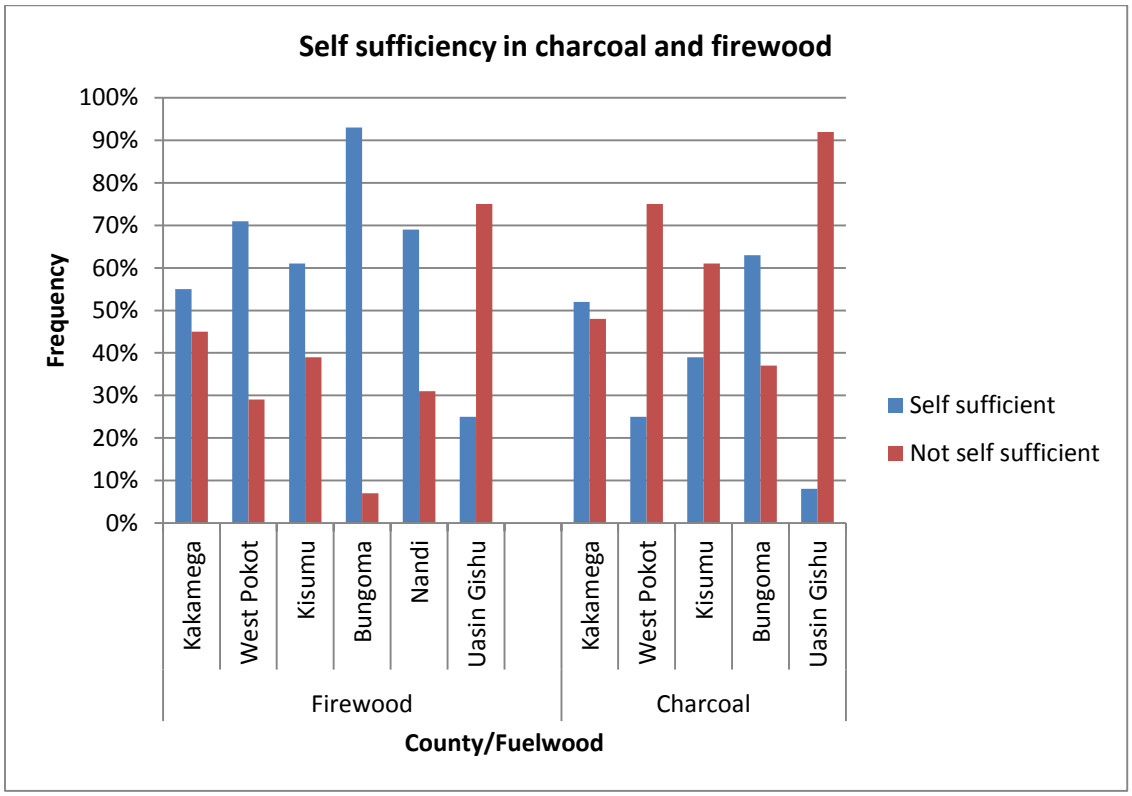


Figure 21: Self-sufficiency in charcoal and firewood

(iv) Accessibility to firewood and charcoal

In regard to accessibility, firewood and charcoal was relatively accessible across all the Counties surveyed. Across all Counties surveyed, 33% of households indicated that firewood was easily accessible, 29% indicated it was accessible, while only 15% indicated it was hardly accessible (Table 10). A different trend was noted for charcoal with 38% of households confirming that charcoal was accessible while 32% said it was hardly accessible.

Table 10: Accessibility to firewood and charcoal

Accessibility	Accessibility of firewood	Accessibility of charcoal
Not accessible	2%	8%
Hardly accessible	15%	32%
Accessible	29%	38%
Easily accessible	33%	13%
Most easily accessible	21%	9%

Firewood and charcoal accessibility however varied in the respective Counties surveyed. There are however households which accessed firewood and charcoal from gazetted forests and trust lands while others bought from vendors or the nearby markets.

The distance travelled to fetch firewood is mostly (79%) less than 2km (Figure 22), however there are places within the Counties studied that fetched firewood from up to distances of more than 5 km but this was minimal (3%). The distance may keep on increasing as the firewood become scarce and this can be sourced through the development of on farm woodlots.

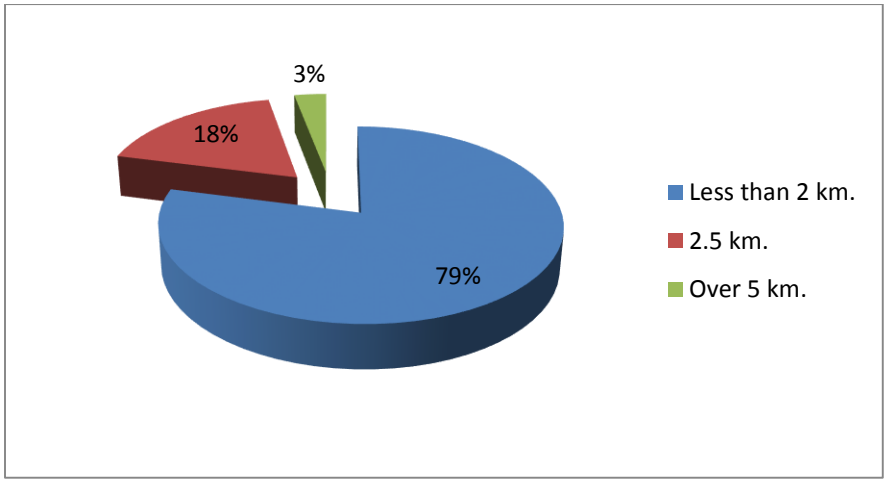


Figure 22: Overall firewood transport distance

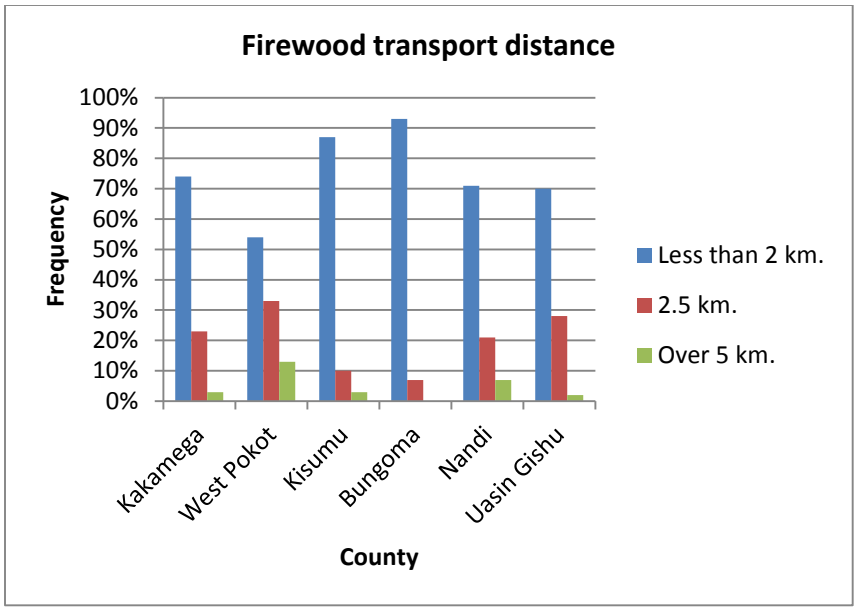


Figure 23: Firewood transport distance with the counties

(v) Prices of charcoal and firewood

Charcoal is mostly sold in bags weighing approximately 50kgs.The maximum price of a bag of charcoal was KShs. 1200 in Nandi, Bungoma and Kisumu. However, the lowest average price recorded was KShs. 400 in Kakamega (Figure 24). In West Pokot, which is the main producer of charcoal, the average price of a bag of charcoal was KShs. 590.

Firewood is collected and sold in headloads weighing between 38kgs and 60kgs. The maximum price of a headload of firewood was KShs 400 in Bungoma, the average and minimum price was KShs 92. The minimum prices of charcoal and firewood in Kakamega, Kisumu and Nandi were not recorded since the households produced from their farms for own consumption.

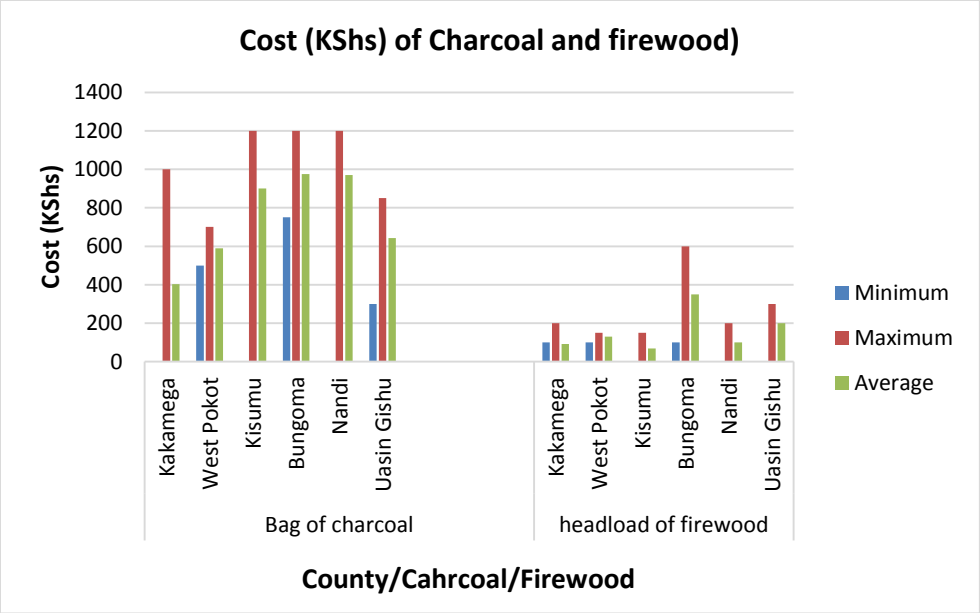


Figure 24: Price of charcoal and firewood

22.1.1 Uses of woodfuels and other energy sources

Firewood and charcoal are mostly used for cooking and heating while kerosene is used for lighting in the rural households. During rainy season it becomes difficult to use firewood and most households use paraffin for cooking. A few homes are connected to electricity which is used for lighting and powering electronic equipment. The limited access to electricity may be due to the high up-front costs of expanding the national grid and when accessible, the relatively high wiring costs retail prices. Solar energy is used also in some areas, however, though quite attractive, its uptake has been impeded by financial constraints and un-affordability of the solar panels and lack of personnel to give maintenance services. There are some homes in the urban areas that use Gas (LPG) for cooking. The low use of LPG in rural and low income areas is attributed to the high cost of LPG appliances (cylinders and cookers). However, there is likelihood increase in the use of LPG with the availability of small quantity packages of LPG which are less costly.

Biogas is used mainly in Secondary Schools and some Hotels in Bungoma County. Biogas is a source of energy generated from feedstock wastes through the use of a digester. There is high potential for biogas generation by farmers in the study area who keep animals in the farms which

can produce waste used to generate biogas for use in cooking and lighting. Uptake of biogas in the study area has however remained quite low due to high capital costs for not only the plant, but also for the modified burners and lighting units.

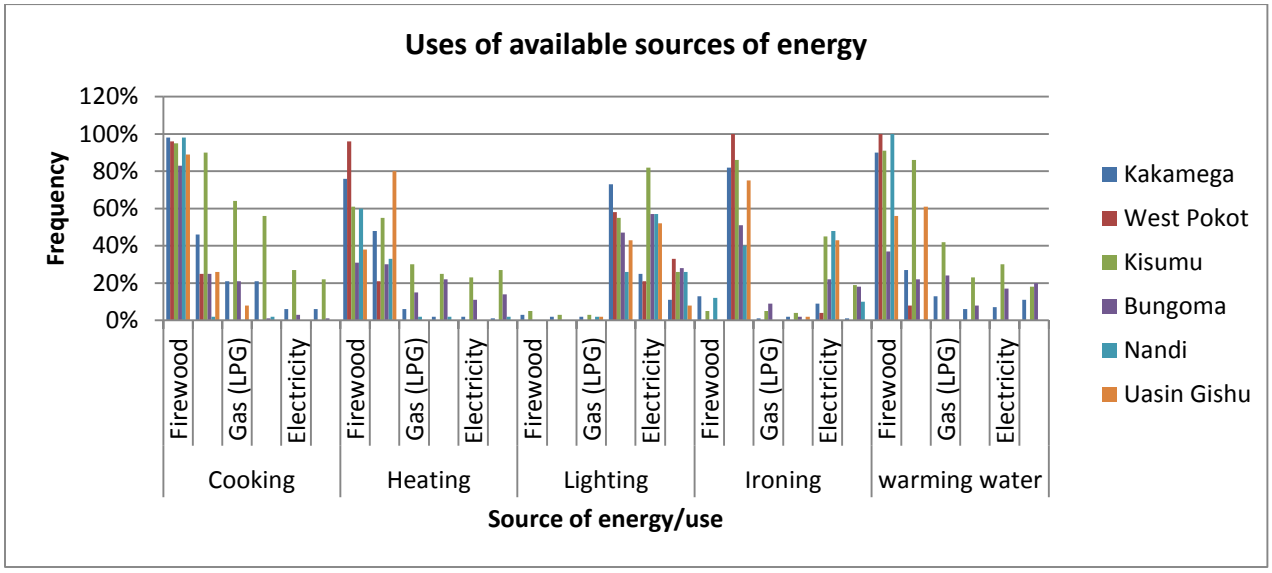


Figure 25: Uses of available sources of energy

23.1.1 Processing and utilization technologies

(i) Charcoal production technologies used

Charcoal production in all the Counties is still done using the traditional earth kiln as shown in the Figure 26 below. However in Kakamega County there are cases where metal kilns are used.

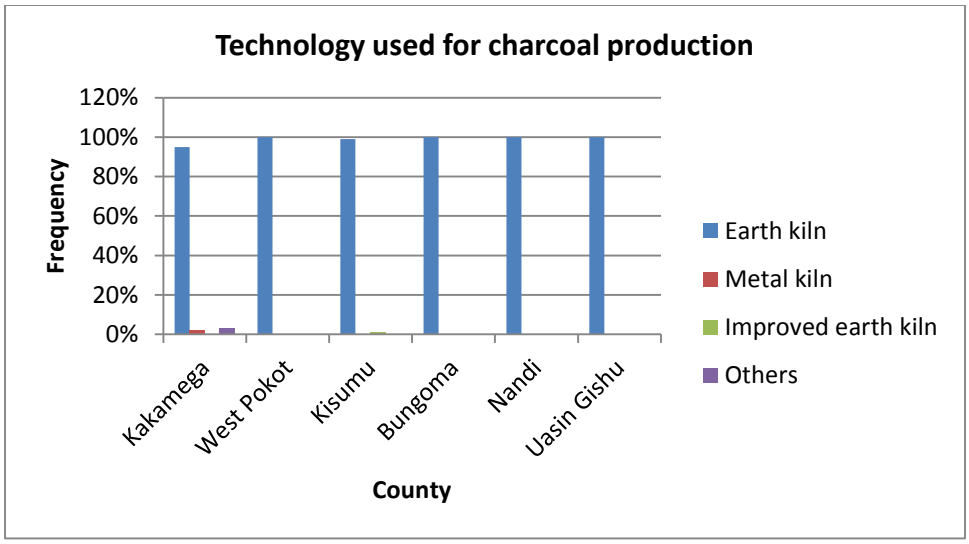


Figure 26: Charcoal production methods

The low adoption of the improved charcoal conversion technologies may be linked to low awareness as indicated in Figure 27 where 96% of the households in all the Counties were not aware of improved methods of charcoal productions.

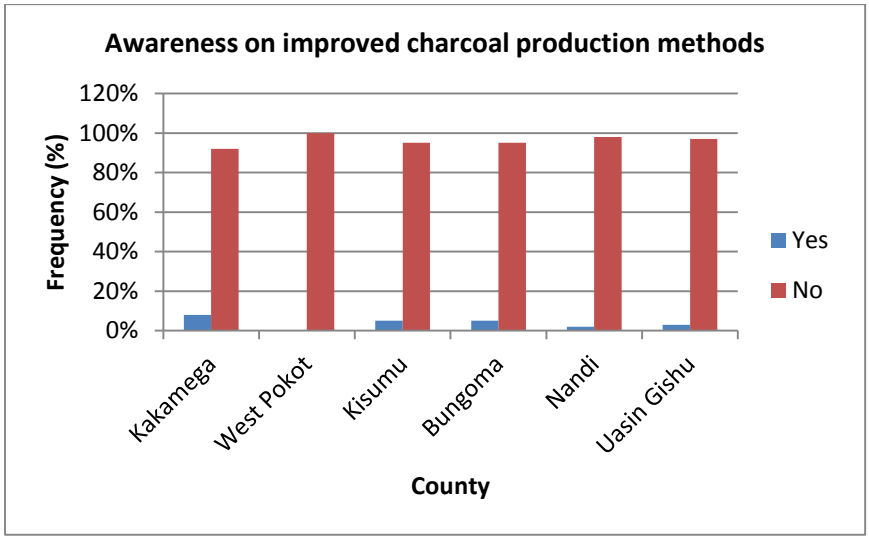


Figure 27: Awareness on improved methods of charcoal production

The household education level did not have influence on the level of awareness on improved methods of charcoal production (Figure 28). 93% of households who attained at least primary level of education were not aware of the improved methods of charcoal production.

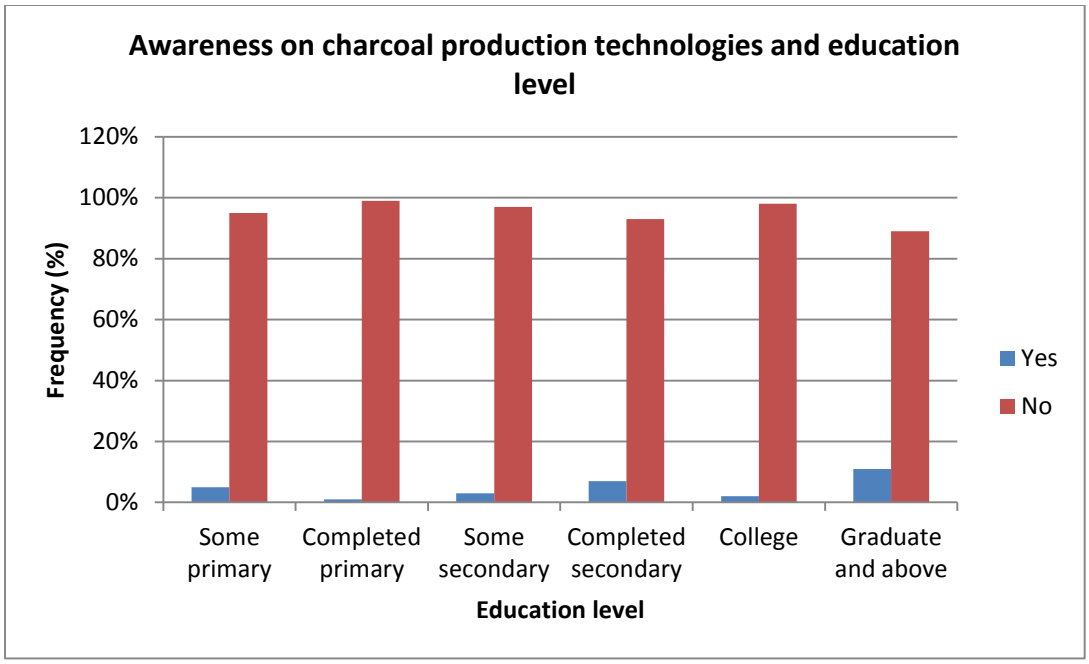


Figure 28: Awareness on improved methods of charcoal production and level of education

One of the strategies to sustainable wood fuel utilization should be creation of awareness of the improved technologies like Casamance kiln which is an improved earth kiln with higher recovery of between 30% and 40%. To increase the adoption of improved kilns in charcoal conversion, the charcoal licenses and movement permits should only be given to those who produce charcoal sustainably through improved kilns.

(ii) Cooking technology used

Majority (79%) of the households still use the traditional three (3) stones for cooking (Table 11). This is also true for all the 6 Counties surveyed (Figure 29). In few areas, the improved firewood stove and improved charcoal stove are being used.

Table 11: Type of cook stove used

Type of cook stove used	Frequency
3 stone fire	79%
Traditional metallic charcoal stoves.	17%
Improved charcoal stove.	14%
Improved firewood stove.	7%
Kerosene stove.	6%
Gas burner.	14%
Fireless cooker	2%
Others	2%

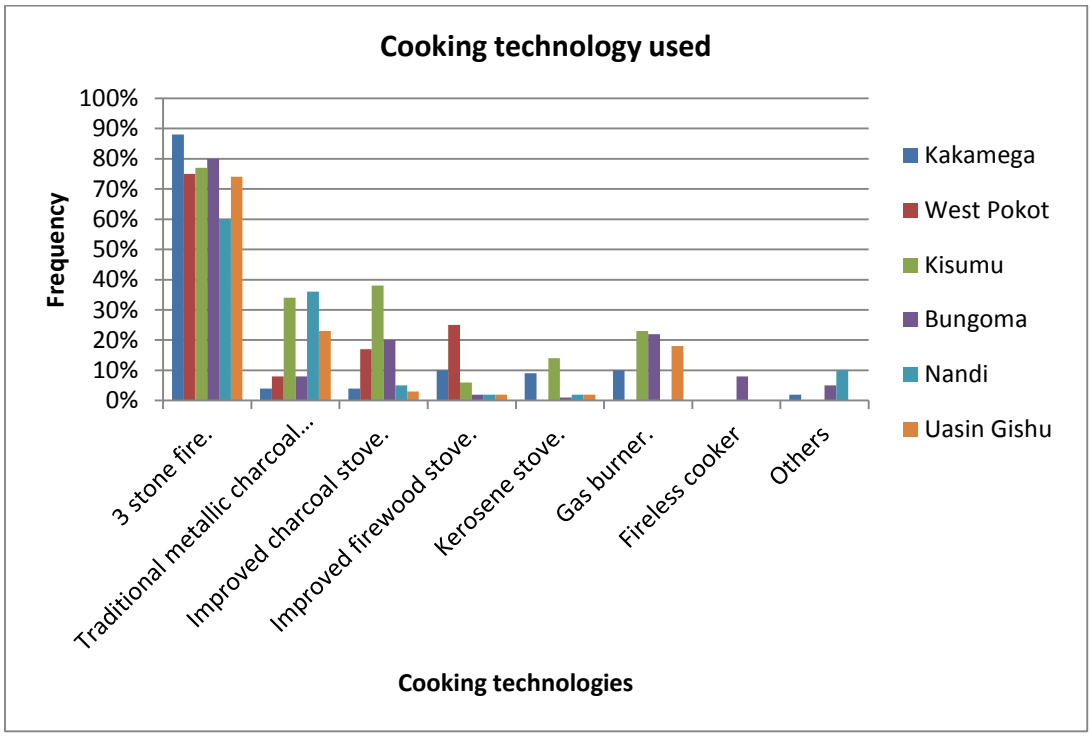


Figure 29: Cooking technologies used

Awareness on improved cook stoves is notable (Figure 30) in all the 6 Counties studied. This could be attributed to the introduction of improved firewood and charcoal stoves by various

organizations in the various Counties studied. However the adoption rate is still low as some households indicated the lack of knowledge on their use and also the high cost of purchasing.

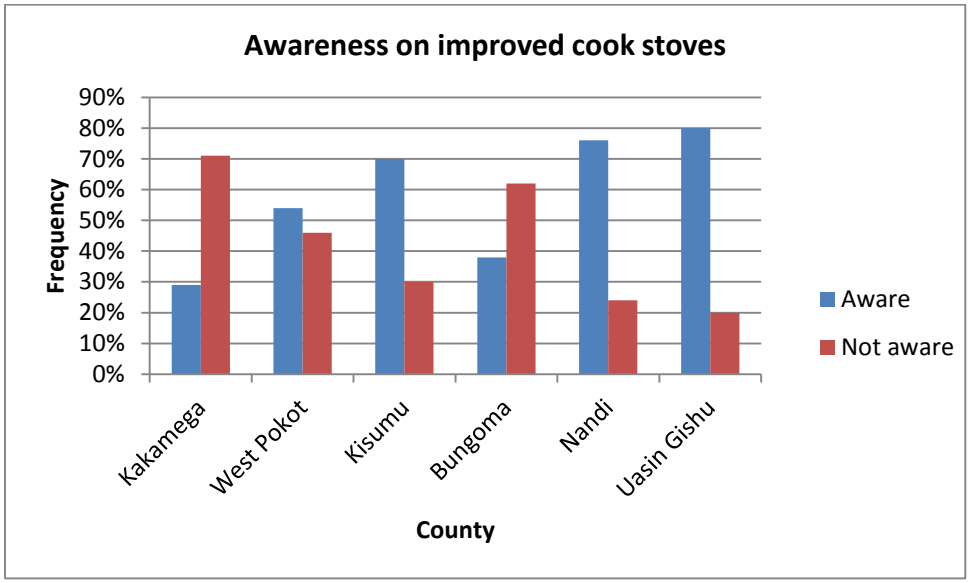


Figure 30: Awareness on improved cook stoves

Even though majority of the respondents were using the 3 stone cook stove, the type of occupation somewhat had influence on the use of improved charcoal stoves with the least number (8%) recorded for the farmers (Table 12). The salaried household heads can be perceived to be able to afford the improved charcoal stoves considering the high percentage of households (30%, 33% and 23% who were clerks, teachers and other occupations respectively) compared to 8% of households who were farmers.

Table 12: Use of cooking technology and occupation of household head

Cooking technology used	Occupation of the Head of Household			
	Farmer	Clerk	teacher	Other
3 stone fire.	84%	30%	81%	70%
Traditional metallic charcoal stoves	16%	20%	15%	18%
Improved charcoal stove.	8%	30%	33%	23%
Improved firewood stove.	6%	10%	7%	8%

Kerosene stove.	5%	0%	0%	9%
Gas burner.	7%	70%	26%	23%
Fireless cooker	0%	0%	7%	4%
Others	2%	0%	0%	3%

The level of education had no influence on the use of improved firewood and charcoal cook stoves as shown in Table 13 below. Across all the levels of education, majority were still using the traditional 3 stone for cooking. It is expected that with high level of education, one would use improved cook stoves. However, the reasons given for the use of the traditional 3 stone in this case were its affordability (you do not have to buy), it is used as per traditions and customs of the people (have been using it ever since) and no skills are required for its use (easy to put up and operate with local skills).

Table 13: Use of cooking technology and Education level of household head

Cooking technology used	Education Level:					
	Some primary	Completed primary	Some secondary	Competed secondary	College	Graduate and above
3 stone fire.	85%	84%	82%	79%	63%	68%
Traditional metallic charcoal stoves	9%	19%	21%	17%	13%	23%
Improved charcoal stove.	8%	7%	15%	10%	35%	25%
Improved firewood stove.	8%	6%	3%	6%	9%	9%
Kerosene stove.	7%	7%	3%	7%	4%	5%
Gas burner.	5%	7%	3%	14%	39%	36%
Fireless cooker	0%	0%	0%	1%	2%	11%
Others	4%	1%	2%	1%	0%	9%

(iii) Awareness on charcoal regulations/laws

As a whole, 52% of the respondents were aware of laws/regulations that govern production and movement of charcoal while 48% were not (Table 14). This however varied within the individual Counties surveyed with Uasin Gishu (97%), Nandi (79%) and Kisumu (60%) having high number

being aware. The highest number (79%) of respondents not aware was recorded in West Pokot County. Charcoal production can be a major contributor to improved livelihoods in many communities. The rules therefore need to be widely disseminated and enforced to the concerned communities and this calls for concerted efforts of all environmental stakeholders.

Table 14: Awareness on charcoal regulations/laws

Awareness	Total	Counties					
		Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Aware	52%	38%	21%	60%	29%	79%	97%
Not aware	48%	62%	79%	40%	71%	21%	3%

24.1.1 Health conditions associated with use of woodfuel

The identified health conditions associated with use of wood fuel were manly related to respiratory conditions resulting from inhaling fumes and smoke. These generally caused chest pains and coughs. Cases of fatigue and suffocation also occurred especially when using charcoal in places with little ventilation. It is suggested that more awareness should be created for improved cook stoves like micro-gasifiers which have very little Green House Gases (GHG) emissions to the kitchens and environment to avoid respiratory health conditions.

Other dangers associated with use of fuel wood included:

- deaths resulting from snake and scorpion bites while fetching firewood
- Accidents occurring while fetching firewood like tree falling on the victim
- miscarriages in pregnant women who fetch firewood and carry
- bees/ insect bites while fetching firewood
- accidents while transporting wood
- burns sustained while unearthing charcoal

1.12 Economic importance derived from use of wood energy sources

The economic importance derived from the use of wood energy in improving the livelihood of individuals and institutions involved in production, supply and consumption of woodfuel is important.

25.1.1 House hold income generated from the fuelwood sales

Raising extra income from sale of the surplus wood fuel demonstrates the potential of woodfuel as source of income to households. Results indicates that charcoal and firewood production for sale from individual farms is very minimal with Nandi County having the highest number of households producing charcoal (33%) and firewood (26%) for sale (Figure 31). Findings show that there are households which sell firewood and charcoal to individual users while others sell to learning institutions/schools.

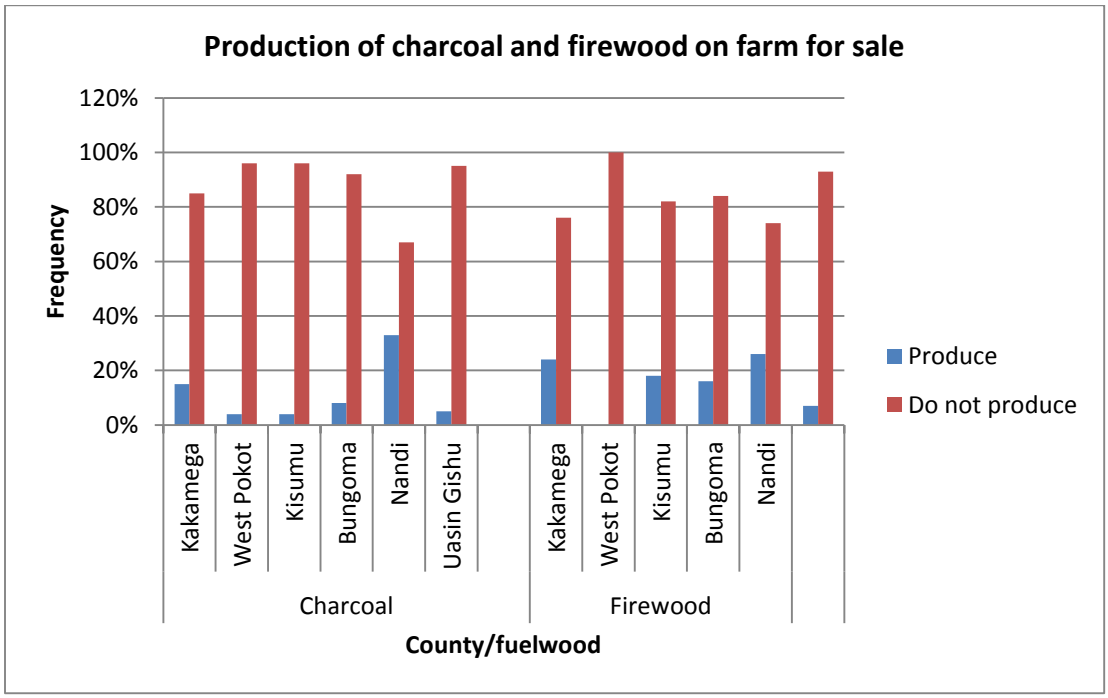


Figure 31: Production of firewood and charcoal for sale

In most household wood fuel collected/purchased was however for own use with only small amount for sale. Table 15 & Table 16 below shows the proportion of households interviewed that have surplus fuelwood and what proportion of households sell the surplus.

Table 15: Proportion of households with surplus fuelwood

Wood fuel surplus/County	Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Surplus (Yes)	46%	47%	26%	48%	30%	12%
No surplus	54%	53%	74%	52%	70%	88%

Table 16: Use of surplus fuelwood

Use of surplus/County	Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Sell	9%	0%	21%	0%	38%	100%
Stock	91%	100%	79%	98%	62%	0%
Any other (specify)	0%	0%	0%	2%	0%	0%

Charcoal production is a major contributor to improved livelihoods of many communities. Sustainable charcoal production can be achieved from own farms if the charcoal rules and improved conversion technologies are adopted. Through the establishment of Charcoal Producer Associations (CPAs) and licensing of charcoal production its commercial production, distribution and marketing can be encouraged. In all the Counties under study, only West Pokot had CPAs established but have not been active since the inception of the devolved government. There are no CPAs in other Counties but illegal charcoal production from the forests was reported. CPAs are responsible for sourcing wood sustainably and ensuring that their members harvest the right species, use the right carbonization technologies, and sell from central collection points. Being a

member of a CPA will improve the efficiency (and sustainability) of charcoal production and help members generate more income through collective action.

26.1.1 Institutions generating income from sale of fuelwood

Most fuel wood supplied from gazetted forests generate revenue for the government as captured by Kenya Forest Service (KFS) based on movement permits. This is more so in Counties like West Pokot, Kakamega and Uasin Gishu which have gazetted forests. Revenue is generated through sale of timber (Blue gum), Monthly Fuel License (MFL) which is mostly for domestic use where households are charged 100/= per month per household for headloads of firewood sourced from the gazetted forests, Charcoal and Timber Movement Permits where charges are made per tonnage such that 2-4 tonnes is charged KSh.1000/=, 5-7 tonnes is charged KShs. 2000/= and more than 7 tonnes is charged charge KShs. 2500/=

Data on revenue generated in 2016-2017 FY up to end of May 2017 in West Pokot County

- Blue gum – 383, 568.55/= (Volume of 64.8m^3)
- Monthly Fuel License (MFL) mostly for domestic use – KShs. 21,600/=
- Charcoal movement permit – KShs. 2.3M (73,365 bags (50kg bags)
- Timber movement permit – KShs.1,330,240/=

1.13 Energy intervention initiatives

From the focus group discussions, a number of energy intervention initiatives are currently being undertaken in the 6 counties surveyed as indicated below. The adoption of energy saving *jikos*, modified three stoned *jiko* in the few households identified has to some extent ensured proper usage of firewood and charcoal plus adoption of solar panels also conserve energy.

27.1.1 Tree planting/environmental conservation

Tree planting initiatives are aimed at increasing tree cover to conserve environment and river banks and also for household income. Individuals with woodlots are able to sell logs as firewood to schools and other institutions and even to other individuals.

This has been accomplished through:

(i) Sensitization of the community members on the benefits of tree planting

This was noted in Kakamega County where sensitization has been done in schools, churches, and other institutions like Colleges and Universities.

(ii) Greening programmmes

School greening programmes, an initiative of Kenya Forest Service (KFS), are undertaken in all the counties. This is done on condition that the target school has fenced the compound to protect the planted trees from destruction by animals. This has gained support by the County governments which buy seedlings from KFS and individual farmers and supplies to schools.

In Uasin Gishu County, an Eldoret town green initiative has been successful and many more are ongoing. The Eldoret Town Initiatives was initiated with objectives of planting more trees around Eldoret town. Youth groups, women groups, universities, NGOs, CBOs and other related authorities are incorporated to ensure that they achieve 1% tree cover per year.

(iii) On-farm tree planting initiatives

On farm tree planting initiatives were reported in all the counties surveyed. The trees are basically planted for firewood, charcoal, timber, poles and also as ornamentals. The approximate area planted with trees on farmlands varies from each farm to the next, depending on the size of land one has. Those with big sizes of land plant woodlots for commercial purpose while those with small sizes practice boundary planting. Notably, in Nandi County land subdivision has resulted into low population of trees on farm. This is because the small pieces of land left are used for growing food crops. Most people therefore do boundary planting of trees. In the low lands of Bungoma County, forests are far as such many people planted woodlots. Preference is also given to woodlots as opposed to boundary planting because there are a lot of boundary disputes reported to KFS office since most do not observe the rules of boundary planting provided. In West Pokot County no much tree planting in the drylands because the survival rate is low because of animals as there is no protection. Tree planting is mostly in the highlands.

The preferred tree species for planting are mostly exotic because they grow faster compared to the indigenous species. Indigenous tree are also planted but on the minimum. Demand for indigenous tree species is very low

Constraints to tree planting

The following constraints were identified during the focus group discussions as hindering factors to tree planting initiatives within Mt. Elgon and Cherengany ecosystems.

- Drought/extreme and harsh weather conditions
- Lack of knowledge on the benefits of trees
- Lack of knowledge on the right area of adaptation for individual tree species
- Cultural beliefs
- insect infestation/destruction like termites and locusts
- livestock interference and poor soils
- Limited land
- Boundary conflicts and not following KFS directive on boundary tree planting

(iv) Establishment of Community Forest Associations (CFA) amongst communities adjacent to gazette public forests

The Forest Act of 2005 Section 46 (1) on community participation in forest conservation and protection allows communities adjacent to gazetted forests to form Community Forest Associations (CFAs). KFS has been spearheading the establishment of CFAs as a way of fulfilling the requirement of the new Forests Act (2005), the implementation of which falls within the mandate of the KFS. Forest associations are found in the Cherengany Forest (1), Mt. Elgon (2), Kakamega (4), and other small forest ecosystems that have a combined number of 10 forest associations. The CFAs involved in forest protection and providing information on destructions in forests, Tendering seedlings in newly opened areas for farming (PELIS). The CFAs are however not able to raise seedlings but is mostly done by individuals member. The members also benefits by getting firewood, getting honey from the forest, grazing and harvesting overgrown timber.

28.1.1 Introduction of improved cook stoves

The introduction of improved cook stoves was noted in all the counties surveyed, however their use in individual households is minimal. Below are highlights of organizations promoting the use of improved cook stoves:-

- In Kakamega County there are households using the Japans G12 model of cook stove notably being constructed by individuals within the county. Kenya Agriculture and Livestock Research Organization (KALRO) and some NGOs have also been promoting energy saving *jikos*. The County government have constructed modern *jikos* to several institutions like the Kakamega referral hospital and Daisy School of the Disabled, and the EMUSARA primary school.

- In Kisumu County Kenya Women Finance Trust (KWFT) sell energy saving *jikos* and solar panels on loan basis to locals. Recently Kirudo women group came up with a good way of improvising the three stones *jiko* in that they teach women how to join the stones with mud and cow dung till only a small opening is left on top. This kind of *jiko* uses less firewood.

29.1.1 Use of alternative energy sources

Use of alternative energy sources were noted in few Counties as highlighted below:-

Kakamega County - The introduction of M-KOPA solar energy initiative by Safaricom which gives out solar panels for lighting within the houses contributes to the reduction in the use of kerosene and firewood for lighting. Many in this community have also installed solar on own initiative for cooking and lighting

Eco2 equilibrium, an NGO, sensitizes the farmers to plant trees and shows them how to produce briquettes from sugarcane waste and sale at affordable prices to their neighbors to add on that they show them how to make energy saving *jikos*.

There are biogases installations which have helped a lot in reducing the production and use of charcoal. These were installed the Green Zone Institution in Bukhungu location in Shirere sub location in Amalemba village.

Kisumu County - initiatives such as solar energy from loaning companies such as M-Kopa solar and lighting of market centers using solar energy in Holo and Ahero areas were noted. Energy

audits are also being carried out in most hospitals and institutions to check on energy usage and encourage implementation and use of alternative sources.

Nandi County - a survey was done to access the needs of the people in terms of energy. This mainly focused on the solar and bio energy aspect. This was an initiative of -Lake Victoria Environmental Management Programme (LAVEMP) and Nature Kenya which came on board to help the community achieve energy sustainability.

CONCLUSION AND RECOMMENDATIONS

1.14 Conclusion

The baseline survey was to a large extent successful in achieving the results which in turn contributed towards the achievement of the overall objectives and project purpose.

The study was able to:

- identify the energy sources used by the communities in the project areas
- determine the energy preferences for the communities in the project areas
- identify and characterize the dominant tree species preferred for energy use in the Counties
- assess the cross-cutting issues (i.e. Livelihoods, shelter and education) and how they relate to energy access and use
- identify possible energy interventions within the communities to ensure sustainability in the project areas;

1.15 Recommendations

Despite the initiatives to ensure energy sustainability, fuel wood energy is still not economically and environmentally sustainable in the counties surveyed with the exception of West Pokot County where fuel wood is not a problem because the tree population in the forest is still high and are well maintained.

More deforestation has been experienced in other counties mainly due to population increase and need for income. To reduce further deforestation due to high demand of firewood and charcoal the following possible intervention measures are suggested to ensure sustainability in the study area.

4.2.1 Promote integration of wood fuel production on farm

Woodfuel production need to be integrated into local farming systems to supplement wood fuel sourced from indigenous forests. This can be supported by intensifying on-farm tree planting

initiatives amongst the individual households by promoting fast growing trees species which match specific environmental and ecological conditions for maximum productivity. Forestry and Agriculture extension officers at the County and Sub-County levels can be used to promote on farm growing of fast growing trees and establishment of commercial woodlots.

4.2.2 Promote use of improved charcoal production technologies and sensitization on charcoal rules

The study showed that almost 100% of the charcoal producers in the study area were using traditional method of charcoal production with between 10% and 20% efficiency. Improved charcoal kilns with efficiency of > 25% should be promoted. Use of dry wood during carbonisation should also be encouraged. The technologies to be used should be simple, cheap and easily adopted by charcoal producers like the improved earth kiln developed by KEFRI (Oduor, 2006). This would lead to a reduction of wood needed for charcoal making significantly.

The continued use of traditional production methods by charcoal producers means low level of awareness on best charcoal conversion methods and the Charcoal Rules 2009 which require them to use efficient charcoal production methods. There is need to create awareness in the area on charcoal production guidelines.

4.2.3 Promotion of improved cook stoves with higher energy efficiency

The conservation of wood energy should be given a priority through promotion of improved stoves with higher efficiency and low emissions. It was observed that over 79% of the households in the study area use 3 stone stoves which were inefficient and also contribute to respiratory health problems. A number of initiatives on the introduction of improved cook stoves were noted in all the counties studied. However the adoption rate is still low as some households indicated the lack of knowledge on their use and also the high cost of purchasing. The improved stoves to be promoted for adoption should consider user needs which include cooking comfort, convenience, health and safety. To ensure availability of cook stoves of affordable prices, training can be offered to artisans at village level on making and maintenance of improved cook stoves.

4.2.4 Promote use of alternative sources of energy

The government policy of promoting cleaner energy use and rural electrification, envisages that the households will slowly substitute woodfuels to alternative cleaner fuels. This will reduce pressure on woodfuel for domestic use leading to its decrease in demand. The use of alternative energy is supported by the Energy Policy of 2004, which promotes the use of cleaner fuels like LPG through subsidies (MoE, 2004). A different system of retailing LPG should be introduced to enable customers to buy whatever quantities of gas they can afford

Alternative uses of energy sources such as solar, biogas and micro hydro power units needs to be promoted in the study area to reduce pressure on fuelwood energy sources used for lighting and cooking. Most of the communities in the study area keep cows in their homesteads and they can be taught the technologies of producing biogas from animal wastes for cooking and lighting. Micro hydro power units have potential to provide energy at a community level on suitable sites remote from the national grid.

4.2.5 Strengthen existing energy centres

The existing energy centers under the Ministry of Energy should be strengthened to assist in disseminating of efficient biomass energy processing and utilization technologies (Biogas production, improved charcoal production kilns, improved cook stoves).

APPENDIX

Appendix 1: Household Questionnaire on Energy sources

SECTION A

Questionnaire No. _____ Enumerator's Name _____
Date _____/ _____/2017
Ecosystem area; County _____ Sub-county _____ Location

DETAILS OF RESPONDENT

Name of the household (Head of Family) _____ Occupation of the Head of Household (e.g. Farmer, Clerk, Teacher, etc.) other…… _____ Number of People in the Household _____ Gender of the head of household Male_____Female _____ Age _____ Education Level: Primary _____ Secondary _____ Tertiary _____ What is the households head monthly income? (KSHS)…….. Other source of income (KSHS)…… How much does the household spend on a daily basis? (KSHS)……..

SECTION B: SOURCES OF ENERGY

1. Type of house
   (i) Stone walled (ii) Timber walled (iii) Cemented wall
   (iv) Mud walled (v) Grass thatched

2. Which of the following do you commonly use as sources of energy for heating and lighting? (Tick as appropriate and rank according to their importance)

Source	Heating(Rank)	Lighting(Rank)
Firewood		
Charcoal		
Crop residues		
Animal dung		
Kerosene		
Gas		
Agriculture waste		
Saw dust/ saw mill wastes		
Biogas		
Briquettes		
Electricity		
Any Others (Specify)		

3. How has the most preferred source of energy changed over the past five years? _____ 1 =No Change 2=Worsen; 3=Improved
4. How many meals per day do you cook? _____ 1=1; 2=2; 3=3; 5>5
5. How many hours a day do you use energy for lighting? _____ 1=1; 2=2; 3=3; 5>5
6. In order of preference indicate the source of woodfuel (firewood and charcoal) that you use? (Rank in order of importance).

Source	Charcoal	Rank	Firewood	Rank
Existing indigenous trees from the farm				
Existing exotic trees from the farm				
Planted woodlots				
Purchased from sellers				
Saw mills				
Gazetted forest				
Trust land				
Others (Specify)				

7. State the trend of the following sources of wood fuel (charcoal and firewood).

Source	Changing		If Yes		Reasons for Increase or Decrease
	Yes	No	Increase	Decrease	
Existing indigenous trees from the farm					
Woodlot					

Purchased from Sellers					
Sawmills					
Gazetted forest					
Trust land					
Others (Specify)					

8. What are the common and preferred indigenous and exotic trees for firewood and charcoal? Indicate as appropriate

Source	Name of the tree species.	Language	Charcoal	Firewood.	Reason.
Indigenous					
Exotic					

SECTION C: SUPPLY AND CONSUMPTION.

9. How much charcoal and firewood do you use daily, weekly or monthly? (Choose only one response for charcoal and firewood)

Charcoal bag	Duration (daily, Weekly/monthly)	Firewood(Head load)	Duration(Daily, weekly, monthly)
Small		1 head load	
Medium		2 head loads	
Large		3 headloads(other)	

10. Are you self-sufficient in firewood and charcoal?
    Charcoal: Yes_____ No_____
    Firewood: Yes _____ No _____
11. Kindly rate the ease of accessibility of the wood fuel (charcoal and firewood)

Wood fuel	Accessibility

Firewood	
Charcoal	

1=Not accessible; 2=hardly accessible; 3=accessible; 4=easily accessible; 5=most easily accessible

12. If **NO** in either cases to above where do you get them? Indicate as appropriate.

Source.	Charcoal	Firewood.
Gazetted forest		
Trust land		
Neighbors farm		
Purchase (Market or vendors)		
Any Other (Specify)		

13. If charcoal or firewood is bought (from the market or vendors) how much is a bag and head load respectively?

Charcoal bag	Amount (KSHS)	Firewood(headload)	Amount (KSHS)
Small		Small	
Large		Large	
Medium		Medium	

14. Where do you get your charcoal from?
Place……..
Distance (Km)……..

15. If **Yes** in either case of **Q10,** do you end up with any surplus? Yes_____ No_____

16. What do you do with the surplus? Sell____ Stock____
Any other (specify)_____

17. In any one occasion, do you produce charcoal/ firewood from your farm for sale?
Charcoal: Yes _____ No _____ Firewood: Yes_____ No_____

18. If yes how often and what quantity do you produce for sale.

Frequency	Charcoal Quantity(small, medium, large)	Firewood Quantity(head load) 0-5,5-10,10-15,15-20,20-25,25-30,30-35,35-40,40-45,45-50, more than 50
Weekly		
Monthly		
Biannual		
Any other		

19. What cost do you sell 1 bag of charcoal and 1headload firewood?

Charcoal: (i) < Ksh 100 (ii) Ksh 100-250 (iii) Ksh 250-300 (iv) Ksh 300-500 (v) Other _____

Firewood: _(i) < Ksh 100 (ii) Ksh 100-150 (iii) Ksh 150-200 (iv) Ksh 200-300 (v) Other _____

20. If the firewood or charcoal is sold from the household farm, who directly benefits from the money received? (i) Man (ii) Woman (iii) Children (v) All

21. What is the diameter of wood used for firewood?
    1. Less than 6 inches
    (ii) 6-9 inches
    (iii) 9-12 inches
    (iv) > 12 inches

22. Which part of wood is mostly used? (Tick as appropriate)
    1) Trunks
    2) Twigs
    3) Branches
    4) Stumps/roots
    5) Whole tree.

23. What is the general opinion on wood fuel situation in your farm? (i) Scarce (ii) Plenty and sustainable (iii) Plenty but unsustainable (iv) Just enough (v) No idea (vi) Other (Specify) _____

24. How is charcoal produced in your area ? Earth kiln _____ Metal kiln _____improved earth kiln---------- Other (specify) _____

25. Are you aware of improved methods of charcoal production Yes------No---------

26. If yes in Q 25 above, name the charcoal conversion methods you know----------
---

27. Which species are preferred for charcoal making in your area?.List in terms of preference -
---

---

28. Do you know of ANY laws/regulations that govern (a) production and movement of charcoal Yes ___ No

SECTION D: LABOUR

29. Who collects the firewood? (You can tick more than one)
    1) Women
    2) Men
    3) Children
    4) Workers/laborers
    5) Others (Specify) _____

30. How many man-hours are used to collect firewood per day/household? _____

31. What distance is the firewood transported?
    (i) Less than 2 km.
    (ii) 2.5 km.
    (iii) Over 5 km.

32. Has this distance (20) been the same? Yes _____ No _____

If **No,** why?

i)Scarcity of woodfuel
ii)Lack of preferred species
iii)No idea
iii) Others specify

_____

SECTION E: USES OF WOODFUELS AND OTHER ENERGY SOURCES

33. How are the available energy sources used? (Tick as appropriate).

Energy Uses	Firewood	Charcoal	Gas (LPG)	Kerosene	Electricity	Other (Specify)
Cooking						
Heating						
Lighting						

Ironing						
Warming Water						

34. What is the quantity of other sources of energy do you use per month?

Source of Energy	Quantity in litres, Kg, KW	Cost
Kerosene		
Gas		
Electricity	*(KW or money used*)	
Other (Specify)		

35. In your own opinion what are the advantages of using woodfuel (charcoal & firewood) over other energy sources (Kerosene, Gas, Electricity, Biogas and Solar). _____ _____ _____ _____

36. What are the threats towards woodfuel as a source of energy? (e.g. scarcity of land, clearing without planting, increased demand by tea factories, etc.) _____ _____ _____

37. What are your suggestions towards effective sustainability of woodfuel as the energy source in your place? _____ _____ _____

SECTION F: COOKING TECHNOLOGY USED

38. Which cooking technology do you use? (Tick as appropriate and rank)
    1) 3 stone fire.
    2) Traditional metallic charcoal stoves.
    3) Improved charcoal stove.
    4) Improved firewood stove.
    5) Kerosene stove.
    6) Gas burner.
    7) Fireless cooker
    8) Others _____.

39. Why do you use the selected technology?

Technology	Reason for Use	Types of food cooked	Cost of the Stove Ksh.
1) 3 stone fire			
2) Traditional metallic charcoal stoves			
3) Improved charcoal stove			
4) Improved firewood stove			
5) Kerosene stove			
6) Gas burner			
7) Fireless cooker			
8) Others			

40. How much time does it take to cook the foods mentioned above?

Types of food cooked	Time spent cooking (Minutes)
1.	
2.	
3.	
4.	
5.	

41. Have you heard of improved cook stoves? Yes_____ No_____

42. Do you possess one? Yes_____ No_____

43. If yes, who decided on the improved energy appliances to be bought?

44. If **NO**, why?
    1) Cost
    2) Non-availability
    3) Not interested
    4) Others _____.

    (You may tick more than one).

45. Are there any health problems associated with the use of woodfuel? Yes ____ No ____

46. If Yes, what type of the problems and how can they be solved.

Problems: _____

Solutions: _____

47. What are some of the ways of reducing pressure on the forest to reduce energy dependence?

    1. 2. 3.

48. Are there energy conflicts (warming, lighting, domestic violence from food smelling smoke e.tc. within the family?
    1. 2. 3.

49. What are some of the environmental and social impacts of using fuel wood energy?
    1. 2. 3.

50. What are the perceptions on utilization of fuel wood from the forest?
    1. 2. 3.

51. What are the challenges with energy saving jikos? (capture technology uptake issues and perceptions)
    1. 2. 3.

52. Would you like to be contacted again for further discussion on energy sources; Yes _____
    No _____

    If Yes please give us your contact:
    Name. _____
    Address _____
    Tel_____

53. Comments by the enumerator _____
    _____
_____
_____

Appendix 2: Key Informants Interview Guide

Target group: {KFS (EC, FORESTERS), Local administration, NGOs}

1. What are the main sources of energy in the County/Sub County? Are the sources of energy readily available and affordable to the communities?
2. What are the quantities of wood energy supplied from gazetted forests based on the movement permit?
3. Are there any registered Charcoal Producer Associations (CPAs) in the area?
4. Which charcoal production techniques are being used in the County?
5. What are the main reasons for tree planting in the county? Does it address firewood and charcoal needs in the County/Sub County?
6. Are there any energy interventions within the communities?
7. What is the relationship between the level of education and type of household homes to energy sources?
8. Is fuel wood energy and charcoal economically and environmentally sustainable in the county?
9. What technologies have been used to ensure sustainable energy management?
10. Which organizations assist the community to achieve energy sustainability?

Appendix 3: Focus Group Discussion Guide

Target group: CFA Committees, CBOs, Community members

1. What are the sources of energy used in your area?
2. What are the preferred energy sources?
3. What are the possible intervention measures to ensure sustainability of the energy source without adverse effect to environment?
4. What is the approximate land area planted with trees on farmlands
5. What are the preferred tree species for planting?
6. What are the constraints to tree planting in the area?
7. Which types of cooking stoves are used by the households?
8. Is there any income generated from the wood fuel sales?
9. What health conditions are related to energy sources?
10. Which charcoal conversion methods are used in your area?

Appendix 4: List of species observed

Species	Frequency %	Plant type	Species	Frequency %	Plant type
Abizia coriara	0.65	Indigenous	*Morus abla*	0.08	Indigenous
Acacia mearnsii	3.39	exotic	mosolen(pokot)	0.08	Indigenous
Acacia mellifera	0.32	Indigenous	mtororo	0.08	Indigenous
Acacia nilotica	0.16	Indigenous	Mtoto	0.16	Indigenous
Acacia seyal	0.08	Indigenous	mukambi	0.08	Indigenous
Acacia Sp	1.45	Indigenous	mukomari	0.08	Indigenous
Acaia polyacantha	0.08	Indigenous	mulandangombe	0.08	Indigenous
Afzeli quanzensis	0.24	Indigenous	*Musa acumunata*	0.08	Exotic
Albizia coriara	2.91	Indigenous	Musassett	0.08	Indigenous
Albizia gummifera	0.08	Indigenous	musemwa	0.08	Indigenous
amarakalu	0.08	Indigenous	musioma	0.08	Indigenous
Annona senegalensis	0.08	Indigenous	Mutswuli	0.08	Indigenous
Artocarpus heterophyllus	0.24	Indigenous	*Myrsine melanophloeos*	0.08	Indigenous
awat	0.08	Indigenous	nabiili	0.08	Indigenous
Azadirachta indica	0.73	Indigenous	namtoto	0.08	Indigenous
Balanites aegyptica	0.32	Indigenous	ndege	0.08	Indigenous
bibilia	0.08	Indigenous	none	0.32	Indigenous
Bridelia micrantha	0.16	Indigenous	Nya maragoli	0.08	Indigenous
Calistemon citrinus	0.16	exotic	obino	0.16	Indigenous
Calliandra calothyrsus	0.16	exotic	Ochok, onera, madat	0.08	Indigenous
Carica Papaya	0.40	exotic	ogaka	0.08	Indigenous
Carissa spinarum	0.08	Indigenous	*Olea capensis*	0.08	Indigenous
Casimoroa edulis	0.08	Indigenous	*Olea europeae*	0.08	Indigenous
Casuarina equisetifolia	0.32	exotic	Olukhoni	0.08	Indigenous
Cedar	0.16	Indigenous	Olukhoni(Wanga)	0.08	Indigenous
chebarus	0.48	Indigenous	Omukhule	0.08	Indigenous
Cheborusiot(Nandi)	0.08	Indigenous	omukokongo	0.08	Indigenous
Chemakaltinik	0.08	Indigenous	Omurave	0.08	Indigenous
Chesim	0.08	Indigenous	omushilinya	0.08	Indigenous
Cheulayat	0.08	Indigenous	omushirinya	0.08	Indigenous
Cheulayatt	0.16	Indigenous	Omusioma	0.08	Indigenous
chinduli	0.08	Indigenous	Ondilo	0.08	Indigenous
Christmas tree	0.24	exotic	onera	0.08	Indigenous
Citrus limon	0.24	exotic	owinoo	0.08	Indigenous
Combertum collinum	0.08	Indigenous	*Persea americana*	3.63	Exotic
Combretum collinum	0.16	Indigenous	*Phoenix reclinata*	0.08	Indigenous
Cordia abyssinica	0.08	Indigenous	*pine*	0.08	exotic
Cordia Africana	0.24	Indigenous	*Pinus patula*	3.39	Exotic
Croton macrostachyus	2.99	Indigenous	*Pinus sp.*	0.08	exotic
Cupressus lusitanica	10.66	Exotic	*Podocarpus Sp*	0.16	Indigenous
Diospyros abyssinica	0.24	Indigenous	porowo	0.08	Indigenous
Ecalyptus Sp.	18.50	Exotic	*Prunus africana*	0.57	Indigenous
Entada abyssinica	0.08	Indigenous	*Psidium guajava*	1.94	Indigenous
Eryobotrya japonica	0.16	exotic	Pumettiot	0.08	Indigenous
Erythrina abyssinica	0.08	Indigenous	red accacia	0.08	Indigenous

Euclea divinorum	0.08	Indigenous	Remiit	0.08	Indigenous
Euphorbia Sp.	0.32	Indigenous	*Rhus natalensis*	0.08	Indigenous
Euphorbia tirucali	0.89	Indigenous	*Ricinus communis*	0.08	Indigenous
Fagaropsis angolensis	0.08	Indigenous	sait	0.08	Indigenous
Ficus sycomorus	1.70	Indigenous	sanandet	0.08	Indigenous
Ficus thonniingii	0.08	Indigenous	*Sapium ellipticum*	0.65	Indigenous
Ficus thonningii	0.24	Indigenous	saye	0.16	Indigenous
Flacourtia indica	0.08	Indigenous	*Senna singueana*	0.08	Indigenous
Garcinia buchananii	0.16	Indigenous	*Senna sp*	0.08	Indigenous
Grevillea robusta	12.20	Exotic	*Sesbania sesban*	0.24	exotic
Hae	0.08	Indigenous	Shikangania	0.08	Indigenous
imbeko	0.08	Indigenous	sokorya	0.16	Indigenous
Jacaranda mimosifolia	1.78	Indigenous	soworswo	0.08	Indigenous
jalio	0.08	Indigenous	*Spathodea campanulata*	0.08	Indigenous
jerusalem	0.08	Indigenous	*Synepalum brevipes*	0.08	Indigenous
Juniperus procera	0.73	Indigenous	*Syzigium cuminii*	0.08	Indigenous
kasia	0.08	Indigenous	*Syzygium cordatum*	0.40	Indigenous
Kigelia africana	0.08	Indigenous	*Syzygium cuminii*	0.32	Indigenous
kipou	0.16	Indigenous	*Syzygium guineense*	0.08	Indigenous
kokop	0.08	Indigenous	tebengwett	0.08	Indigenous
Kombolwett	0.08	Indigenous	*Terminalia brownii*	0.08	Indigenous
kpou	0.24	Indigenous	*Terminalia mollis*	0.08	Indigenous
kumapulusi	0.08	Indigenous	*terminalia sp*	0.08	Indigenous
kumlemba kunyali	0.08	Indigenous	*Terminalia sp.*	0.16	Indigenous
lamai	0.08	Indigenous	*Thevetia peruviana*	0.48	Indigenous
Lannea schweinfurthii	0.08	Indigenous	*Tithonia diversifolia*	0.08	Indigenous
Lantana camara	0.16	Indigenous	tororo	0.08	Indigenous
Leucena leucocephala	0.24	exotic	Totoro	0.08	Indigenous
lunga	0.08	Indigenous	*Trichilia emetica*	0.08	Indigenous
madat	0.32	Indigenous	tuino	0.08	Indigenous
Mangifera indica	4.28	Exotic	umbrella tree	0.65	exotic
Markhamia lutea	7.35	Indigenous	*Vangueria infausta*	0.08	Indigenous
mbortin	0.08	Indigenous	*Vitex doniana*	0.16	Indigenous
member,linear,liramwa	0.08	Indigenous	*Vitex fischeri*	0.08	Indigenous
mikambi	0.08	Indigenous	*Warbugia ugandensis*	0.16	Indigenous
Milicia excelsa	0.32	Indigenous	white gum	0.08	Indigenous
mkambi	0.24	Indigenous	*Zanthoxylum gillettii*	0.08	Indigenous
mkwaju	0.08	Indigenous	*Ziziphus mauritania*	0.08	Indigenous

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