MINISTRY OF ENERGY AND MINERAL DEVELOPMENT (MEMD)

NATIONAL CHARCOAL SURVEY FOR UGANDA 2015

FINAL REPORT

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Empowered lives.
Resilient nations.

Consultants and Acknowledgements

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List of acronyms

BEST	Biomass Energy Strategy
CBOs	Community Based Organizations
CDM	Clean Development Mechanism
CEDAT	College of Engineering, Design, Art and Technology
CFR	Central Forest Reserves
CSOs	Civil Society Organizations
CV	Calorific value
DFOs	District Forestry Officers
EAC	East African Community
ELTRA	Elemental Analysers for C H N O S Analysis
FAO	Food and Agriculture Organization of the United Nations
FGDs	Focus Group Discussions
GDP	Gross domestic product
GEF	Green Charcoal Project
HHV	Higher heating value
HIV	Human Immunodeficiency Virus
AIDS	Acquired Immunodeficiency Syndrome
ICS	Improved Cookstoves
KCCA	Kampala City Council Authority
KIIs	Key Informant Interviews
LC	Local Council
LPG	Liquefied Petroleum Gas
MEMD	Ministry of Energy and Mineral development
MOU	Memorandum of Understanding
MSG	Medium Scale Growers
MSW	Municipal Solid Waste
NAMAs	Nationally Appropriate Mitigation Actions
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NFP	National Forestry Plan
NGOs	Non-Governmental Organization
PCF	Prototype Carbon Fund
PES	Payment for Ecosystem Services
POAs	Programme of Activities
RAID	Rachar Agroforestry Initiative for Development
REDD	Reducing Emissions from Deforestation and Forest Degradation

RGI	RebelGroup International
SSG	Small Scale Growers
ToRs	Terms of Reference
UBOS	Uganda Bureau of Statistics
UGX	Uganda Shillings
UNDP	United Nations Development Programme
USD	United States Dollars
VCS	Verified Carbon Standard
VM	Volatile matter
YYAG	Youth to Youth Action Group

Executive summary

In response to the un-professionalized charcoal industry marred by unsustainable wood harvesting and charcoal production, the Ministry of Energy and Mineral development (MEMD) and UNDP commissioned the National Charcoal survey for Uganda 2015 to provide baseline information for the "Addressing Barriers to Adoption of Improved Charcoal Production Technologies and Sustainable Land Management Practices through an Integrated Approach-Green Charcoal Project".

This report therefore presents an analytical status of charcoal production, supply and usage in Uganda. Specifically, it presents information based on data gathered during the survey along the charcoal value chain and makes recommendations that are geared towards enhancing sustainable charcoal production and trade in the Uganda. This data will be fed into the national statistics and will strengthen the monitoring of biomass energy and charcoal production/usage countrywide.

The survey aimed at generating adequate and reliable data and information on the charcoal industry in Uganda; aiding proper planning and informed decision-making by authorities involved in the management of the charcoal industry; creating a national data base on charcoal; creating a baseline situation for the GEF project and other future interventions; heightening awareness and making the public more knowledgeable on the charcoal value chain and trade.

The survey utilized a multi-method technique approved by UBOS to collect information. This technique comprised of; review of relevant documents, Charcoal Consumption Survey, fuel price market survey, Key informant interviews, Focus Group Discussions, Traffic survey, Cross border charcoal trade survey, Charcoal quality testing and On-Site assessment.

The charcoal consumption survey utilized a quasi-cross-sectional research design given that this was a baseline national charcoal survey. The sample was selected from all the 10 statistical regions[1] in order to achieve a representative scenario of charcoal consumption in the entire country. A total of 2880 households in the entire country were sampled using a multistage sampling technique and were subjected to

[1] According to the Uganda Bureau of Statistics (UBOS). 2014. Uganda National Household Survey 2012/2013. Kampala Uganda; UBOS. there are 10 statistical regions namely: Kampala, Central I, Central II, East Central, Eastern, Mid-Western, North-East, West-Nile, Mid-Western, and South Western

an approved and pretested questionnaire. A total of 990 institutions comprising of schools, hotels, hospitals, prisons, barracks and industries were sampled as well.

Charcoal quality testing was conducted at the College of Engineering, Design, Art and Technology (CEDAT). All the charcoal samples were collected from Earth mound kilns in 25 out of 28 districts. The charcoal parameters analysed were heating value, fixed carbon, volatile matter, moisture content, ash content, bulk density and hardness.

Data was cleaned and entered using EPIDATA and Excel screens, double-checked and exported to STATA for further management, processing and analysis. The analysis was largely descriptive using frequencies, totals, ratios, rates and graphs organized according to statistical regions. Some bivariate and multivariate analysis was used to get a better understanding especially of the key variables. The results of the quantitative analysis were triangulated with the results of the qualitative analysis to get a better understanding of the results.

The study found that the main source of wood for charcoal production in Uganda is from privately owned forests (43%), followed by central forest reserves (22%), on-farm trees (20%) and others (14%). The study further shows that there is no dedicated forest plantations for charcoal production.

The study found that only 41% of charcoal producers engage in full-time charcoal production. According to charcoal producers, a total of 101 tree and shrub species are used for charcoal production. The major tree species/shrubs used are Acacia hockii, Ficus natalensis, Albizia coriaria, Eucalyptus grandis, Combretum molle, Maesopsis eminii, Mangifera indica and Milicia excelsa.

The majority of charcoal producers (89%) indicated that they do not sort the wood species before burning charcoal. Majority (63%) of the producers reported an output of 0.5 to 10 bags per carbonization process. Most charcoal is produced during the wet season (48%) because producers readily access wet soil to cover the kilns. On the other hand, 36% of the producers noted that they mostly produce charcoal during the dry weather since they are less busy with agricultural activities.

Also, the study noted that majority of the charcoal producers conduct carbonization processes within their home localities. It was also found out that the challenges experienced most by charcoal producers included high labour intensity, wood scarcity and health complications.

Majority of charcoal producers utilize the earth mound (traditional) kilns to produce charcoal. District Forestry Officers (DFOs) recommended sensitization and training of charcoal producers through demonstrations and regulation of the sector to compel charcoal producers to adopt efficient technologies.

Charcoal supply to all urban centres is mainly carried out by charcoal transporters. The Kampala charcoal business chain comprises of suppliers buying a bag of charcoal at an average of UGX. 25,000/= from producers and selling it at an average of 44,700/= per bag to vendors and users. About 837 Metric Tonnes of charcoal are supplied to Kampala per day in dry season and 1,017 Metric Tonnes of charcoal in the rainy season. The traffic survey and cross-border survey indicated that the charcoal trade across the border is two-way.

The survey indicates that central (40.9%) and northern regions (39.5%) are the major sources of charcoal. Furthermore, central region is the main source of charcoal supplied to Kampala (63.4%), followed by northern region (21.8%). The leading supplier-districts of charcoal to Kampala comprise of Nakasongola, Nakaseke, Luwero, Kyakwanzi, Masindi, Kiboga, Gulu, Arua, Mukono, and Hoima. Interestingly, only 43% of the charcoal transporters had movement permits.

Charcoal is mainly consumed in urban areas while firewood is mostly used in rural areas. In the urban areas, 65.7% of the households use charcoal while 33.4% use firewood for cooking. On average, a household spends more (UGX 2,015/=) on the main cooking fuel per day during the wet season than in the dry season (UGX 1,942/=). Households in Kampala purchase a bag of charcoal at an average price of UGX. 56,600/=. Overall, about 4,961 metric tonnes of charcoal is used by households in Uganda per day. Important to note is that only 9.6% of the households enrolled in the survey were using improved cookstoves (wood and charcoal), only 0.1% were using LPG while majority were using 'wasteful' traditional (three stones, clay and metallic) stoves.

Institutions use various fuels comprising of firewood, charcoal, LPG, electricity and others for heating and cooking. Specifically, 49% of the institutions in Uganda use charcoal as the main fuel for cooking during the dry and wet seasons. In addition, institutions consume a total of 887.3 metric tonnes of charcoal per day. 22.7% of the institutions use improved cookstoves (firewood or charcoal) and 11.9% use LPG.

Laboratory tests indicated that the average moisture content of charcoal is 5.5 %, with an average fixed carbon content of 69.9%. The average heating value of charcoal was found to be 29.7 MJ/kg which is within the range of 27 - 33 MJ/kg for good quality charcoal. In conclusion, the charcoal is generally of acceptable quality irrespective of the wood species used and the charcoal produced from different areas of Uganda is of consistent quality.

Charcoal production is practiced in almost all the districts in Uganda, mainly from privately owned forests, following tree felling for construction or during land clearing for farming. The replenishment of trees is critically poor. The charcoal production process is wasteful and comprises of unskilled labourers with little or no attention given to the charcoal quality. Specifically, majority of the charcoal burners are not knowledgeable of the best production practices such as sorting wood prior to carbonization.

Traditional earth mound kilns are predominant and the adoption of improved charcoal production kilns is majorly hindered by the producers ignorance of the available improved options. Moreover a permanent improved kiln is not feasible for most charcoal burners in Uganda, who engage in charcoal production as a part time activity. Charcoal production is commonly done on site (or near forests being cleared) to avoid the challenges of transporting wood to distant sites.

The supply of charcoal to Kampala is done throughout the year but is marred with poor transportation practices which compromise the quality of charcoal, such as, wetting of charcoal by rain, breaking of charcoal during transportation, compaction during loading and throwing charcoal bags during offloading. This culminates into a loss to the vendor and consumer. The vendors sell charcoal in volumes and not weight and sell both poor and good quality at the same price. Charcoal for domestic purposes alone consumes approximately 32% of the average household income.

In general, the charcoal sector is poorly regularly and in its current form is unsustainable. Sustainable production of quality charcoal that meets international standards for exportation and local consumption requires a multi stakeholder approach with significant contributions by key players at all stages of tree planting, harvesting, sorting, carbonization, packing, transportation, marketing and consumption. Dedicated fast-growing tree plantations of approximately 15,000 hectares per district for charcoal production should be established. The unutilized government land should be leased to investors to plant tree deliberately for charcoal production. The use of mobile improved kilns (portable metal kilns) should

be promoted since charcoal producers move from place to place sourcing for feedstocks.

The subsector value chain players should be organised into associations through which interventions such as trainings could be conducted to professionalize the industry. Importantly, the use of non-woody biomass feedstocks should be promoted for charcoal production. Investment in the use of alternative fuels such as biogas, briquettes and LPG should be made to reduce pressure on the available charcoal feedstock.

1 Introduction

1.1 Overview of biomass resources in Uganda

Uganda is estimated to have a forest area of 2,347,400 Hectares, depicting a forest area of 9% to the total land area.[8] Uganda's vegetation cover (trees, forests and woodlands) significantly reduced from 45% in 1890[1] to about 14%[2] in 2010 and to 11.7% in 2013[3], due to the ever increasing pressure and demand exerted by the rapid population growth and economic activities[4-6]. If not curbed, Uganda's forest cover will not improve and attain the Uganda Vision target of 24%.[9]

While Central Forest Reserves (CFRs) are still well protected, most of the deforestation takes place on public and private land. The high rate of deforestation and high charcoal consumption result in an accelerating discrepancy between demand and supply. Uganda is already estimated to have moved into national fuel wood deficit in the year 2000. [10] This decline already affects the poorest Ugandans, in terms of time and money, who are the least able to respond to shortages and use of alternative sources.[11]. The districts, which are rapidly losing vegetative cover, include Masindi, Nakasongola, Luweero and other districts surrounding the three major consuming cities Kampala, Jinja and Entebbe.[11]

1.2 Existing Policy and Regulatory Frameworks

Existing policies and regulatory frameworks in Uganda are focussed on recognising the role of forestry in national development. The Constitution of Uganda obligates government to, "promote and implement energy policies that will ensure that people's basic needs and those of environmental preservation are met." In line with the constitution, several policies and legal instruments like National Environment Act, Cap 153 (1995), the National Forestry Policy (2002), National Forestry and Tree Planting Act (2003), the Land Act (2001), the Local Government Act (1997), National Environment Policy (1995), National Wetlands Policy (1994), the Uganda Wildlife Policy (2003), Biomass Energy Strategy 2013 and Vision 2040 have been formulated.

All these regulatory frameworks support sustainable use of natural resources including forestry resources. However, the level of compliance to these policies

and regulations is still very low leading to misuse and degradation of the environment.[4]. Despite the existence of these supportive legal frameworks, the forestry sector still faces the challenges of low funding and poor regulation.

1.3 Overview of the Biomass Sector

Biomass is the main source of energy in Uganda, contributing about 94% of all energy consumed.[15] Of the total biomass consumed, wood fuel accounts for about 80%, charcoal 10% and crop residues 4%.[16] Firewood and crop residues are majorly consumed in rural areas while charcoal is consumed in urban areas. Limited storage space in urban areas, high standards of living, higher calorific value of charcoal than for wood and easier handling by vendors makes charcoal the favoured fuel over firewood in urban areas. [11]

The charcoal subsector provides employment to a large number of semi-skilled and unskilled labourers at different stages of production, transportation and distribution. The contribution of firewood and charcoal to Uganda's GDP is estimated at USD 48 million and USD26.8 million respectively.[19] Despite its significant contribution to the national energy supply and economic development, the subsector is unfortunately characterized by low interest from investors, inadequate enforcement of regulations, poor organisation of players, use of inefficient technologies, lack of standards and unsustainable production practices.[13]

1.3.1 Charcoal production in Uganda

According to the findings of an earlier survey on charcoal supply in Kampala, the five most important charcoal production districts for Kampala are Luweero (25.3 %), Nakasongola (14.5 %), Kiboga (13.6 %), Mpigi (10.8 %) and Masindi (6.9 %).[11]

Traditional earth kilns dominate the production of charcoal in Uganda. These include the Kinyankole ("the bus") and the Kasisira ("the banda") earth kilns with an estimated wood to charcoal conversion efficiency between 10-15% maximum.[11]. Charcoal is often produced from species are slow growing and are therefore particularly vulnerable to overexploitation. Consequently, its production has raised concerns about its ability to sustain the growing demand and its negative impacts on the environment. [22, 23].

Introducing improved technologies may increase efficiency to achieve 3 to 4 kg of wood per kg of charcoal which is 60% to 50% efficiency respectively on an energy basis.[13]

Relatedly, as part of the Nationally Appropriate Mitigation Action (NAMA) for Uganda, the Casamance and Adam retort kilns are recommended as means of producing green charcoal in the country.[13]

1.3.2 Charcoal consumption

Charcoal is the most preferred fuel for heating and cooking in urban areas both by households and commercial enterprises.[13] By 2004, the annual consumption of charcoal was about 400,000 tonnes, 300,000 tons of this being consumed in Kampala alone.[11].

The per capita consumption of charcoal in Uganda is 4kg/year and 120kg/year for rural and urban areas respectively. Alternative fuels used in urban households include kerosene, LPG and electricity; however their usage is majorly limited due to the high installation costs and expensive fuel.[13]

1.3.3 Improved/ energy efficient cookstoves

In Uganda, 78% of the population uses '3-stone open fire' while about 10%uses improved charcoal and wood [13]. Use of traditional metallic charcoal stoves is estimated at 80% in urban areas.[13]. Improved charcoal stoves, improved wood stoves and institutional stoves reduce fuel consumption by an average of 36%, 58% and 45%, respectively.[25]. Also, users enjoy a much healthier cooking environment since the cleaner burning stoves cause significantly less smoke.[26]

In the last decade, effort has been made to promote adoption and continued usage of ICS with the government target to reach 6.5 million households using efficient charcoal and wood stoves by 2017.[19]

1.4 Charcoal Quality

The quality of charcoal is perceived in many ways depending on its end use. Both scientific and non-scientific methods are used in defining quality of charcoal. The energy content (as given by the heating value), density, volatile matter (VM) content, fixed carbon, ash content, and burning time - all represent the key elements used to appreciate the different types of charcoal. Intrinsically, charcoal of good quality retains the grain of the wood. It is jet black in colour with a shining lustre in a fresh cross-section. It is sonorous with a metallic ring, and does not crush, nor does it soil the fingers. It floats in water, is a bad conductor of heat and electricity, and burns without flame. [27]

Some standards have been quoted to define what should be expected in a good quality charcoal. Typically, heating values should be between 28 and 33 MJ/kg, whereas volatile matter in the range of 20 – 30% (domestic) and 10 – 15% (metallurgical) and ash content of 0.5 – 5% are generally accepted.[28]

Other tests that are generally acceptable as a measure for charcoal quality include: crashing effect, hardness and lump formation.[29] Crashing effect represents the tendency of the charcoal lump to remain in its shape without disintegrating, i.e. its hardness. Lower effect shows the ability of charcoal to be transported or handled over time without being crashed into powder. A hardness pencil is standard tool for measuring this property. Lump formation is the tendency to form larger size lumps. These are normally harder, more stable and more regular (resembling the wood pieces from which they were carbonized). Larger lumps are therefore associated with high quality charcoal.

2 Rationale

The entire value chain of charcoal in Uganda is not well understood and there has been scanty information on what is happening in the sector and the contribution of charcoal to the national economy. In addition, the sector is plagued by challenges that need to be adequately addressed. Such challenges include poor methods of charcoal production, packaging, transportation, absence of standardization, negligible forestation for charcoal production plus inadequate regulation of this sector. Although these challenges are generally acknowledged as existent, until now, they have not been assessed quantitatively to facilitate appropriate policy formulation and interventions necessary for sustainable charcoal production and use.

Proper regulation of the charcoal sector could present a conducive investment environment which in turn could increase job opportunities. For instance, the sector could benefit from increase in commercial charcoal producers committed to sustainable production, in addition to the small scale individual charcoal producers who currently dominate the sector. Also, standardization of charcoal production and packaging could provide a reference for evaluation of costs and performance for substitute fuels such as briquettes. To realize these opportunities, several interventions such as, public awareness and sensitization for behaviour change, provision of fast-growing tree species for charcoal production, technical support to charcoal producers and regulation of the charcoal value chain are imperative. Empirical data for appropriate forecasting and planning of these interventions is pre-requisite.

This study has been carried out in a wide geographical area over the entire country and provides a powerful insight into the *status quo* of the charcoal value chain, giving qualitative and quantitative baselines that will be invaluable to the Government of Uganda and development partners for the purpose of formalizing the charcoal business and promoting its sustainability.

3 Terms of Reference

3.1 Description of the assignment

The National Charcoal Survey for Uganda 2015 was commissioned by the Government of Uganda through the MEMD in partnership with UNDP. The study was part of a larger project titled "Addressing Barriers to Adoption of Improved Charcoal Production Technologies and Sustainable Land Practices through an Integrated Approach-Green Charcoal Project". The contract was performance based spanning a period of 24 weeks.

3.2 Purpose of the report

The purpose of this report is to present information and data gathered during the survey along the charcoal value chain and make recommendations that enhance sustainable charcoal production and trade in the country. It presents survey results and findings that will feed into the national statistics to strengthen monitoring of biomass energy and charcoal production/usage countrywide and also aid the planning process, as well as, sound decision making by all relevant authorities. The report will also be used to make a charcoal policy brief that will provide enforcement of regulations governing the biomass energy sector in particular those related to sustainable charcoal production and use. This study has accordingly responded to the terms of reference by collecting the necessary data and carrying out subsequent analysis.

3.3 Objectives of the survey

The main objectives of the study were to;

1. Generate adequate and reliable data and information on the charcoal industry in Uganda.
2. Aid proper planning and informed decision-making by authorities involved in the management of the charcoal industry.
3. Create a national database on charcoal.
4. Create a baseline situation for the GEF project and other future interventions

5. Heighten awareness and make the public more knowledgeable on the charcoal value chain and trade.

3.4 Outputs and deliverables

The following milestones were achieved in the course of the implementation of the survey.

1. **Inception report**: An inception report was submitted at the end of the inception phase providing details of the proposed approaches, methods, timelines specifying the issues and themes to be studied. The approach and method included data gathering and analysis as well as a specification of indicators and identification of key stakeholder groups.
2. **Methodology:** A comprehensive methodology and survey procedures for carrying out the assignment were agreed on with UBOS before using them in field.
3. **Progress reports:** Three meetings were held to discuss the progress on intermediate findings and also to check whether the survey was still on track to achieve the objectives.
4. **Final National Charcoal Survey Report:** The report was completed after a final validation meeting.
5. **Data and information organized into database:** A data base from the survey was developed to facilitate future activities related to charcoal production and biomass usage countrywide.
6. **Policy brief:** This was prepared to inform stakeholders on the key findings and proposed recommendations.
7. **Documentary** of the charcoal industry in Uganda that depicts the day to day business in production, transportation, vending and usage of charcoal. It also shows the key stakeholders, their roles and linkages in the sub-sector

3.5 Scope of work

The terms of reference (Appendix 1) provided a number of guidelines on how to undertake the assignment to realize planned objectives and while executing the assignment, the consultant was expected to:

- Carry out a stakeholder mapping and analysis for the entire charcoal industry and value chain to establish relevant actors and practitioners as a target for the survey at all levels.
- Establish technologies, methods and practices employed during the charcoal production and testing their efficiencies.
- Investigate on the quality of charcoal produced in different regions looking at lump charcoal, moisture content, calorific value and hardness.
- Find out the quantity of charcoal produced in different regions of Uganda.
- Find out the quantity of charcoal consumed in Kampala and other major towns of Uganda.
- Compare the proportion of sustainable with unsustainable charcoal production methods on Uganda's energy markets.
- Project the production and consumption of charcoal in Uganda.
- Establish the per capita firewood and charcoal consumption for the greater Kampala and nationally.
- Find out the price of charcoal in different regions of Uganda.
- Establish the social and economic importance of charcoal industry in terms of employment, business opportunities in production and entire value chain.
- Find out the potential for utilizing non woody feed stocks
- Compile the quantities consumed by different sectors including household, commercial users like hotels, institutions and industries.
- Analyze the local, regional and international markets.

3.6 The team

The consultant team composed of Experts and Research Assistants in the following capacities-A team leader, a statistician, a charcoal specialist and 30 Research Assistants. The team was backstopped by an energy expert and the team liaison.

4 Study Approach and Methodology

Several methodologies and techniques were applied to undertake the study and to achieve all the objectives and outputs of the assignment. These included:

4.1 Review of relevant documents

Using a synthesis and distillation approach, the consultant reviewed available information on study aspects such as the charcoal value chain, production and consumption of charcoal, the alternative improved charcoal production systems in Uganda and other countries in the world. Additional information was sought on alternative fuels used in Uganda, challenges/ barriers to adoption of more efficient charcoal production technologies, level of access to improved ICS, tree types commonly used for charcoal production, rate of reforestation in the country, with emphasis on major charcoal production districts and players involved in charcoal production and distribution and regional and global market of charcoal.

4.2 Charcoal Consumption Survey

The survey was conducted in households and institutions with the objective of estimating the quantity of charcoal (and other fuels) consumed by households, commercial (hotels, restaurants, meat roasters) institutions and industries. The survey also helped to estimate the price of charcoal in the country.

4.2.1 Study and sampling design

A quasi-cross-sectional research design was used given that this was a baseline national charcoal survey. The sample was selected from all the 10 statistical regions[2] in order to achieve a representative scenario of charcoal consumption in the entire country. The design also ensured that both urban and rural households were represented in the sample.

[2] According the Uganda Bureau of Statistics (UBOS). 2014. Uganda National Household Survey 2012/2013. Kampala Uganda; UBOS. there are 10 statistical regions namely: Kampala, Central I, Central II, East Central, Eastern, Mid-Western, North-East, West-Nile, Mid-Western, and South Western

4.2.2 Target population and sampling method

The target population was all households and institutions in Uganda. Given that the sampling frame of the households that use charcoal for cooking was not available by the start of the survey, the list of enumeration areas, where households reside, was used as the sampling frame. The latest list of enumeration areas was obtained from UBOS. All institutions and business establishments in the selected enumeration areas and or districts were also targeted.

Multistage sampling was used. The number of households within the selected clusters (enumeration areas) was sampled using systematic random sampling. The number of Institutions in the districts were also selected by systematic random sampling while considering their proportionate distribution. This was because institutions vary quite significantly in terms of fuel uses as well as quantities used.

4.2.3 Sample size and sampling frame

The household sample size was determined using multistage sampling. The main characteristic estimated in this survey was a quantitative variable-quantity of charcoal consumed. However, owing to the dearth of previous studies on household charcoal consumption, the proportion of households that use charcoal for cooking was used as a proxy variable in the equation for sample size determination.

The equation used to determine the number of enumeration areas surveyed is:

$$C \geq \frac{\frac{SD_B{}^2}{\bar{P}^2} X \frac{M}{M-1} + \frac{1}{\bar{u}} X \frac{SD_W{}^2}{\bar{P}^2} X \frac{(\bar{N}-\bar{u})}{(\bar{N}-1)}}{\frac{0.2^2}{1.96^2} + \frac{1}{M-1} X \frac{SD_B{}^2}{\bar{P}^2}}$$

Where:

C Number of enumeration areas sampled
M The total number of enumeration areas in the population
$\bar{u}$ Number of households sampled within each enumeration area
$\bar{N}$ Average households per enumeration area

SD_B^2 Variance between enumeration areas
SD_W^2 Average within enumeration area variation
P Overall proportion of households that use charcoal for cooking;
1.96 Represents the 95% confidence required
0.2 Represents the 20% relative precision
$\bar{P}$ Is the average proportion of households that use charcoal for cooking

Using 20.5%[17] as the national proportion of households that use charcoal for cooking, level of confidence of 95% and a statistical power of 80%, different possible numbers of enumeration areas and the resulting overall sample sizes were generated as shown in Table4-1.

Table 4-1: Possible numbers of enumeration areas and sample sizes

Number of households to be sampled from each enumeration area	Number of enumeration areas to Sample
5	178
10	148
15	139
20	134
25	131
30	129
35	127
40	126
45	126
50	125

For operational purposes, a total of 150 enumeration areas was selected in the entire country. 15 enumeration areas were selected from each of the 10 statistical regions. In each enumeration area, a sample of 20 households was selected resulting into a sample size of 3000 households in the entire country. The database of enumeration areas constructed by UBOS was used as the sampling frame.

The 10 statistical regions stratified on the basis of common socio-demographic characteristics are as follows:

1. Kampala area under the jurisdiction of the Kampala City Council Authority (KCCA);
2. Central I (Kalangala, Masaka, Mpigi, Rakai, Sembabule, Wakiso,

Lyantonde, Bukomansimbi, Butambala, Gomba, Kalungu and Lwengo);
3. Central II (Kiboga, Luwero, Mubende, Mukono, Nakasongola, Kayunga, Mityana, Nakaseke, Buikwe, Buvuma and Kyankwanzi);
4. East Central (Bugiri, Iganga, Jinja, Kamuli, Mayuge, Kaliro, Namutumba, Buyende and Luuka);
5. Eastern (Busia, Kapchorwa, Katakwi, Kumi, Mbale, Pallisa, Soroti, Tororo, Kaberamaido, Sironko, Amuria, Budaka, Bududa, Bukedea, Bukwo, Butaleja, Manafwa, Bulambuli, Kibuku, Kween, Namayingo, Ngora and Serere);
6. Mid-Northern (Apac, Gulu, Kitgum, Lira, Pader, Amolatar, Amuru, Dokolo, Oyam, Agago, Alebtong, Kole, Lamwo, Nwoya and Otuke);
7. North-East (comprising the districts of Kotido, Moroto, Nakapiripirit, Abim, Kaabong, Amudat and Napak);
8. West-Nile (comprising the districts of Adjumani, Arua, Moyo, Nebbi, Yumbe, Koboko, Maracha and Zombo);
9. Mid-Western (comprising the districts of Bundibugyo, Hoima, Kabarole, Kasese, Kibaale, Masindi, Kamwenge, Kyenjojo, Buliisa, Kiryandongo, Kyegegwa and Ntoroko);
10. South Western (comprising the districts of Bushenyi, Kabale, Kisoro, Mbarara, Ntungamo, Rukungiri, Kanungu, Ibanda, Isingiro, Kiruhura, Buhweju, Mitooma, Rubirizi and Sheema).

For purposes of minimizing the costs of data collection, a random sample of three districts was selected from each statistical region using probability proportional to size sampling. Unlike other statistical regions, Kampala statistical region had one district. A complete list of selected districts in each statistical sub-region is given in Table 4-2.

Table 4-2: The randomly selected districts for the study

Serial Number	Statistical Sub-Region	Selected Districts
1	Kampala	Kampala
2	Central I	Bukomasimbi, Wakiso, Rakai
3	Central II	Mubende, Nakasongola, Mukono
4	East-Central	Jinja, Iganga, Kamuli
5	Eastern	Soroti, Bududa, Pallisa
6	Mid-Northern	Apac, Amolatar, Gulu
7	North-East	Kaabong, Moroto, Napak
8	West-Nile	Adjumani, Zombo, Arua

9	Mid-Western	Kyegegwa, Hoima, Kasese
10	South-Western	Kabale, Kiruhura, Mbarara
Overall	Uganda	28 Districts

For Kampala statistical region, the enumeration areas were equally distributed across the 5 divisions of Kampala to improve precision of the estimates. A sample of 3 enumeration areas was selected from each division of Kampala.

In addition, about 35 [30] institutions were surveyed in each of the selected 28 districts, totalling to about 990 institutions for all the statistical regions. They include schools, hotels, hospitals, prisons, barracks and industries.

4.3 Fuel price market surveys

Fuel price surveys were conducted in the markets or neighbourhoods most frequently accessed by the study population. Market prices for the charcoal and wood were recorded and crosschecked with prices which households and institutions claimed to pay for. Weights of fuel quantities of different prices were taken using digital weighing scales. This information was pooled to calculate the fuel prices and consumption in the country.

4.4 Key informant interviews

Key informant interviews were conducted with knowledgeable persons and key players in the charcoal value chain consisting of mainly charcoal producers, vendors (distributors), tree planters, local leaders, researchers from institutions of learning, NGOs and CBOs, charcoal consuming enterprises, and officials from relevant government institutions. Specifically, over 400 key informants were interviewed on various topics including; charcoal production and consumption levels, charcoal production technologies, employment and business opportunities, impact of charcoal production, supply and demand, barriers to adoption of more efficient charcoal production systems, weakness and strengths, land management and sustainability practices among others. The key informants were selected using purposive sampling technique. Stakeholders interviewed included, but were not limited to the following

- Ministry of Energy and Mineral Development officials

- National Forestry Authority, District Forestry Officers or natural resources officers from the selected districts in Uganda
- Companies and NGOs such as New Forest Company, Global Resources, Green Resources Bukaleba etc.
- Players along the charcoal value chain (land owners, charcoal producers, packers, transporters, vendors, largescale charcoal dealers and industrial consumers)
- Commercial charcoal consumers like tea factories, schools etc.
- Researchers at universities and other institutions
- Green Charcoal Project focal district leaders (Chief Administrative Officers, LC5 chairpersons, DFOs and GEF project officers)

4.5 Focus Group Discussions

Focus Group Discussions (FGDs) were held with charcoal burners, charcoal transporters, charcoal vendors and charcoal consumers throughout the study districts. The purpose of the FGDs was to bring together a homogenous section of the community to discuss issues affecting them. One FGD per category of target group was carried out per district.

4.6 Traffic survey

A charcoal traffic survey was conducted, aimed at estimating the quantity of charcoal supplied to Kampala district, given that the large percentage of charcoal is consumed in the district. Also, the survey was conducted in Gulu, Mbarara and Mbale districts as major districts for each of the Northern, Western and Eastern regions respectively.

The survey documented the number and capacity of transportation vehicles and other means of transport (including private cars and government vehicles) delivering charcoal into the selected main towns every day for a period of seven days. To effect this, the assistance of Uganda Police Force was sought to mount day and night checkpoints on main roads entering the selected towns. The checkpoints were mounted strategically to minimise the cases of transporters dodging the survey team.

The transporters were interviewed to establish the number of bags in each vehicle, price of the charcoal at the source as well as the market price, the district where the charcoal was got from, the target market for the charcoal and how frequently the transporter delivers the charcoal.

4.7 Cross border charcoal trade survey

In order to understand the charcoal traded across the Ugandan boarders, a cross border charcoal trade survey was conducted in selected border districts of Busia, Kabale, Kasese, Arua, and Rakai. The district DFOs, LC 1 Chairpersons of border villages and charcoal transporters involved in cross border trade were interviewed.

4.8 On-Site assessment

Field visits to charcoal production facilities and sites in the selected districts were conducted in order to assess the existing technologies, technology performance i.e. source and tree species used for charcoal production, quality and quantity of charcoal produced among others. During the on-site field visits, samples of charcoal produced from each charcoal production technology were collected for analysis. The samples were packed in air tight zip-lock bags to avoid loss/gain in moisture.

4.9 Charcoal quality testing

The collected charcoal samples were tested at the College of Engineering, Design, Art and Technology (CEDAT), Makerere University, to determine the charcoal's heating value, fixed carbon, volatile matter, moisture content, ash content, bulk density and hardness.

4.9.1 Physical and Chemical Properties

The apparatus used to determine the physical and chemical properties was the Computerised Thermographic Analyser with an in-built and integrated ELTRA 84 GmbH precision digital weighing scale. The analyser is integrated with a non-

oxidizing environment (99.99% pure argon gas or 99.999% pure nitrogen gas) and an oxidizing environment (99.99% pure oxygen) which are computer controlled by Tga software version Tga 1.4.2.12 with internally programmed application for analysing four physical properties of biomass, namely: moisture content, volatile matter, fixed carbon and ash content. The apparatus has 19 workstations and each analysis takes a minimum of six hours to complete.

Three subsamples were extracted from each of the collected samples. A total of 103 samples were analysed. The specimens were homogenised by crushing into a powder. Three specimens were extracted from each of the homogenised samples of the charcoal. The three specimens of minimum weight 1100 milligrams were placed in three of the 19 workstations of the thermographic analyser. An in-built programme of the Tga software version 1.4.2.12 for analysing biomass was triggered to commence the analysis which lasts a minimum of six hours.

The moisture content, volatile matter and fixed carbon were analysed in a purely non-oxidising environment and ash content was analysed in a pure oxidising environment.

The bulk density measurements were done using Mettler PC 4400 Digital weighing scale and 250ml Beaker. The charcoal samples were crushed to smaller particles to increase its packing factor by pounding in a closed container.

The beaker was placed on the digital weighing scale and its mass zeroed. The charcoal particles were then filled in the container, weighed and mass recorded. This represented the weight of the sample and the beaker known volume was the volume of the sample. The bulky density was therefore calculated from the empirical formula given by

Bulk density = (Mass of Charcoal in beaker)/(Volume of the beaker)

4.9.2 Heating value

The apparatus used to determine the heating value of the charcoal samples include the IKA C2000 automated digital bomb calorimeter and a precision Denver S1-234 digital weighing scale, with accuracy of ± 0.0001g.

Two specimens were extracted from each of the charcoal samples submitted and weighed on the precision weighing scale and the mass recorded. The specimens were then put in a crucible and enclosed in a bomb calorimeter for the heating value tests. The higher heating value (HHV) of the samples was measured using an internal programme in the bomb calorimeter. Samples weighing between 700 mg to 1100 mg are placed in the bomb calorimeter and subjected to complete combustion in an adiabatic environment, internally stabilized by a computer, heaters and circulating water. The HHV was then calculated from measured temperature increase in the adiabatic system.

4.9.3 Hardness test

Charcoal hardness was determined by the Mohs scratch test method which is used in mineralogy. Mineral hardness or scratch hardness is the standard test for charcoal. It is a measure of how resistant a sample is to fracture or permanent plastic deformation due to friction from a sharp object. The principle is that an object made of a harder material will scratch an object made of a softer material. One tool to make this measurement is the sclerometer.

The method uses reference materials which are a set of 10 calibrated minerals shown in Table 4-3. In this method, the tests are done by trial starting from the least hard reference material in in an incremental step by step until the test material cannot scratch the reference material above its hardness.

Once the test material fails to scratch a particular reference material, the conclusion that the hardness of the test material is equivalent to previous reference material which it was able to scratch and the hardness number of the reference is taken to be that of the test material.

The hardness of the charcoal samples was determined by scratching them with a mineral of the hardness scale.

Table 4-3: Mohs Hardness Scale

Mohs Hardness No.	Mineral	Associations and Uses
10	Diamond	Hardest mineral known. Used in jewellery and cutting tools. Four times as hard as corundum.
9	Corundum	Sapphire and ruby are varieties of corundum.

		Twice as hard as topaz.
8	Topaz	Hard file. Emerald and aquamarine are varieties of beryl with a hardness of 8.
7	Quartz	Penknife
6	Feld spars	Window glass
5	Apatite	Tooth enamel, copper coin, brass pin. Apatite is a mineral in vertebrate bones and teeth.
4	Fluorite	Fluorine from fluorite prevents tooth decay.
3	Calcite	Limestone and most shells contain calcite.
2	Gypsum	Finger nail, plaster of Paris.
1	Talc	Talcum powder.

For intermediate hardness, the Table 4-4 incorporates additional substances that may fall between levels:

Table 4-4: Mohs Hardness Scale – Intermediate hardness

Hardness	Substance or mineral
0.2–0.3	caesium, rubidium
0.5–0.6	lithium, sodium, potassium
1	Talc
1.5	gallium, strontium, indium, tin, barium, thallium, lead, graphite, ice
2	Hexagonal boron nitride, calcium, selenium, cadmium, sulphur, tellurium, bismuth, gypsum
2.5–3	gold, silver, aluminium, zinc, lanthanum, cerium, Jet (lignite)
3	calcite, copper, arsenic, antimony, thorium, dentin

4.10 Data Collection Tools

Various tools, summarized below, were used in the data collection activities. The detailed tools are shown in Appendix 1.

i. Household survey (Appendix 2.1)
ii. Institutional survey (Appendix 2.2)
iii. Fuel market price survey (Appendix 2.3)

iv. KII guide for Forestry Officers (Appendix 2.4)
v. KII guide for CBOs/NGOs (Appendix 2.5)
vi. KII guide for Charcoal Consuming enterprises (Appendix 2.6)
vii. KII for LC1 Chairpersons (Appendix 2.7)
viii. KII guide for Land owners (Appendix 2.8)
ix. KII guide for Charcoal producers (Appendix 2.9)
x. KII guide of Motor vehicle charcoal transporters (Appendix 2.10)
xi. KII guide for other charcoal transporters (Appendix 2.11)
xii. KII guide for Charcoal vendors (Appendix 2.12)
xiii. KII guide for Cross border survey (Appendix 2.13)
xiv. FGD guide for charcoal producers (Appendix 2.14)
xv. FGD guide for charcoal transporters (Appendix 2.15)
xvi. FGD guide for charcoal vendors (Appendix 2.16)
xvii. FGD guide for charcoal users (Appendix 2.17)
xviii. Traffic survey (Appendix 2.18)
xix. Charcoal sample selection form (Appendix 2.19)

The tools were developed in continuous consultation with UBOS, MEMD and UNDP.

4.11 Quality assurance and quality control

The survey was conducted with professionalism and quality assurance was ensured throughout all the stages through the following mechanisms and measures;

a) Inception meeting

Prior to any data collection activities, the study methodology and survey tools were subjected to intense scrutiny by a group of knowledgeable persons during a one day inception meeting organised by MEMD and UNDP. The recommendations generated at the meeting were incorporated in the methodology and survey tools appropriately.

b) Training of the survey team

A team of 30 experienced research assistants was recruited and trained in all aspects of sampling and data collection. The training involved both theoretical

and practical aspects to ensure that all the research assistants are competent to collect the desired data.

Furthermore, a team of 26 experienced data clerks was recruited to conduct the data entry exercise. The data clerks were given a practical training in data entry, editing, cleaning, validation, storage, retrieval and backup to ensure that they were all conversant with the data entry screens, editing and cleaning before the actual data entry exercise commenced. The data clerks were assigned practical exercises to ascertain their suitability for the work before data entry began.

c) Pre-testing of data collection tools

The study tools were pre-tested in a 3-day pilot test exercise conducted in Mpigi district and part of Kampala district before their use in the field. The pre-testing exercise facilitated the fine-tuning of the tools and was also used to ensure uniform understanding and interpretation of the data collection protocol and tools before the actual field data collection activity.

d) Data collection protocol

A data collection protocol (Appendix 3) was developed for use by the research assistants. This mainly included, among others, the procedures for handling cases of non-response (refusals, not-at-home, out-of-population cases and related cases), sampling procedures, study activities and targets, equipment use and project materials provided etc. In addition, the definition of each of the study variables, mode of data collection and recording were highlighted.

e) Data quality assurance through the process

Data quality was maintained throughout the entire study process. The field data collection team always met to plan and review the execution of activities on a daily basis. The data collection team always compiled and cross-checked for accuracy and completeness of the responses on a daily basis. Close supervision of the data collection process was done.

The data clerks were also supervised throughout the data entry process. Errors that cropped up during the data entry exercise were resolved immediately. Each data entrant was assigned a separate and clearly identified set of questionnaires for data entry by the data entry supervisor. Data was backed up on daily basis by the data entry supervisor.

f) Continuous Engagement with MEMD and UNDP

Throughout the process, UNDP and MEMD were updated on the progress of the survey to ensure that all aspects remain on track. Regular briefs were conducted with UNDP and MEMD as an opportunity of quickly taking collective actions to any challenges that arose and to give MEMD and UNDP the confidence that the work was credible.

g) Backstopping Staff

Several backstopping staff were availed to support the team leader and the experts to make sure that all study outputs were in accordance with the ToRs. In addition, all reports were subjected to the editorial team before they were submitted.

4.12 Data analysis and reporting

a) Development of Data Entry Screens

Data entry screens were developed in EPIDATA and Excel for the purpose of data entry. The screens were accompanied by corresponding check programs and logical checks to minimise data entry errors.

b) Data Cleaning and Validation

To ensure accuracy of the data being captured, check programs with in-built logical checks and skip patterns were developed to minimize errors in data entry. In addition, simple descriptive statistics were used to identify and correct any missing cases, outliers and any other peculiarities in the data before data processing and analysis began.

In addition, double data entry was used on a sample basis for purposes of validating the data and further eliminating any data entry errors. Computerized data validation bolstered the quality of data entered.

c) Data Management and Processing

The data was then exported to STATA for further management, processing and analysis. Appropriate value labels were assigned to all the categorical response variables to make the datasets user-friendly. In addition, labels were assigned to all variables in the datasets for ease of identification. Unique identifiers in each dataset were clearly spelt out to facilitate merging and linking of data in the different datasets to facilitate analysis.

d) Data Analysis

The analysis was largely descriptive using frequencies, totals, ratios, rates and graphs organized according to statistical regions. However, some bivariate and multivariate analyses were done to get a better understanding especially of the key variables. The results of the quantitative analysis were triangulated with the results of the qualitative analysis to get a better understanding of the results. Since, the analysis was based on survey data, appropriate weights were applied during the analysis. In addition, the analysis took into account the sampling design using the survey analysis options in STATA.

4.13 Challenges faced

A few challenges were experienced during the implementation of the survey.

- **Large sample size:** The sampling frame considered for this survey led to a huge sample size than earlier anticipated. Additional manpower in the form of enumerators was mobilized and trained
- **Difficulty in finding study participants.** Given that the survey took place during school holidays, it was difficult to find schools which were open in order for the teams to conduct the surveys. Best effort was made to get the contacts of school management so that they are followed-up later by phone to fill the data gaps that existed. During traffic surveys, some charcoal transporters refused to stop at various checkpoints. These mainly were government and organisation vehicles. The team used refusal forms to record the type of vehicle and the estimated number of bags being transported in order to capture the charcoal being transported.
- **Elections effect.** Due to the national elections that were conducted in February 2016, some teams went through difficult scenarios or delays and some were briefly arrested by local authorities on the fear that the survey activities were political. Therefore, the survey team had to first

get clearances from the Resident District Commissioners, District police commanders, Chief Administrative Officers before embarking on the study activities, in addition to meeting the District Forestry officers. While this process took time, it smoothened the team's activities in the districts. The traffic survey for Kampala was postponed for 2 weeks on the advice of Uganda Police Force as a precautionary measure against post-election violence in Kampala.

- **Failure to get charcoal samples:** On a couple of occasions, the study team failed to pick charcoal samples from production sites in the districts, particularly because there was no active charcoal burning/harvest at the time of the visit. In some instances, carbonization was still on-going while in other cases, the charcoal had been harvested and sold already.

5 Policy and regulatory framework

5.1 Documents required in the charcoal business

Information on the type of documents required in the charcoal business was gathered from the District Forest Officers (DFO), charcoal vendors and transporters. Responses from District Forest Officers identified five key documents as highlighted in Table 5.1 below. These documents include charcoal burning license reported by 23 DFOs, movement license (permit) as reported by 22 DFOs, charcoal selling license/permit as reported by 15 DFOs. One DFO reported the requirement of a document referred to as a declaration form.

Table 5-1: Documents required in the charcoal business

Document	Frequency
Charcoal burning license/permit	23
Movement license/permit	22
Selling license/permit	15
Declaration form	1
Felling permit	1
None	1

5.2 Proportion of vendors with/without charcoal trading licenses

The charcoal vendors were asked if they had charcoal trading licenses. A total of 70.5% (86) indicated that they did not have while 29.5% (36) of them reported that they had a trading license. Those who had a license were requested to indicate how easy or difficult the process of obtaining a license is. Up to 52.6% (20) indicated that it was difficult to obtain a charcoal trading license while 39.5% (15) said that it was very easy to get one from the local council. One vendor reported that he did not have any money to pay for a license while two indicated that they were not sure. For the last two possibly they have not attempted to get the documents.

The vendors who did not have charcoal trading licenses were requested to give

reasons for not having them. A total of 12 reasons were given. The most common reasons given were that: the vendors were new in the business as reported by 21.9% (16), it was not necessary 19.2% (14), there was no enforcement 17.8% (13) and 12.3% said they were not aware of the requirement for a license. The other reasons are as detailed in Table 5-2.

Table 5-2: Reasons for not having a trading license

Reason	Frequency	Percentage (%)
Just began business	16	21.9
Not necessary	14	19.2
No enforcement by officials	13	17.8
Was not aware of requirement for license	9	12.3
No money to get it	6	8.2
Paid but not received	4	5.5
Does not know how to get	3	4.1
Temporary location	2	2.7
Not attempted to get it	2	2.7
Only pay daily taxes	2	2.7
Not sure	1	1.4
Bureaucracy	1	1.4
Total	**73**	**100**

5.3 Organizations that issue the trading license/permit

The vendors were asked to indicate the organizations that issue the charcoal trading licenses/permits. A total of 16.7% (8) did not know, 10.4% (5) indicated that they get from the Forest Department as shown in Table 5-3. Others included the town council, municipal council, local council, local government and sub-counties. These results indicate the need for streamlining license issuing for charcoal vendors/traders for efficiency in the business.

Table 5-3: Organisations that issue trading licenses/permits

Organization	Frequency	Percentage (%)
Doesn't know	8	16.7
Forest Department	5	10.4
KCCA	5	10.4
Zombo Local Government	4	8.3
Local Council	4	8.3
Pallisa Town Council	3	6.3
Soroti Municipal Council	3	6.3
Bududa Town Council	2	4.2
Kenshunga Sub County	2	4.2
Mbarara Municipal Council	2	4.2
Kasese Municipal Council	1	2.1
Apac Town Council	1	2.1
Sub County	1	2.1
Chief Finance Officer	1	2.1
Hoima Municipal Council	1	2.1
JICTA	1	2.1
Kakoba Division	1	2.1
Kamuli Town Council	1	2.1
Moroto Local Government	1	2.1
Rushere Town Council	1	2.1
Total	**48**	**100**

5.4 Cross border sale of charcoal

Respondents on cross border sale of charcoal were requested to indicate if it is legal to sale charcoal to other countries. The responses show that 45.2% (14) said yes, another 45.2% said no, while three (9.7%) did not know. When asked to

identify the trade documents they obtain to sell charcoal across the border, 29.4% said they use a Trade License , 29.4% had no documents/were not sure, and 5.9% (2) said they used Movement permits while Certificate of Origin was used by only 2.9% (1) . The majority (32.4%; 11) said they use other documents. The other documents were daily receipts of 1000 and above (33%; 3), daily receipts of 500 and above (22%; 2) and market fees (33%; 3) and parking receipt (11%; 1). The above also shows the need to have specific documentation for charcoal trade across the borders.

5.5 Charges to vendors for different trading documents

The vendors were requested to indicate how much they pay for the different documents which they use in their business. A total of 40 different charges were identified as listed in Table 5-4. This underscore the demand for standards and harmonization of trade and legal charges of the sector.

Table 5-4: Charges for different trading documents

Charges (UGx)	Frequency	Percentage (%)
5,000 (General receipt)	4	6.8
Not sure	4	6.8
500/day council fees	3	5.1
10,000/bag	3	5.1
500/bag municipal council	3	5.1
3,000/month market dues	3	5.1
1,000/bag	2	3.4
15,000/year trading license	2	3.4
300/bag - Forest fees	2	3.4
50,000/year trading license	2	3.4
4,000/month market dues	2	3.4
1,000/day receipt	2	3.4
0	1	1.8
50,000/??	1	1.8

1,000/week	1	1.8
20,000/year trading license	1	1.8
500 – trading permit	1	1.8
1,000 transport permit	1	1.8
60,000/year trading license	1	1.8
2,000 (District Forest Office)	1	1.8
54,000 (Movement permit)	1	1.8
45,000 (General receipt)	1	1.8
70,000 (General receipt)	1	1.8
100,000/year trading license	1	1.8
20,000/quarter trading license	1	1.8
20,000/year trading license	1	1.8
270,000/year trading license	1	1.8
5,000/year trading license	1	1.8
7,000/month council fee	1	1.8
20,000/month market dues	1	1.8
200,000 movement permit	1	1.8
40,000 movement permit	1	1.8
1,000/bag NFA	1	1.8
25,000 NFA	1	1.8
15,000 Town council	1	1.8
2,000/day security fee	1	1.8
300/bag stocking	1	1.8
500/bag taxes	1	1.8
3,000/tender	1	1.8
Total	**59**	**100**

6 Charcoal feedstock systems and barriers to sustainable supply

6.1 Main sources of wood for charcoal production

According to the District Forest Officers interviewed, the main source of wood (47%) for charcoal production in Uganda is from forests owned privately.. Central forest reserves and on-farm tree contribute about 22% and 20% of the wood used for charcoal production respectively, see Figure 2.

Figure 6-1: Land owner inspects charcoal burners on her private land

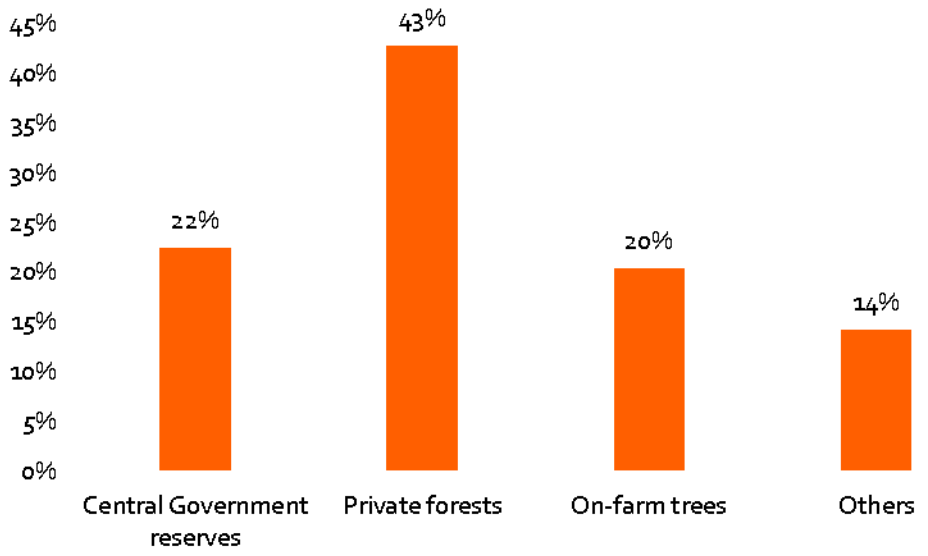

Figure 6-2: Main sources of wood for charcoal production

Also important to note is that the proportion of wood used for charcoal production from government forest reserves is only 16%. The proportion of wood for charcoal production from on-farm trees, private forests and other sources is about 54% respectively, see Figure 6.3.

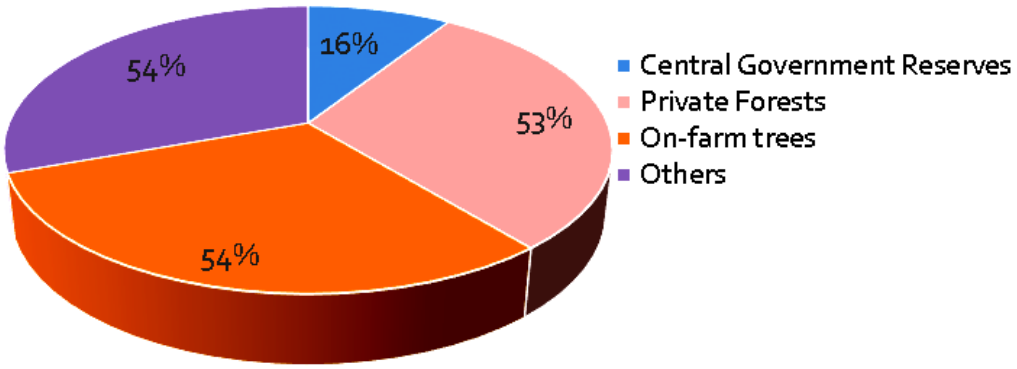

Figure 6-3: Proportion of wood used for charcoal production per source

6.2 Sustainable charcoal feedstock supply

Of the 24 District Forest Officers interviewed, 23 indicated that they had no forests planted specifically for charcoal production in their districts. However, 9

DFOs indicated that there were naturally growing forests dedicated for charcoal production in their districts. The reasons given for absence of forest plantations dedicated to charcoal production are summarized in Table 6-1.

Table 6-1: Reasons why no land is dedicated to charcoal supply

Reasons why no land is dedicated to charcoal	Frequency	%
There are a lot of indigenous trees all over the land	6	25.0
There are no forests and trees are scarce	4	16.7
People use their own farm trees for charcoal wood (ready source of charcoal available).	2	8.3
In the urban areas, there are no trees that could be set aside for charcoal	2	8.3
The land is dedicated to agriculture	2	8.3
The private land owners are not concerned with charcoal. There is no law that requires them to plant trees or set aside forest land for charcoal	2	8.3
The Local Government doesn't have land for charcoal	1	4.2
The land is dedicated to animal rearing	1	4.2
There are a few charcoal burners available in the area	1	4.2
There is so much land fragmentation that no land is available for charcoal forests	1	4.2
There is lack of planting materials – seedlings and cuttings	1	4.2
N/A	1	4.2
Total	**24**	**100**

6.3 Enhancing sustainable supply of charcoal feedstocks

The following strategies can be very useful in ensuring sustainable supply of charcoal feedstocks for the country.

1. For monitoring of production quantities, all the chair persons of LC1 should have a record of how much charcoal is produced every month.

One community person could be elected to take responsibility for environmental matters and this individual could ensure that the records are accurate and are collected and submitted to the District Forestry Office on time.

2. The chairpersons of LC1 could also have a record of how many trees are planted every year in their area of jurisdiction and how many of them survive.
3. A national conference should be organized for all the projects involved in tree planting to strategize on how trees or forests can be planted or set aside specifically for charcoal. Suggestions include every district having a proportion of the district land (e.g. 20% of the total land area) set aside for charcoal forests as a cash crop or an area of forests dedicated to charcoal production e.g. 200,000 hectares established or set aside for commercial production of charcoal.
4. Standardization of measurement units should be done so that when one says a bag of charcoal, it means the same in the whole country. Charcoal should be measured in terms of kilograms e.g. 1kg, 5kg, 10kg, 20kg, 30kg, 40kg, 50kg etc. depending on what the market demands.
5. Three models of wood production could be adopted. These are: (i) Small Scale Growers (SSG) – e.g. 0.1 – 10 acres, Medium Scale Growers (MSG) 10.1 – 50 acres and Large Scale Growers – 50.1 and above. Each should have financial products developed for investment provided mainly by a government supported micro-finance institution.
6. Appropriate kilns should be recommended for different categories of charcoal producers e.g. mobile steel kilns for hire should be located at the LC1 Chairpersons place for the small scale producers. Large scale producers could have masonry kilns in the plantations.

6.4 Potential for utilizing non-woody biomass feedstocks

Although non-woody biomass is key in the much needed shift from the unsustainable woody biomass production and utilization[31], there are limitations such as low public awareness and inadequate adjustments of policy and regulatory mechanisms.[32]

Biomass energy from non-woody biomass/ feedstocks has a huge potential for utilization in the country. Crops can produce biomass energy from agricultural residue made available from growing, harvesting and processing food crops such as cereals and roots as well as cash crops such as tea, cane sugar and coffee.[33] In addition, common fuels like briquettes can be made from waste agricultural residues and/or dried organic municipal solid waste (MSW).[32]

Reports indicate that about 1.2 million tonnes of agricultural wastes are available each year (see Table 6-2) and an additional 1,500 tonnes of MSW are estimated to be produced in the capital city Kampala on a daily basis. Assumptions are that these two sources combined could produce enough briquettes to replace 6% of the country's total wood consumption and up to 50% of the charcoal trade.[32] Importantly, however, practical limitations such as seasonal variations, competing uses and collection significantly lower the amount of raw material available for commercial opportunities. Therefore, briquettes are only a part of the solution to the looming biomass crisis in Uganda.

Table 6-2: Annual production of agricultural residues

Agricultural Residue	Annual Production ('000 tons/year)
Bagasse	590
Rice Husks	25-30
Rice Straw	45-55
Sunflower Hulls	17
Cotton Seed Hulls	50
Tobacco Dust	2-4
Maize Cobs	234
Coffee Husks	160
Groundnut Shells	63

[Source: Uganda Renewable Energy Policy, MEMD, 2007 (Retrieved from the Hamish Ferguson (2012)[32]. Briquette Businesses in Uganda document)]

7 Charcoal production and technologies used

7.1 Charcoal production patterns

Charcoal production is mainly conducted by part-time charcoal burners (59%) as shown in Figure 7-1 basing on the interviews with 90 charcoal burners who responded. The average monthly income from charcoal was reported as UGX 317,000- for full-time charcoal burners and UGX 170,000 for part-time burners.

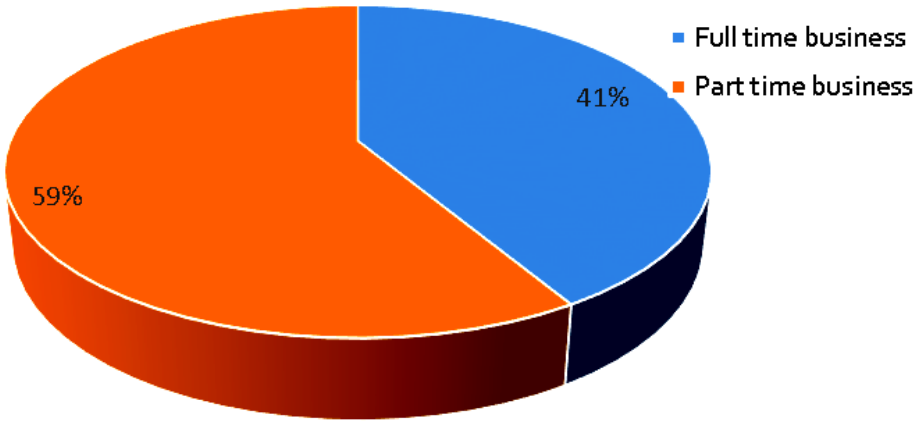

Figure 7-1: Charcoal burning business

Of the 248 LC1 chairmen who responded, 148 (59.7%) indicated that there was charcoal burning in their LC1. Up to 99 (39.9%) reported that there was no charcoal burning in their LC1 while 1 (0.4%) indicated that he was not sure. The details are as summarized in Table 7-1.

The majority of charcoal burners (46%) indicated that they purchase wood for charcoal production while 41% reported to get wood free for charcoal production, as shown in Figure 7-2. About 5% of charcoal burners exchange labor for wood particularly during clearing the land for farming or other uses. A small group of burners reported that they both buy wood and get it for free or cut their own trees. A total of 25 (41%) of LC 1 who burn charcoal were reported to buy the wood they use from other areas, 11 (18%) buy from the surrounding villages and 8 (14.8) get from their own farms. Other sources include from farms alone (8.2%), from around the villages alone (8.2%), forest 3 (4.9%) and from timber sawing remains 2 (0.3%).

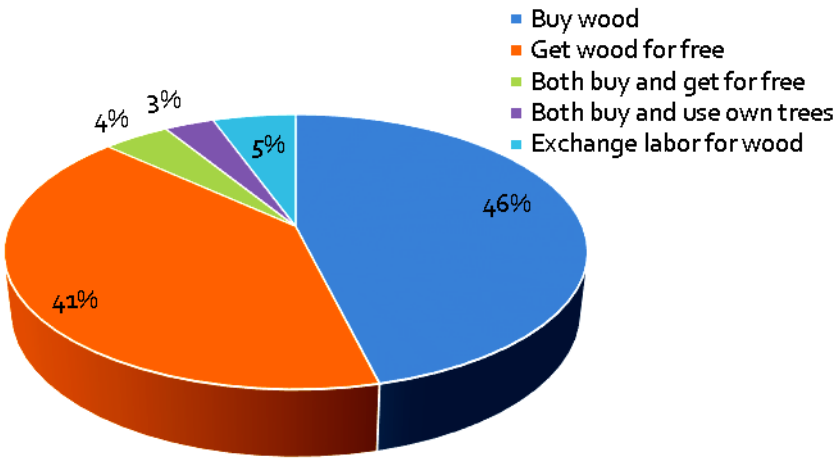

Figure 7-2: Sourcing wood for charcoal burning

Table 7-1: Proportion of LC 1 that burn charcoal

Response	Frequency	%
Burn Charcoal	148	59.7
Do not burn charcoal	99	39.9
Not sure	1	0.4
Total	**248**	**100**

It was also found that majority (52%) of the charcoal burners leave the wood to dry before loading it in the kiln for charcoal production while 48% burns the wood when still wet (Figure 7-3). Hence the sector is still inefficient given that burning charcoal from wet wood is very wasteful and inefficient. Charcoal burners reported to leave wood to dry for an average of 14 days, with the minimum being 2 days while the maximum being 90 days as shown in Figure 7-4.

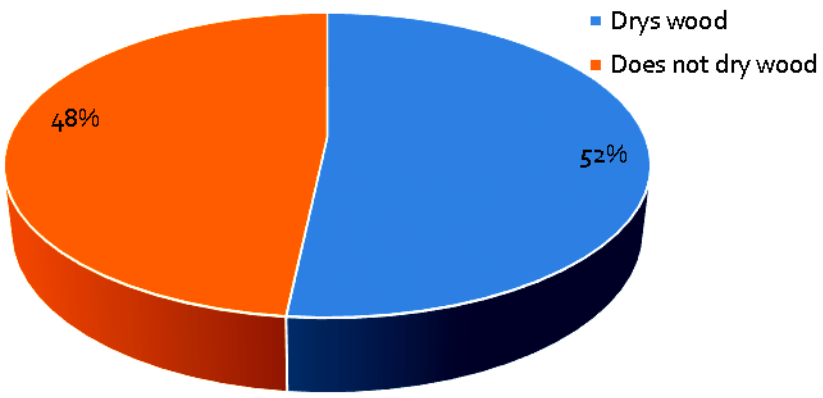

Figure 7-3: Preparation of wood before burning charcoal

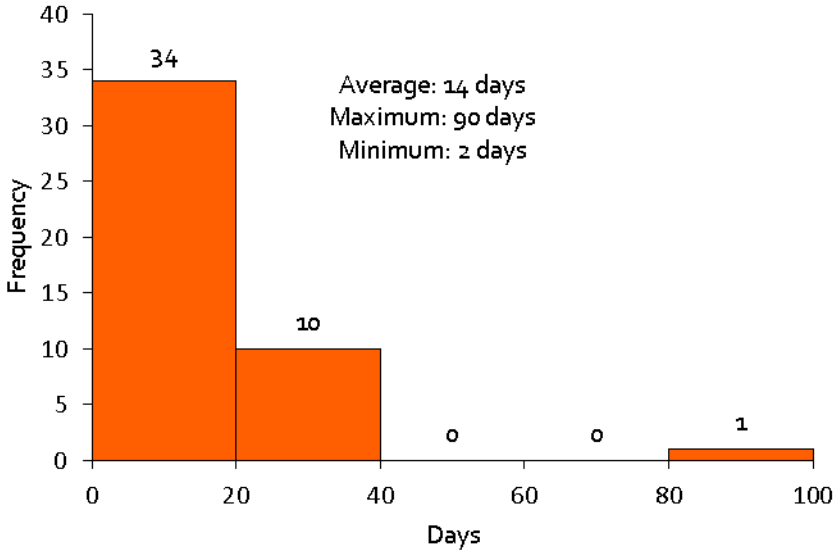

Figure 7-4: Number of days for drying wood before burning charcoal

A total of 101 tree and shrub species were mentioned by the charcoal burners as the trees they use for producing charcoal. The majority of charcoal burners (89%) indicated that they do not sort the wood species before burning charcoal. The 11% who sort wood species do so because of the following reasons.

i. The quality of charcoal varies with tree species hence the need to sort them.
ii. Different species of wood burn at different rates and hence becomes a challenge if not sorted.

Likewise, twenty eight FGD groups of charcoal burners indicated that they mix the tree and shrub species when burning charcoal while eight of them reported that they also sort them so as to determine the quality of charcoal which they require.

The charcoal burners were asked to indicate the distance from their villages to where they burn charcoal. Up to 67.6 % (50) were within a distance of 0 - 5 km, 12.2% (9) were between 5.1-10 km and 2.7% within 10.1 - 15 km. The rest are as indicated in Table 7-2. This implies that most of the charcoal burners, an estimated at over 82% are from within their home localities. The other about 18% travel to distant areas to burn charcoal. Suggesting that where land availability is not a constraint, people can plant trees within their own area for charcoal production.

Table 7-2: Distance of charcoal burner from the village to the place of charcoal burning

Distance (Km)	Frequency	Proportion (%)
0 – 5	50	67.6%
5.1-10	9	12.2%
10.1 – 15	2	2.7%
15.1 – 20	4	5.4%
20.1 – 50	1	1.4%
50.1 – 100	2	2.7%
>100	6	8.1%
Total	**74**	**100%**

The 99 charcoal burners who responded indicated that they burn between half a bag and 100 bags of charcoal per one firing. The most common quantity (mode) was 0.5-10 bags reported by 62 (63%) charcoal burners followed by 10-20 bags as reported by 21 (21%) charcoal burners. The others are as detailed in Table 7-3. This has implications on the size of improved charcoal kilns that would be desired by charcoal burners. It means that most charcoal burners would want kilns that can produce up to 20 bags of charcoal.

Table 7-3: Number of bags of charcoal produced most of the time

Number of bags	Frequency	Proportion (%)
0.5 to 10	62	63
10 to 20	21	21
20 to 30	6	6
30 to 40	2	2
40 to 50	3	3
50 to 60	2	2
60 to 70	2	2
Above 70	1	1
Total	**99**	**100**

Asked how the charcoal burners cool their charcoal during harvesting, the majority (91%) indicated that they use wet or cool soil to cover the charcoal, 4% said they pour water on the charcoal, 2% spread the charcoal in open air while 2% use other means such as pouring sand on the charcoal and shutting down the firing chamber/closing the chimney as shown in Figure 7-5. The charcoal is packed in bags such as those shown in Figure 7-6.

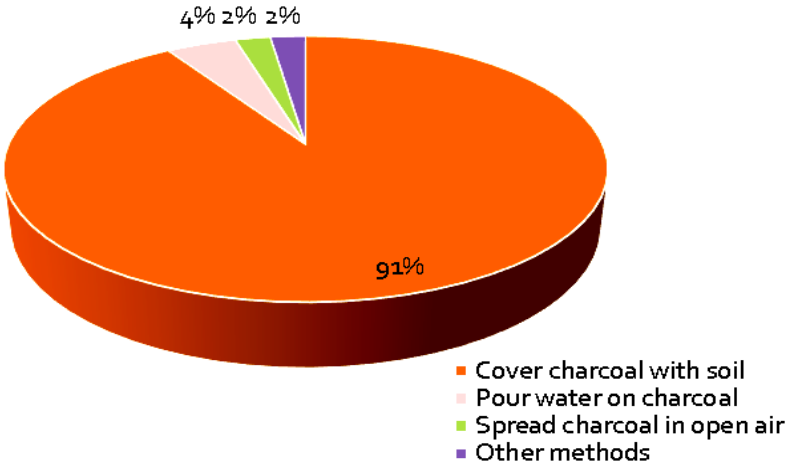

Figure 7-5: Methods used to cool charcoal during harvesting

Figure 7-6: Charcoal burners packing their charcoal on production site.

On average, most charcoal burners reported to burn charcoal twice per month as shown in Figure 7-7. The maximum number of carbonization cycles were 4 per month. This low number is due to the difficulty in getting wood, the poor tools used in cutting/chopping trees and the high labor requirements throughout the process.

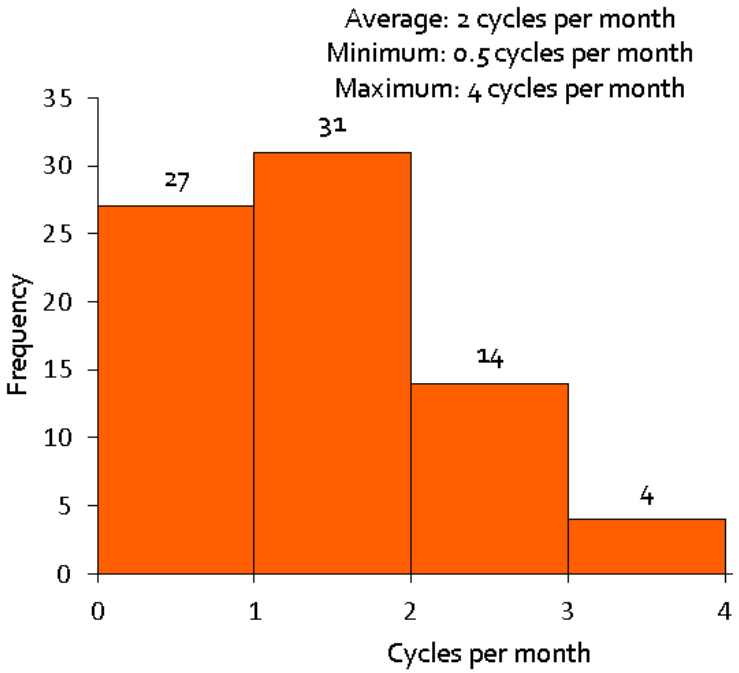

Figure 7-7: Number of charcoal production cycles per month

Most charcoal is produced during the wet season (48%). This is followed by the dry season with 36%. The rest is produced in both seasons with 16%. Reasons given for the choice of season for burning charcoal are as given in Table 7-4. The reason given by majority is that covering kilns needs wet soil and this is easier during the wet season. Other respondents argue that people are preoccupied with farming activities during the wet season so most of the charcoal is produced during the dry season when people are comparatively less busy.

Table 7-4: Reason for season of charcoal production

Reason	Frequency	Percentage
Covering kilns need wet soil (easier in wet season)	9	34.6
People preoccupied with farming in wet season	4	16.0
Production best in dry season	3	12.0
Wood burns slower in wet season	2	8.0
High demand for charcoal in festive seasons	2	8.0
Cool weather favours production	2	8.0

Roads are passable	1	4.0
Charcoal as alternative source of income	1	4.0
People idle in dry season	1	4.0
Not sure	1	4.0
Total	**26**	**100**

The average cost of charcoal production was estimated to be UGX 105,000 per cycle with a minimum of UGX 1,200 and a maximum cost of UGX 1,303,000 as shown in Table 7-5. These estimates were derived from the costs of the charcoal burning processes right from harvesting and preparation of wood to fees charged for charcoal production for an average yield of 12 bags (minimum 1 bag and maximum 70 bags).

As seen, the charcoal production costs vary significantly from one burner to another mainly due to following reasons;

a) Sourcing of feedstock (wood). There are different ways in which charcoal burners get wood for charcoal production. Some buy it, others get it for free (illegally or otherwise) and others burn their own wood while others trade their labor for wood.
b) Labor used. Some burners employ people to carry out some activities while others just do the work themselves using their family members. In such cases, burners don't count their own labor input.
c) The quantity of charcoal being produced. The cost of charcoal production is generally proportional to the quantity of charcoal produced. Burners that produce more charcoal spend more money in the process than others.
d) Purchase of packing bags. Some burners purchase their charcoal bags while in many cases, packing bags are purchased by transporters.
e) Payment of Fees and Permits. Not all burners pay for the charcoal production permit or the charged feeds for their business.

Table 7-5: Charcoal production costs by activity

Activity	Average (UGX)	St dev	Minimum (UGX)	Maximum (UGX)
Harvesting/chopping wood	35,597	50,993	-	300,000
Setting up kiln	14,767	19,470	-	100,000
Firing/tending to kiln	5,556	13,631	-	80,000
Harvesting charcoal	6,914	10,583	-	50,000
Cooling charcoal	3,078	10,244	-	84,000
Purchase of bags	13,271	13,052	1,200	84,000
Packing charcoal	5,617	12,641	-	60,000
Permits	7,568	39,591	-	350,000
Fees	3,295	13,278	-	105,000
Others	9,460	28,019	-	180,000
Total	**105,122**		**1,200**	**1,393,000**

The main challenges reported by charcoal burners from the focus group discussions were that charcoal burning is labor intensive (19.3%), there is scarcity of wood (13.4%), there are health hazards 12.6% and inadequate market (8.4%). Others are as indicated in Table 7-6.

Table 7-6: Main challenges that charcoal burners face

Challenges faced by charcoal burners	Frequency	Proportion (%)
Labor intensive	23	19.3%
Scarcity of wood	16	13.4%
Health hazards & complications (lack of protective gear)	15	12.6%
Inadequate market	10	8.4%
Hunger (lack of food & water)	7	5.9%
Many taxes, charges & fines	5	4.2%
Long distance to production site	5	4.2%
Poor roads	4	3.4%
Very small profit margin	4	3.4%
High transportation costs	4	3.4%

Lack of capital	3	2.5%
A lot of heat (gets burnt)	3	2.5%
Expensive to produce	3	2.5%
Insecurity especially in forests	3	2.5%
Lack of good equipment especially for felling trees	3	2.5%
Toxic gases	2	1.7%
Harassment from officials	2	1.7%
Losses	2	1.7%
Animals destroy kilns	1	0.84%
Lack of storage facilities	1	0.84%
Hard to get soil during dry season	1	0.84%
Default in payment from clients	1	0.84%
Theft	1	0.84%
Total	**119**	**100%**

When asked for possible solutions, the charcoal burners provided many possible solutions. However, the most frequent included; promoting use of improved charcoal production technologies, provision of market, promotion of afforestation and re-forestation, provision of safety and protective gear, better equipment such as power saws, and capital or credit. The others are as indicated in Table 7-7. Planning for a sustainable charcoal sector has to take these challenges and the possible solutions in consideration.

Table 7-7: Ways of addressing the challenges faced by charcoal burners

Solutions to charcoal burners challenges	**Frequency**	**Proportion**
Encourage use of improved production technologies	7	8.6%
Avail ready market	7	8.6%
Promote afforestation & re-afforestation	7	8.6%
Provision of safety & protective gear	7	8.6%
Provision of good equipment (e.g. power saws,	7	8.6%

packing machines)		
Provision of capital or credit	6	7.4%
Form groups and associations for charcoal burners	5	6.2%
Creation of water points	5	6.2%
Provision of tree seedlings (fast maturing hardwoods)	5	6.2%
Streamline licensing and taxation	4	4.8%
Allocate plantations for trees & charcoal burning	4	4.8%
Provision of subsidized medication for burners	2	2.4%
Promotion of alternative energy sources	2	2.4%
Reduce taxes	2	2.4%
Repair roads	2	2.4%
Government to provide alternative investments	1	1.2%
Government to give locals power to govern forest resources	1	1.2%
Legalize charcoal burning	1	1.2%
Increase pay for charcoal	1	1.2%
Promote briquette production	1	1.2%
Negotiate with land owners	1	1.2%
Reduce transportation costs	1	1.2%
Regulate burning of trees for charcoal	1	1.2%
Provision of food	1	1.2%
Total	**81**	**100%**

7.2 Charcoal Production Technologies used

All the 27 FGD groups of charcoal burners (100%) reported that they use the traditional earth kiln for their charcoal burning. This was also reported during the charcoal burners key informant interviews. It was similarly reported by transporters during the traffic surveys. Figure 7-8 shows that the predominant

charcoal production technology for the charcoal supplied in Kampala, Mbale, Gulu, and Mbarara is reported to be the traditional earth mould (Figures 7-9 &7-10).

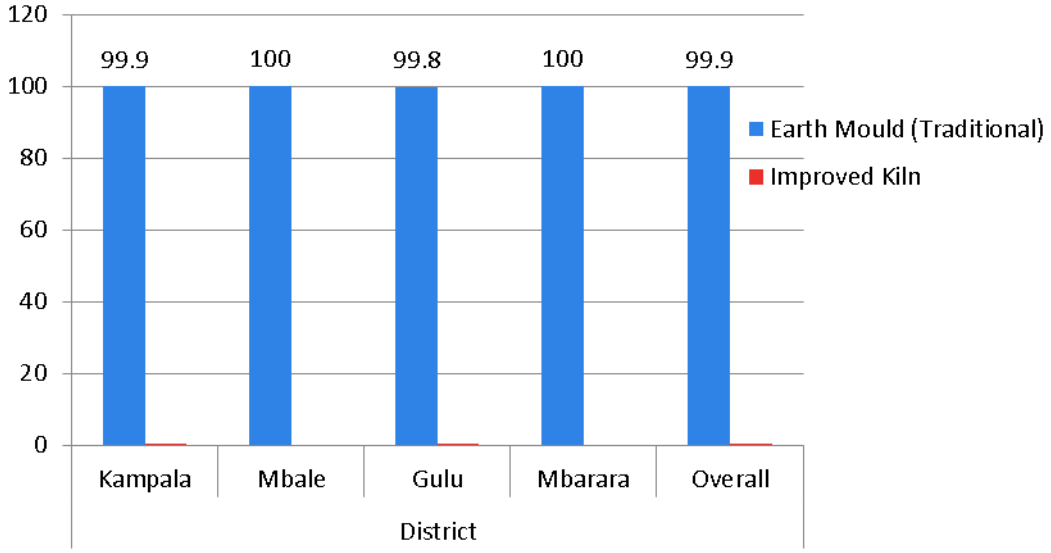

Figure 7-8: Charcoal Production Technologies

Figure 7-9: Wood stacked in form of a traditional earth mound kiln in Nakaseke district.

Figure 7-10: Traditional earth mound kiln under carbonization

7.3 Adoption of efficient charcoal production technologies

When asked on the strategies to enhance adoption of efficient charcoal production technologies, the DFOs indicated the need for building the capacity of the charcoal burners to be able to acquire/construct, operate and maintain efficient charcoal technologies. This would involve training and imparting skills as well as financial support.

As shown in Figure 7-11, it was also indicated that sensitization of charcoal value players, mainly charcoal burners, about the existence, availability and benefits of efficient charcoal production technologies would be good in order to cover the knowledge gap that exists. Furthermore, the use of demonstrations in different regions of Uganda would help to raise more awareness about improved technologies.

Other strategies suggested include putting in place regulations to compel charcoal burners to adopt efficient technologies as well as promotion of some types of technologies that can be adopted by the value chain players.

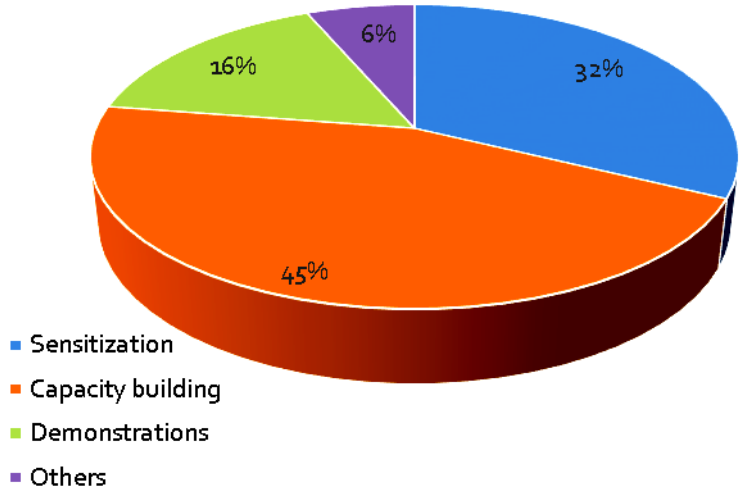

Figure 7-11: Enhancing adoption of efficient charcoal production technologies

8 Charcoal supply patterns

8.1 Charcoal supply to main towns

As shown in Figure 8-1, most of the charcoal supplied to Kampala, Mbale, Gulu, and Mbarara is purchased from charcoal burners and Middlemen/retailers. Worth noting is that most of the charcoal supplied to Mbale is purchased from Middlemen (Retailers) (66.5%). Also worth noting is that about a tenth of the charcoal supplied to Gulu and Mbarara is supplied by the charcoal burners themselves, see Figure 8-1.

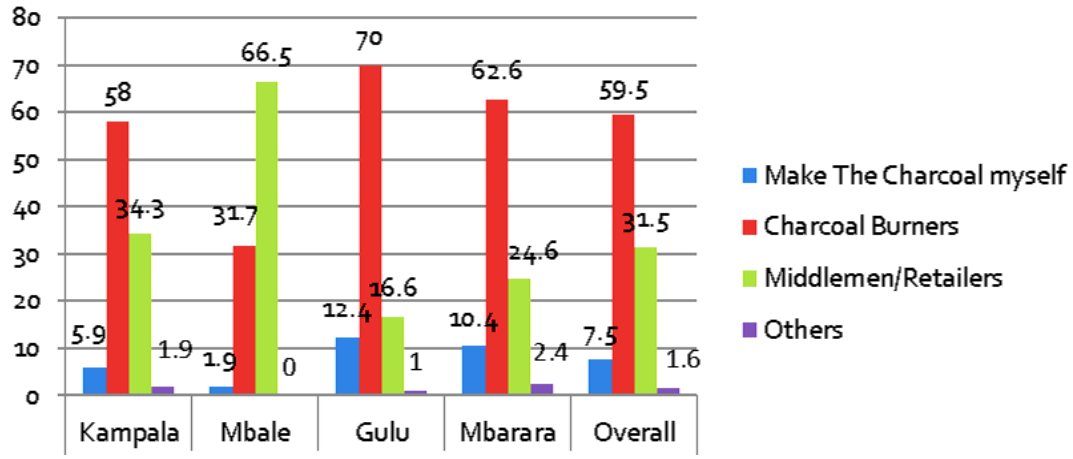

Figure 8-1: Clients from Whom Charcoal is Purchased

The suppliers of charcoal were asked about the prices at which they purchase charcoal from either charcoal retailers or producers. Table 8-1 shows that suppliers to Kampala paid on average UGX. 25,000/= per bag purchased from retailers, while suppliers to Gulu paid on average UGX. 16,600/= per bag purchased from retailers. Table 8-2 shows that suppliers to Kampala paid on average UGX. 26,000/= per bag purchased from producers, while suppliers to Gulu paid on average UGX. 16,000/= per bag purchased from producers.

Table 8-1: Purchase Price of Charcoal from Retailers by District

District	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	24,990	348	24,307	25,673
Mbale	21,000	626	19,772	22,229
Gulu	16,590	471	15,665	17,515
Mbarara	24,765	1,040	22,724	26,806

Table 8-2: Purchase Price of Charcoal from Producers By District

District	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	25,876	235	25,415	26,337
Mbale	19,611	804	18,033	21,189
Gulu	16,028	185	15,665	16,391
Mbarara	26,496	936	24,660	28,332

The findings show that charcoal supplied to Kampala, Mbale, Gulu, and Mbarara is predominantly sold to charcoal vendors, see Figure 8-2.

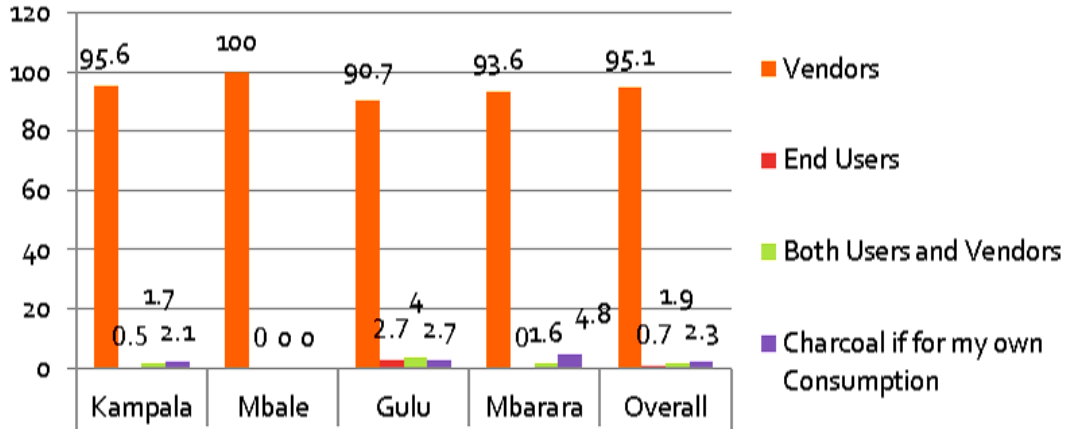

Figure 8-2: Clients to whom charcoal is sold

The suppliers of charcoal were asked about the prices at which they sell charcoal to either charcoal vendors or users. Table 8-3 shows that suppliers to Kampala sold on average UGX. 44,700/= per bag of charcoal sold to charcoal vendors, while suppliers to Gulu sold on average UGX. 28,300/= per bag of charcoal sold to charcoal vendors. Table 8-4 shows that suppliers to Kampala sold on average

UGX. 44,800/= per bag of charcoal sold to charcoal users, while suppliers to Gulu sold on average UGX. 27,350/= per bag of charcoal sold to charcoal users.

Table 8-3: Sale Price of Charcoal to Vendors by District

District	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	44,712	640	43,458	45,967
Mbale	33,786	901	32,019	35,552
Gulu	28,311	572	27,188	29,434
Mbarara	36,303	1,043	34,257	38,349

Table 8-4: Sale Price of Charcoal to Users by District

District	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	44,832	503	43,845	45,819
Mbale	33,733	1,101	31,571	35,894
Gulu	27,350	473	26,421	28,278
Mbarara	38,286	1,353	35,630	40,941

The charcoal suppliers were asked about the average weight of charcoal per bag they were transporting during the dry and rainy seasons. Tables 8-5 and8-6 show the survey results. Table 8-5 shows that the average weight of a charcoal bag in Kampala was estimated to be 60.5 Kgs during the dry season, while the average weight of a charcoal bag in Gulu was estimated to be 44.8 Kg during the dry season.

Table 8-5: Average Weight of Charcoal per Bag during Dry Season

District	Mean (kg)	Std. Err.	[95% Conf.	Interval]
Kampala	60.5	2.8	55.0	66.1
Mbale	53.3	1.4	50.5	56.1
Gulu	44.8	0.8	43.2	46.3
Mbarara	80.4	21.5	38.3	122.5

Table 8-6 shows that the average weight of a charcoal bag in Kampala was estimated to be 73.5 Kgs during the rainy season, while the average weight of a charcoal bag in Gulu was estimated to be 54.2 Kg during the rainy season.

Table 8-6: Average Weight of Charcoal per Bag during Rainy Season

District	Mean (kg)	Std. Err.	[95% Conf.	Interval]
Kampala	73.5	0.7	72.1	75.0
Mbale	65.4	1.8	61.8	69.0
Gulu	54.2	1.0	52.2	56.2
Mbarara	65.5	1.4	62.6	68.3

Suppliers of charcoal to Kampala, Mbale, Gulu, and Mbarara, were asked whether there were times of the year when they don't supply charcoal. Figure 8-3 shows that slightly less than half of the suppliers (47.3%) don't supply charcoal throughout the year. Mbarara reported the highest proportion of suppliers (57.4%) who don't supply charcoal throughout the year, followed by Mbale (54.6%).

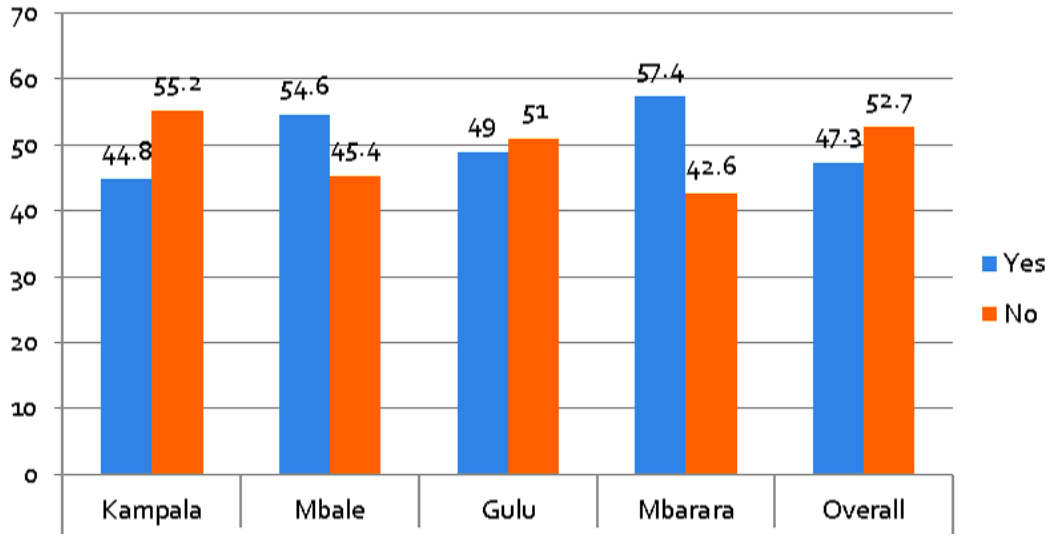

Figure 8-3: Whether there are times when Suppliers Don't Supply Charcoal

The months of the year in which most charcoal suppliers don't supply charcoal were: April (47.2%), May (29.8%), March (24.4%), and June (21.3%) apparently due to slippery roads arising from heavy rains during the March-June Season, see Table 8-7.

Table 8-7: Months of the Year When Charcoal is not supplied

Month	Number of responses	Percent
January	156	15.6
February	116	11.6
March	244	24.4
April	473	47.2
May	299	29.8
June	213	21.3
July	173	17.3
August	182	18.2
September	111	11.1
October	113	11.3
November	169	16.9
December	145	14.5
Overall	**1002**	**100**

The survey sought information on the amount of charcoal supplied to key urban centres in Uganda. The results show that about 837 Metric Tonnes of charcoal are supplied to Kampala per day in dry season, see Table 8-8.

Table 8-8: Total Amount of Charcoal Supplied Per Day in Metric Tonnes in Dry Season

District	Total (Tones)	Std. Err.	[95% Conf.	Interval]
Kampala	837	27	783	891
Mbale	68	22	24	111
Gulu	91	9	74	108
Mbarara	32	5	22	42

The results also show that about 1,017 Metric Tonnes of charcoal are supplied to Kampala per day in the rainy season, see Table 8-9. The survey sought information on the amount of charcoal produced in Uganda per annum. The results show that about 2.1 Million Metric Tonnes of charcoal are produced in Uganda per year, see Table 8-10.

Table 8-9: Total Amount of Charcoal Supplied Per Day in Metric Tonnes in Rainy Season

District	Total (Tonnes)	Std. Err.	[95% Conf.	Interval]
Kampala	1,017	33	952	1,082
Mbale	83	27	30	136
Gulu	110	11	89	131
Mbarara	26	4	18	34

Table 8-10: Total Annual Charcoal Produced in Uganda in Metric Tonnes

Sub Region	Total	Std. Err.	[95% Conf.	Interval]	CoV[3] (%)
Central I	97,823	46,274	6,270	189,377	47.3
Central II	947,387	24,198	899,899	994,876	2.6
East-Central	3,625	1,638	133	7,117	45.2
Eastern	28,059	5,143	17,768	38,351	18.3
Mid-Northern	537,760	30,690	477,522	597,999	5.7
North-East	20,487	3,849	12,603	28,371	18.8
West-Nile	227,159	14,559	198,403	255,915	6.4
Mid-Western	242,764	14,503	214,189	271,338	6.0
South-Western	39,274	6,377	26,712	51,835	16.2
Uganda	**2,144,338**	**66,380**	**2,014,177**	**2,274,500**	**3.1**

8.2 Cross border charcoal trade

When asked whether charcoal is sold across the border from Uganda to other countries, 96.8% of the respondents interviewed at selected borders indicated that charcoal is sold to other countries. Only 3.2% said no charcoal is sold across the border. As shown in Table 8-11, the main reasons that drive cross border charcoal trade are high demand from the other country, need for income and favorable interest rates.

[3] CV-Coefficient of Variation. The lower the CV, the better the estimate, the best case occurring when CV=0%

Table 8-11: Reasons that drive cross border charcoal trade

Incentives	Frequency	Percentage (%)
Get income	10	25.6
High demand from the other country	10	25.6
Favorable exchange rate	5	12.8
Ready market	4	10.3
More profit	3	7.7
When there is scarcity in Congo	2	5.1
Scarcity of trees	1	2.6
Less losses	1	2.6
Does not sell across border	1	2.6
Do not sell on debt	1	2.6
Not sure	1	2.6
Total	**39**	**100**

However, it was also observed during traffic surveys that charcoal is sold into Uganda across the border from neighboring countries namely, Southern Sudan, Congo, Tanzania and Kenya.

9 Charcoal transportation

9.1 Charcoal transportation to major towns

Charcoal transportation to major towns of Uganda was tracked through traffic surveys conducted over a 24 hour period for 7 consecutive days in each of the 4 major towns. In collaboration with the Traffic Police in each of the 4 districts where the traffic survey was conducted, check points were staged at all entry routes into the town (as shown in Figure 9-1) and all vehicles entering the town were stopped and checked to find out whether or not they were transporting charcoal.

Figure 9-1: A charcoal transporter being interviewed a checkpoint on Bombo road

The distribution of the respondents is presented in Table 10-1. A total of 2,708 respondents were interviewed in the 7-day traffic survey. Most of the respondents (63.9%) were interviewed in Kampala. The overwhelming majority of the respondents (96.2%) were male, see Figure 10-1.

Table 10-1: Distribution of the Respondents by District

District	Number of respondents	Percent (%)
Kampala	1,729	63.9
Mbale	162	6.0
Gulu	606	22.4
Mbarara	211	7.8
Total	**2,708**	**100**

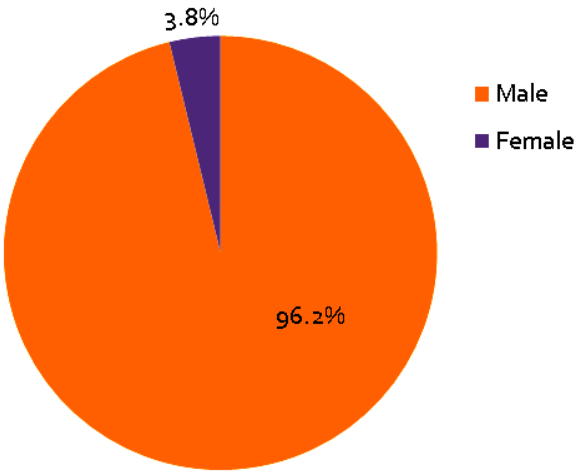

Figure 10-2: Distribution of the Respondents by Sex

Most of the respondents (39.1%) were in the age group 30-39 years followed by those in the age group 20-29 years (28.7%%). A bout a fifth of the respondents (21.4%) were in the age group 40-49 years, see Table 10-2.

Table 10-2: Distribution of the Respondents by Age Group

Age Group	Number of respondents	Percent (%)
10-19	34	1.3
20-29	737	28.7
30-39	1,005	39.1
40-49	550	21.4
50-59	196	7.6
60-69	41	1.6
70-79	6	0.2
80-89	2	0.1
Total	**2,571**	**100**

In terms of education attainment, most of the respondents had attained education up to O-Level (31.5%). About a quarter of the respondents (26.1%) had attended primary school but did not complete it, while a fifth of the respondents (20.3%) had completed primary school, see Table 10-3.

Table 10-3: Distribution of the Respondents by Highest Level of Education Attained

Highest Level Of Education Attained	Number of respondents	Percent (%)
No Formal Education	212	8.4
Primary/Elementary Incomplete	662	26.1
Primary/Elementary Complete	515	20.3
Secondary/High School Incomplete	798	31.5
Secondary/High School Complete	161	6.3
Vocational/Technical	31	1.2
College/University (Undergraduate)	64	2.5
Graduate/Postgraduate	90	3.5
Other	1	0.0
Don't Know	2	0.1
Total	**2,536**	**100**

The survey results revealed that Central (40.9%) and Northern regions (39.5%) were the major sources of charcoal, see Figure 10-3.

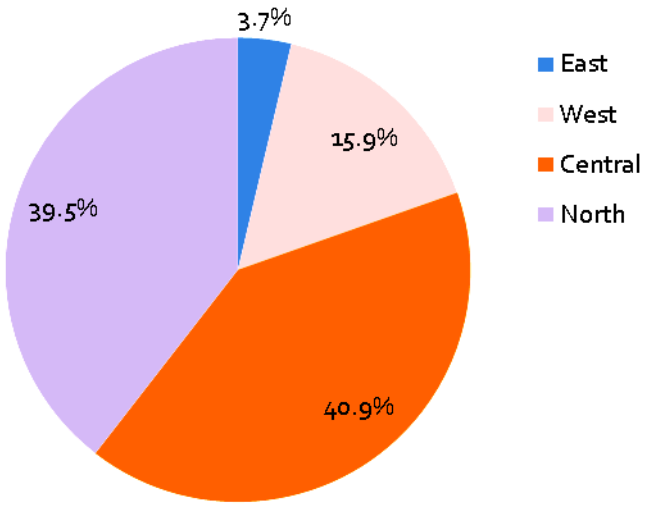

Figure 10-3: Sources of Charcoal by Region

Charcoal transporters were asked to mention, the source of the charcoal they were transporting at the time of the survey. In terms of district, central region was the main source of charcoal supplied to Kampala (63.4%), followed by Northern Region (21.8%). Northern region is the main source charcoal supplied to Mbale (57.8%), followed by Eastern region (40.1%). Northern region was almost the sole source of charcoal supplied to Gulu (99.3%). Likewise almost all the charcoal supplied to Mbarara was from Western region (98.6%), see Figure 10-4.

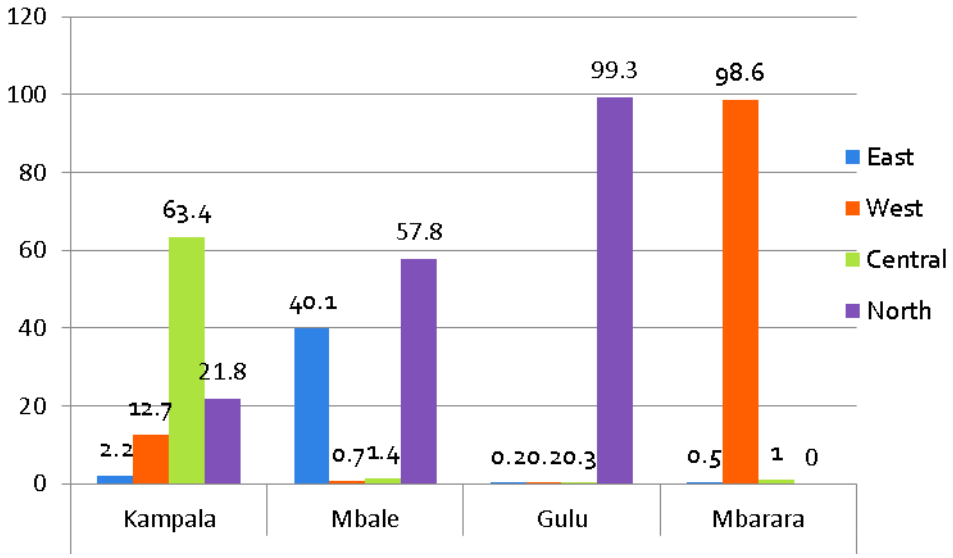

Figure 10-4: Sources of Charcoal by District by Region

Charcoal transporters were also asked to mention the source of the charcoal they were transporting at the time of the survey. The survey revealed that Kampala was supplied by charcoal from 69 districts across the country, with only 13 districts supplying 80% of the charcoal as shown in Figure 10-5. The leading three districts from which charcoal supplied to Kampala was obtained were: Nakasongola, Nakaseke and Kyakwanzi. The rest (56 districts) contribute 20% and include Abim,Adjumani, Agago,,Amolatar, Apac, Bugiri, Buikwe, Bukomansimbi, Busia, Butambala, Gomba, Iganga, Isingiro, Jinja, Kaabong, Kabale, Kabarole, Kaberamaido, Kalangala, Kaliro, Kamuli, Kanungu, Kasese, Kayunga, Kibuku, Kiruhura, Kiryandongo, Kitgum, Koboko, Kotido, Kyegegwa, Kyenjojo, Lira, Lwengo, Masaka, Mbarara, Mityana, Moroto, Moyo, Mpigi, Mubende, Nakapiripirit, Namutumba, Napak, Oyam, Pader, Rakai, Soroti, Ssembabule, Wakiso, Yumbe, Zombo, South Sudan, Congo, and Kenya.

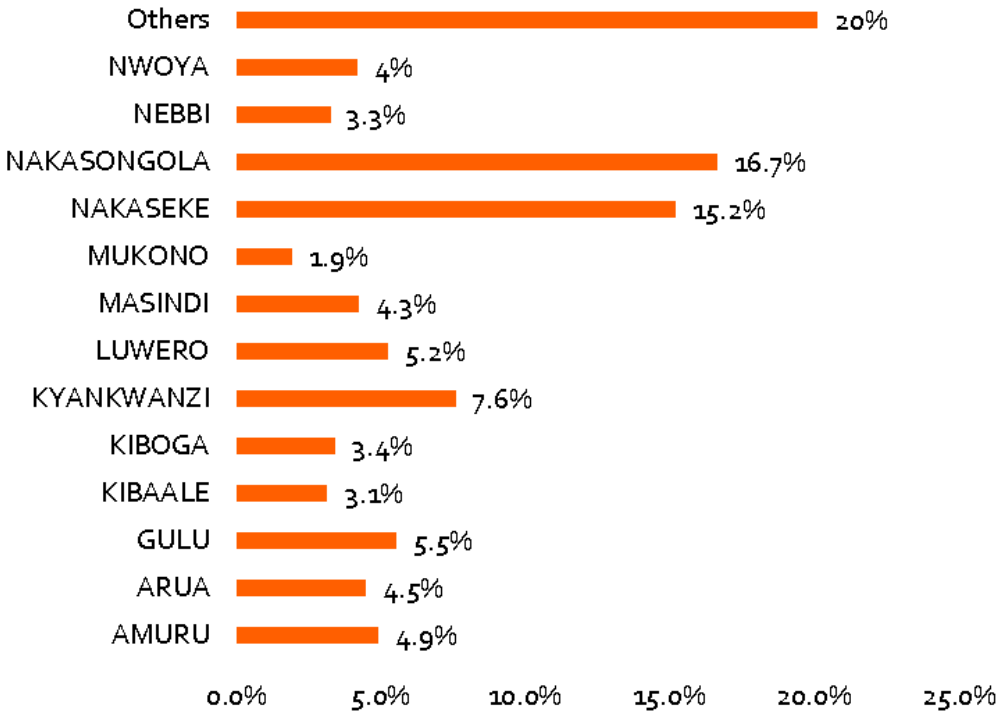

Figure 10-5: Sources of Charcoal Supplied to Kampala

Figure 10-6 shows that the leading districts from which charcoal supplied to Gulu was obtained were: Amuru (55%) Gulu (19%), Pader (6%) and Nwoya (3%) with the others contributing (17%). They include Adjumani, Agago, Kitgum, Lira and Nakasongola.

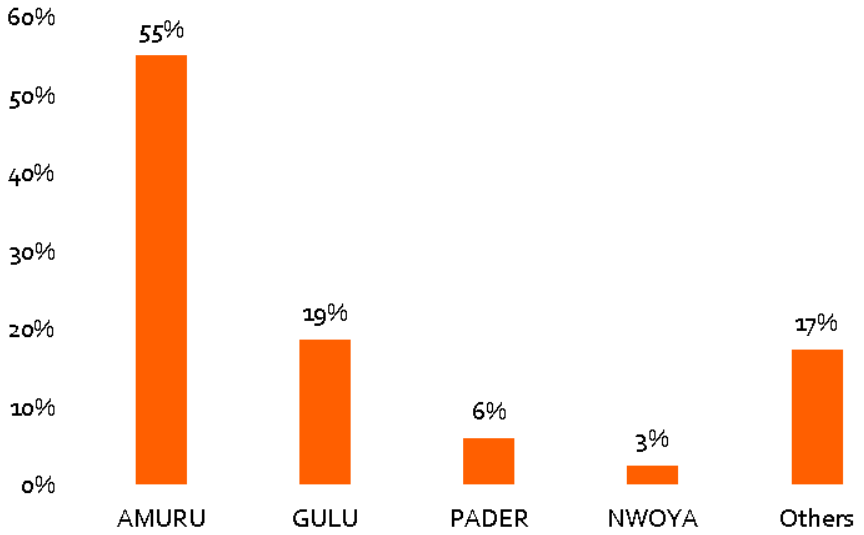

Figure 10-6: Sources of Charcoal Supplied to Gulu

Figure 10-7 shows that the leading sources of charcoal supplied to Mbale were South Sudan (37%), Pader (17%) and Amudat (10%). Other sources contribute 16 % and include the following: Abim, Adjumani, Amolatar, Amuria, Amuru, Apac, Arua, Budaka, Bukedea, Bukwo, Bulambuli, Dokolo, Kapchorwa, Kiryandongo, Kitgum, Koboko, Kotido, Kumi, Lira, Mbale, Moroto, Nakapiripirit, Napak, Nebbi, Nwoya, Otuke, Sironko, Soroti, Congo and Tanzania

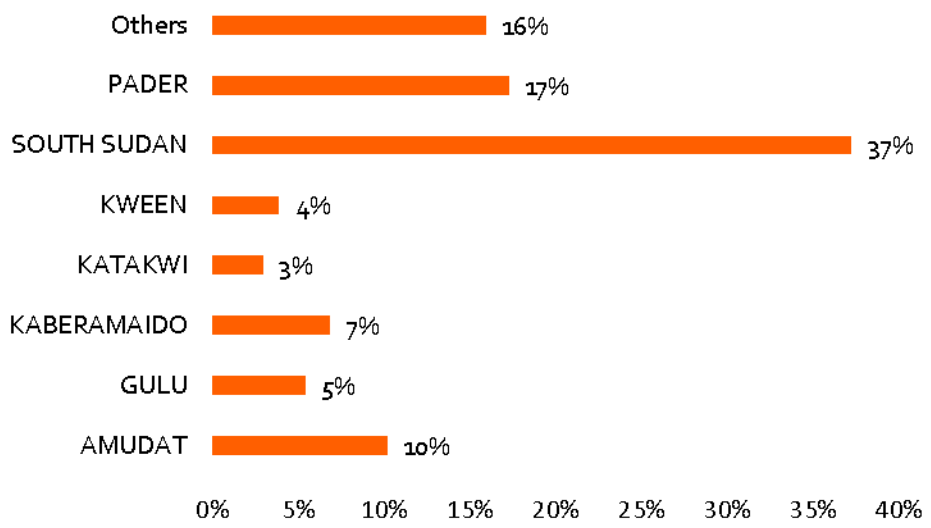

Figure 10-7: Sources of Charcoal Supplied to Mbale

Figure 10-8 shows that the leading districts from which charcoal supplied to Mbarara was obtained were Kiruhura (45%), Ssembabule (21%) Isingiro (10%) and Kamwenge (10%). The other districts include: Bushenyi, Ibanda, Kabale, Kyegegwa, Ntungamo.

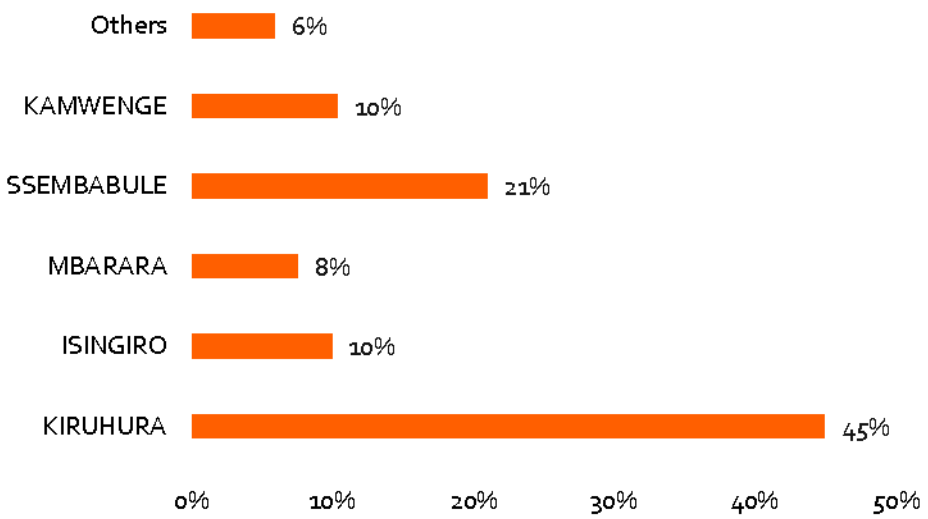

Figure 10-8: Sources of Charcoal Supplied to Mbarara

Figure 10-9 shows that most of the charcoal supplied to Kampala, Mbale, Gulu, and Mbarara was purchased from charcoal burners and Middlemen/retailers. Worth noting is that most of the charcoal supplied to Mbale was purchased from Middlemen (Retailers) (66.5%). Also worth noting is that about a tenth of the charcoal supplied to Gulu and Mbarara was supplied by the charcoal burners themselves.

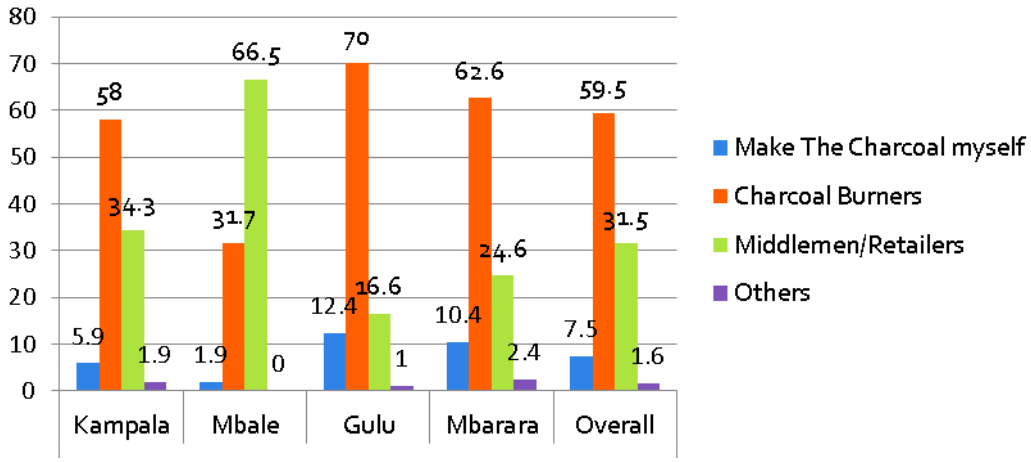

Figure 10-9: Clients from Whom Charcoal is Purchased

Figure 10-10 shows that generally most of the transportation vehicles (88.8%) were privately owned. The results also show that about a third of the suppliers of charcoal to Mbale (32.5%) used company vehicles.

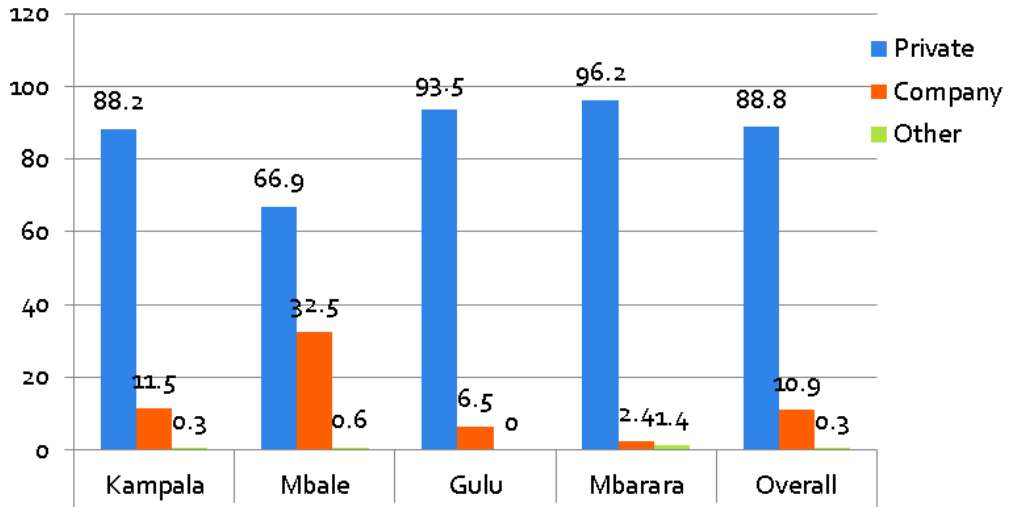

Figure 10-10: Ownership of Transportation Vehicle

The charcoal suppliers were asked whether they possessed a Movement Permit that allows them to transport charcoal. The results revealed that only 43% of the charcoal transporters had Movement Permits, see Figure 10-11. Mbarara had the least number of charcoal suppliers issued with movement permits. Only 3.3% of the Charcoal suppliers to Mbarara had Movement Permits. Further analysis showed that the most of the Movement Permits were issued by the District Forest Office amongst those who had Movement Permits.

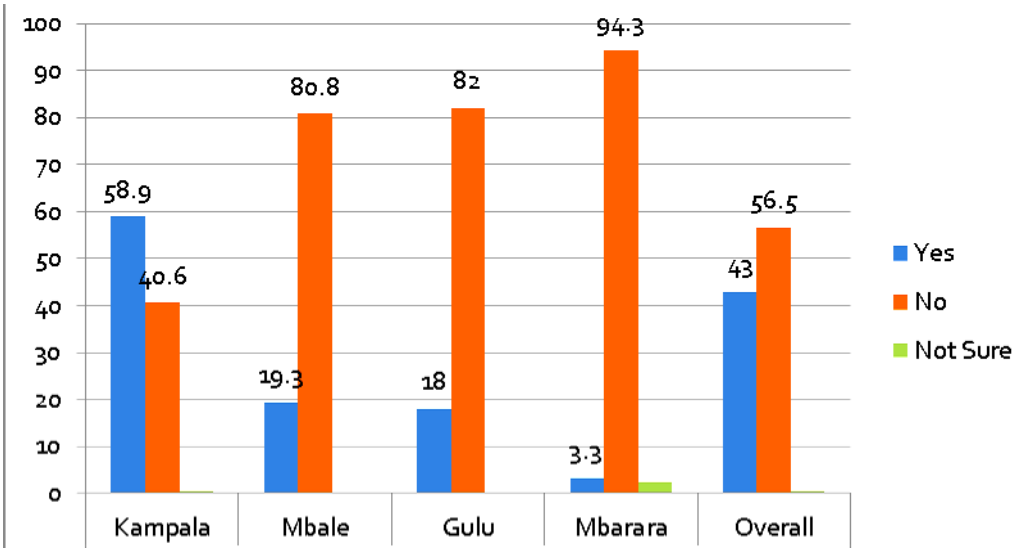

Figure 10-11: Possession of a Movement Permit

Figure 10-12 shows that the predominant transportation means used was others (36.2%), followed by the Fuso truck (25.4%). Others comprised mainly of Motor Cycles, Canter Trucks, Isuzu vehicles, Tata trucks, and Mini Buses (Taxi's).

Suppliers of charcoal in Mbale mainly use Fuso trucks (31.5%) and Trailers (30.3%) to supply charcoal. While in Mbarara charcoal suppliers mainly use bicycles (39.8%) and other means of transport (38.9%) comprising mainly of Motor cycles to supply charcoal. Some examples of large trucks are shown in Figure 10-13.

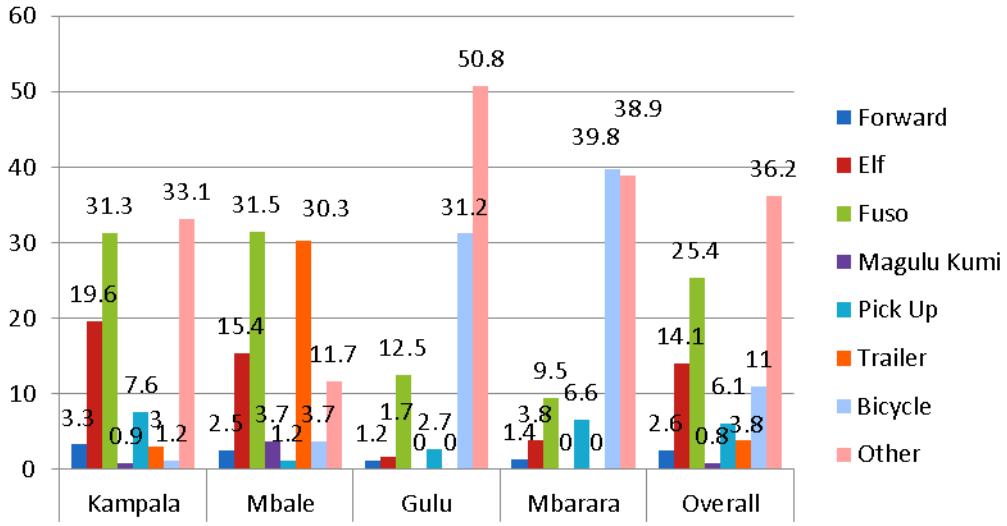

Figure 10-12: Transportation means used

Figure 10-13: Large charcoal transporters

9.2 Small scale charcoal transporters

Charcoal value chain actors who transport charcoal in small quantities using motorcycles, bicycles, wheel barrows, head loads and backloads, as illustrated in Figure 10-13, were also interviewed to determine the nature of their involvement in the sector.

Figure 10-14: Small scale charcoal transporters

A total of 102 small scale charcoal transporters were asked to indicate how long they have been in the charcoal transportation business. The overall time period ranged from 2 months to 42 years. However, the majority 68.6% had been in the business for less than 5 years as indicated in Table 10-4.

These category of traders transport from 0.5 bags to 20 bags per day with, the majority transporting between 1-4 bags of charcoal. This accounts for 68.9% of the total number of respondents interviewed. The mean for the whole group is 4 bags per day.

Table 10-4: Length of time small scale charcoal transporters have been in business

Number of years	Frequency	Percentage (%)
0.1 - 5	70	68.6%
5.1 – 10	15	14.7%
10.1 – 15	8	7.8%
15.1 – 20	4	3.9%
20.1 – 25	2	2.0%
25.1 – 30	1	1.0%
30.1 – 35	0	0%
35.1 – 40	1	1.0%
40.1 – 45	1	1.0%
Total	**102**	**100%**

9.3 Charcoal transportation challenges

Charcoal transporters face many challenges, main of which are bad roads (39%) and illegal fees by traffic police (39%) as shown in Table 10-5. The illegal fees by traffic police are essentially bribes. Other reasons include bribes taken by forestry officials (6%), untrustworthy vendors (6%) who default on payment for the charcoal they get among others.

Table 10-5: Main challenges faced by transporters

Main challenges	Frequency	Percentage
Untrustworthy vendors	2	6%
Bad roads	13	39%
Illegal fees by Traffic Police	13	39%
Bribes by forestry offices	3	9%
Cartels	1	3%
High movement permit fees	1	3%
Total	**33**	**100%**

The majority of transporters (65%) acknowledge that charcoal quality is compromised during its transportation as shown in Figure 10-14. 33% of the transporters do not think the charcoal quality is compromised. The transporters

reported two things that happen to charcoal during transportation: charcoal breaks into fine dust and its moisture content is increased.

Charcoal mainly breaks during loading and offloading (50%) as during transportation on bad roads (28%) as shown in Table 10-6. Rains wet the charcoal during transportation (13%).

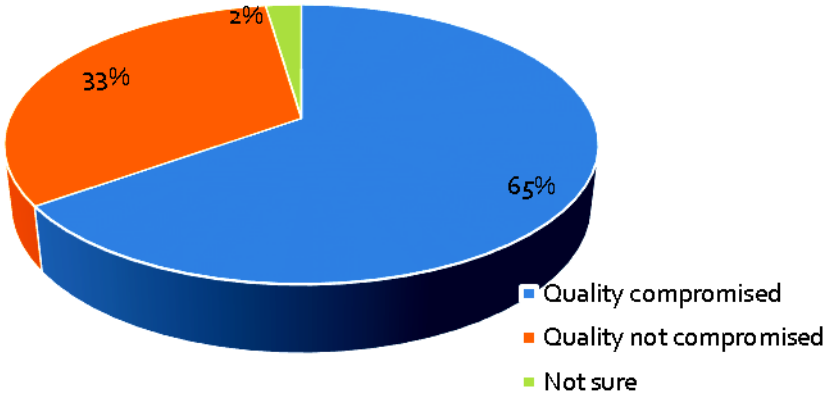

Figure 10-15: Charcoal quality during transportation

Table 10-6: Reasons for charcoal quality compromise

Reasons for charcoal quality compromise	Frequency	Percent
Charcoal breaks during loading/offloading	16	50%
Charcoal breaks due to bad roads	9	28%
Rain wets the charcoal	4	13%
Others	3	9%
Total	**32**	**100%**

It is worth noting that 26% of the respondents reported the involvement of cartels in the charcoal value chain who sometimes cause challenges in the selling of the charcoal by the transporters. However, the majority (65%) said that there are no cartels in the value chain, see Figure 10-14.

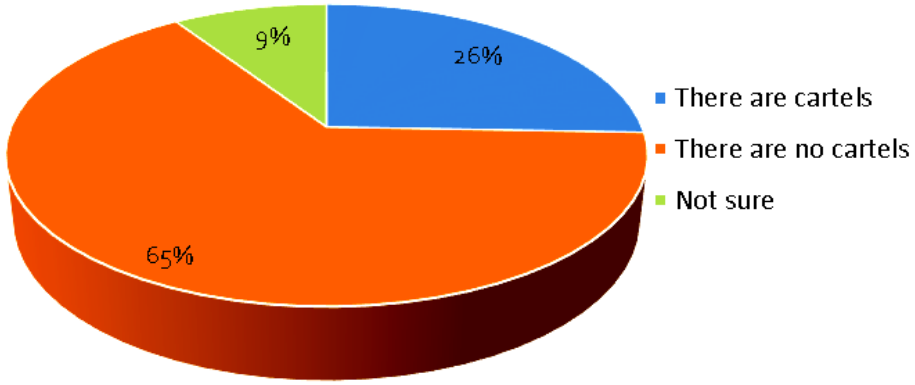

Figure 10-16: Cartels in the charcoal value chain

The small scale charcoal transporters identified 30 challenges they face. The leading seven were bad roads, lack of ready markets, long distances especially those using bicycles, tiresome, high council fees and low profits. Others are as detailed in Table 10-7.

Table 10-7: Challenges faced by small scale charcoal transporters

Challenges	Frequency
Poor/bad roads	24
Lack of ready customers/market or few customers	22
Long distances (especially tiring for bicycles)	22
Tedious and tiresome work leading to fatigue &health problems	17
High council fees/taxes	16
Steep license fees	13
Thin profit margins	13
Delayed payment from customers (Defaults)	10
Charcoal makes one dirty	7
Scarcity of charcoal	7
Damage to the charcoal	6
Harassment from forest officials	6
High transportation costs	5

Harassment from police	5
Lack of capital	5
Mechanical Breakdown	4
Dangerous for walking transporters (snake bites, cuts, bruises, etc)	4
Un-cooled charcoal (hazard)	3
Fake licenses from impersonating officials	3
High maintenance costs	3
Accidents on the road	3
Competition from larger transporters	3
Bribes	2
Scarcity of trees	2
Killing by thieves	2
Lack of collection sites for charcoal	2
Impermanent job	1
Lack of good storage	1
Lack of good quality charcoal	1
Poor hospitality (food & accommodation)	1
N/A	1
Total	**214**

Twenty two possible solutions were proposed to address the challenges. The leading five included repair/construction of roads, council and foresters to reduce fees and taxes, have a recognized market place for charcoal traders, acquire alternative transportation such as car or motorbike and provision of credit facilities for small scale transporters (Table 10-8).

Table 10-8: How the challenges for small scale transporters can be addressed

Solutions to the challenges	Frequency
Repair or construction of roads	25
Reduce taxes on transporters	18
There should be a recognized marketplace for charcoal traders	14
Acquire alternative transportation e.g. car, motorbike	10
Lending facilities for traders and transporters	8
Get a better job	7
Government to increase price of charcoal	6
N/A	5
Provide trees for planting	4
Abolish fees	4
Protective gear/clothing	4
Educating burners and transporters by government (technology, licenses etc)	3
Deal with cash only, no credit	3
Police/ Forest officers should cease harassing transporters	3
Government to buy traders transportation	2
Ensure charcoal is well packed	2
Improve security for transporters	2
Reduction on spare parts for vehicles	2
Getting a shop	1
Create one comprehensive license	1
Weed out ingenuine forest officers (impostors)	1
Reduction in fuel prices	1

Their leading aspirations in expanding charcoal business are as indicated in Table 10-9. The most commonly cited included acquiring a better vehicles, having access to credit facilities and starting their own stores.

Table 10-9: Aspiration in expanding charcoal transportation business

Aspirations for small scale charcoal transporters	Frequency
Acquire better vehicle e.g. motorbike, car, lorry etc	39
Find lending facility/grow capital	11
Start own store	10
None	9
People should be sensitized to use more charcoal (Increase market for charcoal)	4
Become rich	4
Start burning charcoal	2
Work on the roads	1
Planting more trees	1
Form association of charcoal transporters	1
Offer better services to customers	1

10 Charcoal consumption patterns

10.1 Household charcoal consumption

A total of 2,880 households were interviewed in this study, as shown in Table 10-1. Slightly over two thirds of the respondents (72.0%) were female.

Table 10-1: Distribution of the Respondents by Statistical Sub-Region

Statistical Region	Number of respondents	Percent (%)
Kampala	277	9.6
Central I	301	10.5
Central II	303	10.5
East Central	299	10.4
Eastern	299	10.4
Mid-Northern	301	10.5
North-East	297	10.3
West-Nile	200	6.9
Mid-Western	301	10.5
South Western	302	10.5
Total	**2,880**	**100**

Households were asked about the stove type currently used most of the time. About six out of every ten of the households (61.6%) reported to be using the three stone fire, 8.6% reported to be using the Ceramic charcoal stove, 7.2% reported to be using the Metal charcoal stove, see Figure 10-1. Some of the stoves are shown in Figure 10-2.

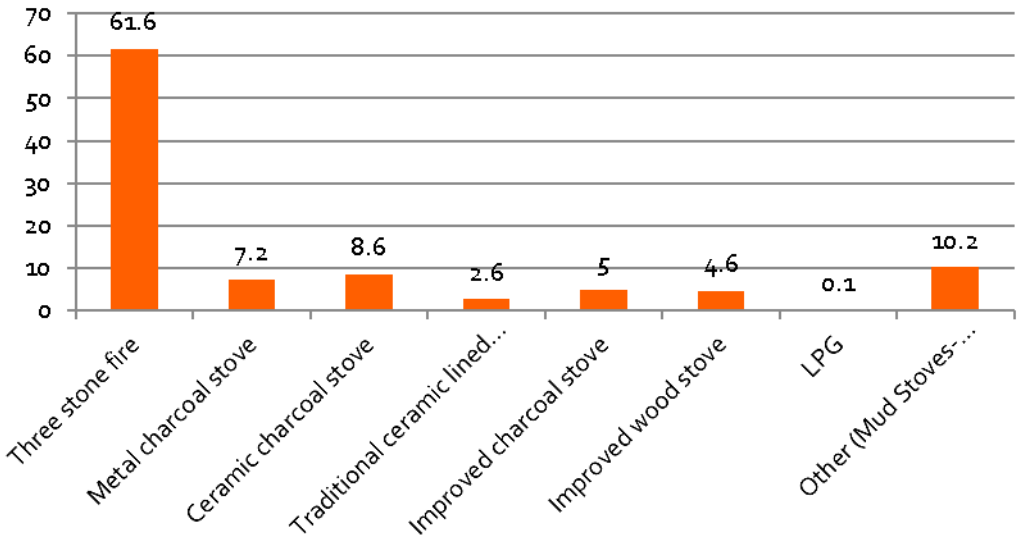

Figure 10-1: Stove Type Used Most of the Time

Figure 10-2: Some of the traditional stoves used by households

Households were asked about the secondary stove type currently used by the household. About four out of every ten of the households (39%) reported to be using the three stone fire, 17% reported to be using the Ceramic charcoal stove, 16.6% reported to be using the Metal charcoal stove, see Figure 10-3.

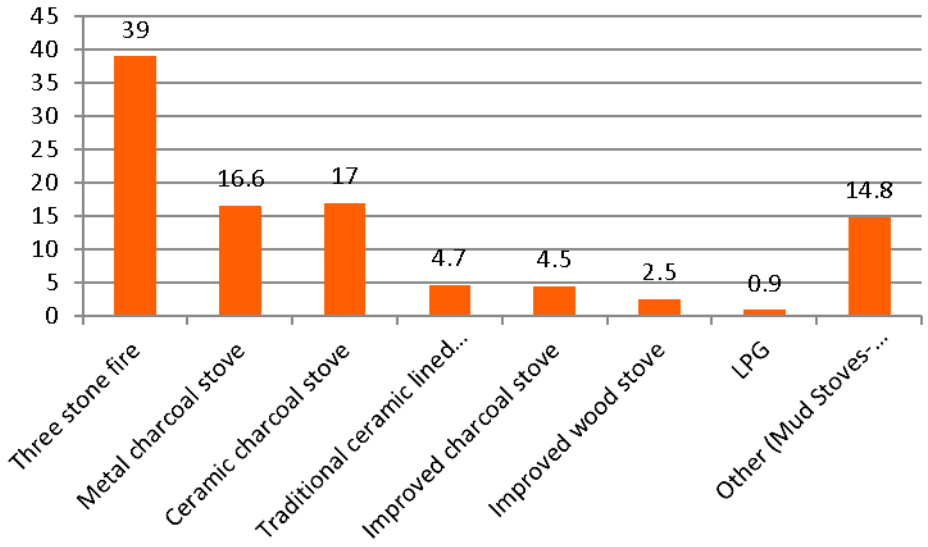

Figure 10-3: Secondary Stove Type Used in the Household

Households were asked about the cooking place both during the dry and wet seasons. Figures 5.3 presents the results of the study. The results show that most of the households (64.5%) cook their meals in a separate building during the wet season, compared to 62.8% during the dry season. In the rainy season, 15.3% of the households cook inside the main living area of the house compared to 4.7% in the dry season, see Figure 10-4.

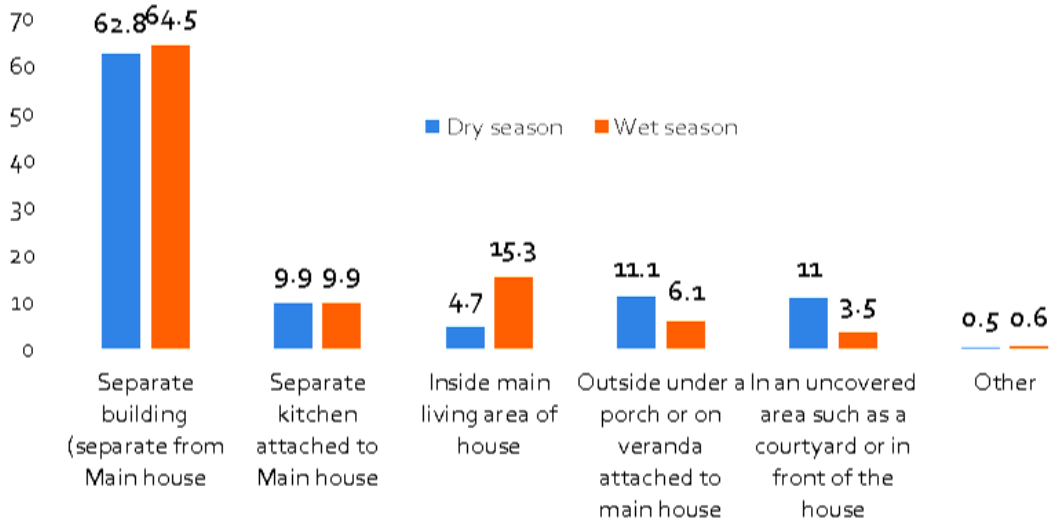

Figure 10-4: Cooking Place during the Dry and Wet Seasons

Rain was advanced as the main reason (93.2%) for swapping cooking locations among the households that reported to swap cooking locations between dry and rain seasons. About two thirds of the households that swap cooking locations between dry and wet seasons (65.6%) reported to pick up and move the stove between the seasons, while the rest (34.4%) reported to have different stoves in the different locations.

Households were asked about the cooking fuels used in their households both in the wet and dry seasons. Figures 10-5, 10-6, 10-7 and10-8 present the findings of the study.

Figure 10-5 shows that nationally; the main fuels for cooking during the wet season were firewood (70.7%) and charcoal (28.6%). In terms of location: the main fuels for cooking in the rural areas were: firewood (83.9%) and charcoal (15.4%). The main fuels for cooking in the urban areas were: charcoal (68.6%) and firewood (30.6%).

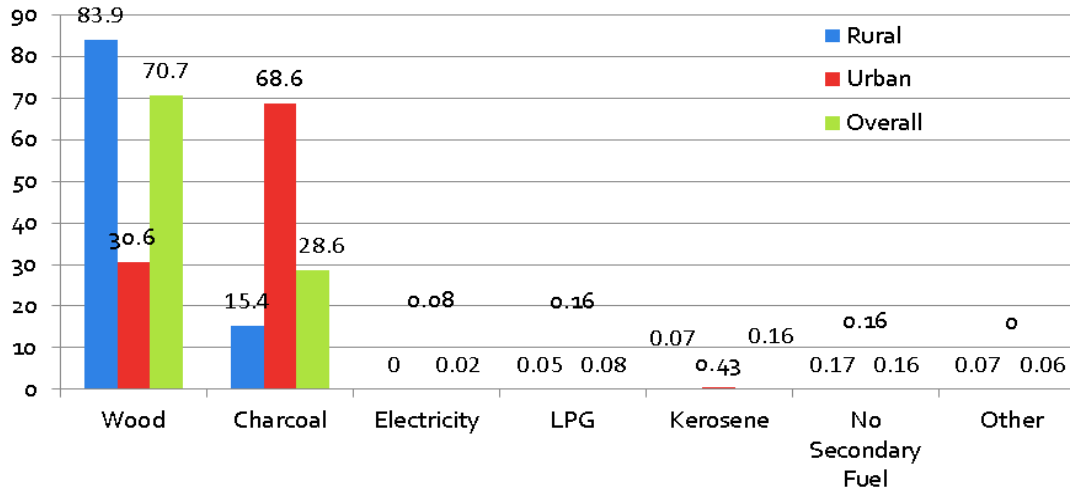

Figure 10-5: Main Fuels for Cooking During Wet Season by Location

Figure 10-6 shows that nationally; the main fuels for cooking during the dry season were firewood (73.5%) and charcoal (25.8%). In terms of location: the main fuels for cooking in the rural areas were: firewood (86.7%) and charcoal (12.7%). The main fuels for cooking in the urban areas were: charcoal (65.7%) and firewood (33.4%).

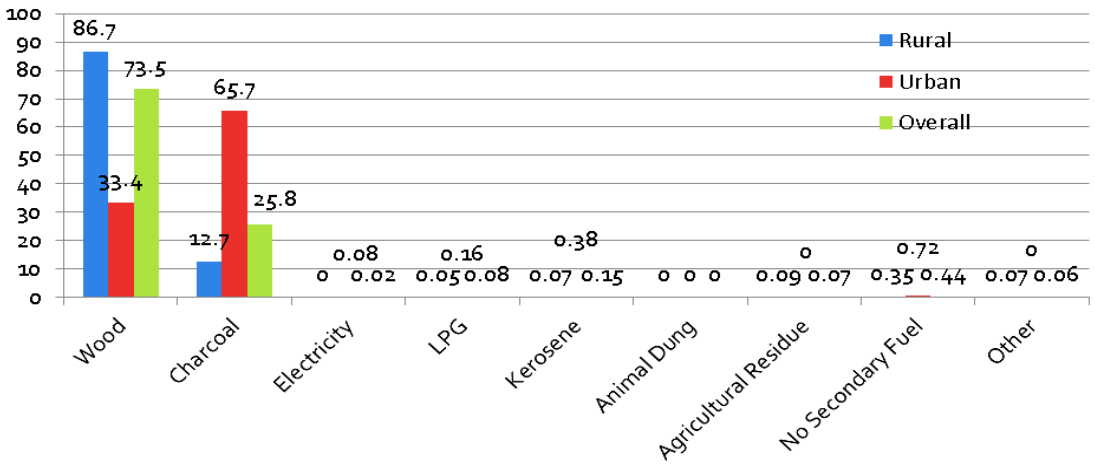

Figure 10-6: Main Fuels for Cooking During Dry Season by Location

Figure 10-7 shows the proportion of households that use firewood as the main cooking fuel during the wet season. Overall, 70.7% of all households in Uganda, use firewood as the main fuel for cooking during the wet season. The findings show that North-Eastern region (Karamoja region) had the highest proportion of households using firewood as the main fuel for cooking during the wet season (94.2%), while Kampala region had the least proportion of households using firewood as the main fuel for cooking (9.4%).

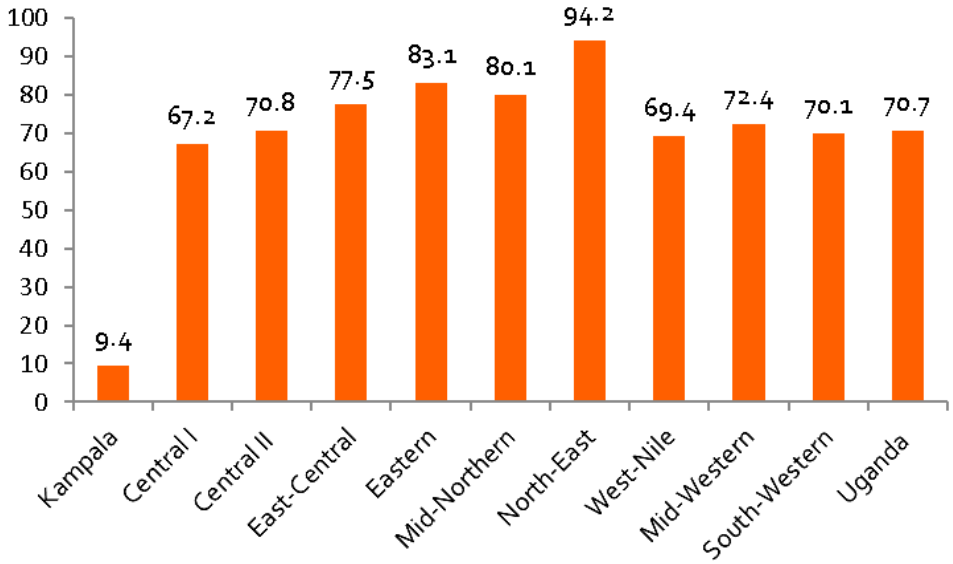

Figure 10-7: Firewood as the Main cooking Fuel in the Wet Season

Figure 10-8 shows the proportion of households that use charcoal as the main cooking fuel during the wet season. Overall, 28.6% of all households in Uganda, use charcoal as the main fuel for cooking during the wet season. The findings show that Kampala region had the highest proportion of households using charcoal as the main fuel for cooking during the wet season (88.1%), while North-East region (Karamoja region) had the least proportion of households using charcoal as the main fuel for cooking (5.9%).

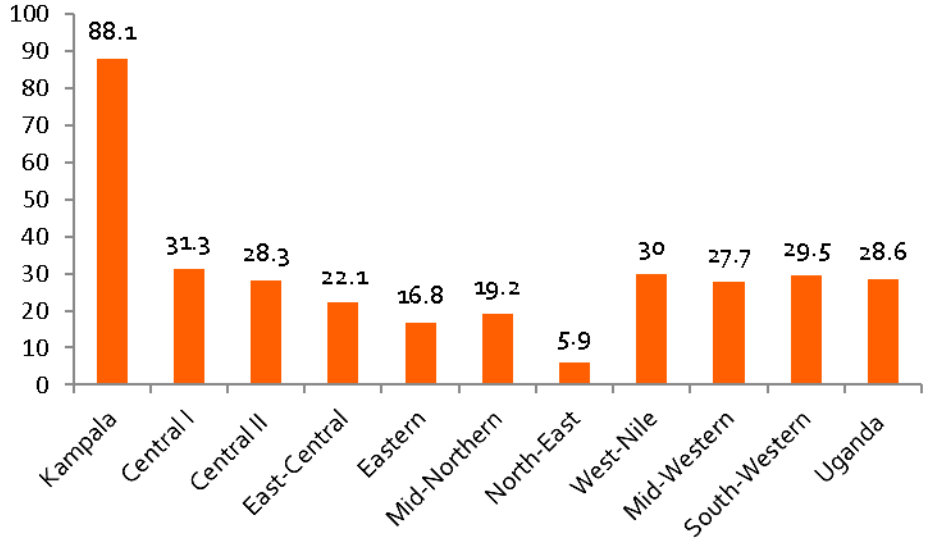

Figure 10-8: Households that use Charcoal as the Main cooking Fuel in the Wet Season

Figure 10-9 shows the proportion of households that use firewood as the main cooking fuel during the dry season. Overall, 73.5% of all households in Uganda, use firewood as the main fuel for cooking during the dry season. The findings show that North-Eastern region (Karamoja region) had the highest proportion of households using firewood as the main fuel for cooking during the dry season (93.9%), while Kampala region had the least proportion of households using firewood as the main fuel for cooking (10.5%).

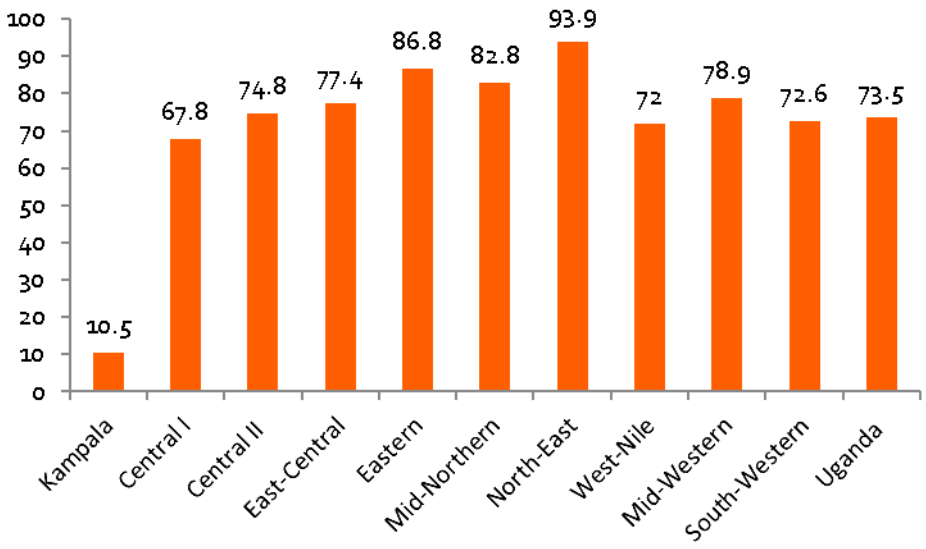

Figure 10-9: Households that use Firewood as the Main cooking Fuel in the Dry Season

Figure 10-10 shows the proportion of households that use charcoal as the main cooking fuel during the wet season. Overall, 25.8% of all households in Uganda, use charcoal as the main fuel for cooking during the wet season. The findings show that Kampala region had the highest proportion of households using charcoal as the main fuel for cooking during the wet season (87%), while North-East region (Karamoja region) had the least proportion of households using charcoal as the main fuel for cooking (5.5%).

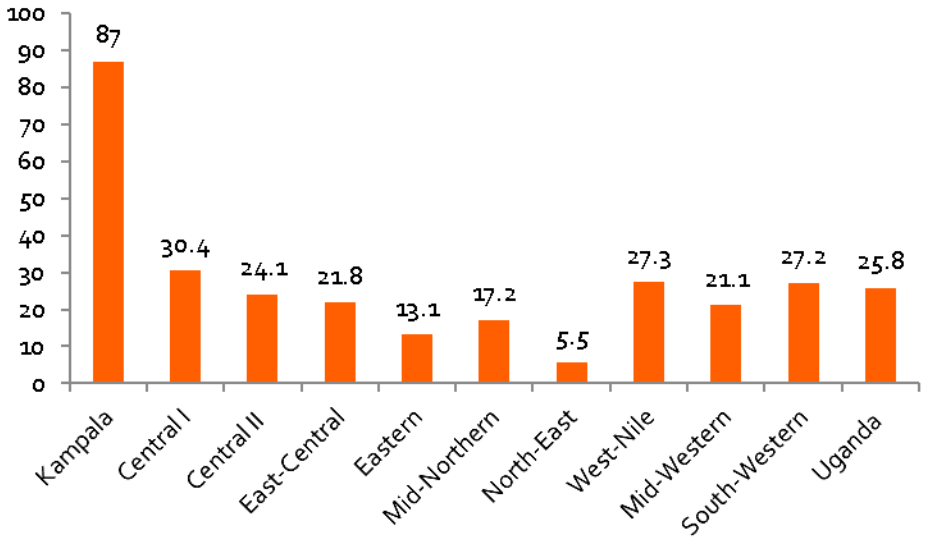

Figure 10-10: Households that use Charcoal as the Main cooking Fuel in the Dry Season

Households were asked about the proportion of the main fuel used by households that was purchased versus that which was collected. The findings show that most of the households (55.1%) collected all the fuel they used for cooking during the wet season, while 37.1% of the households purchased all the main fuel they use for cooking during the wet season, see Figure 10-11.

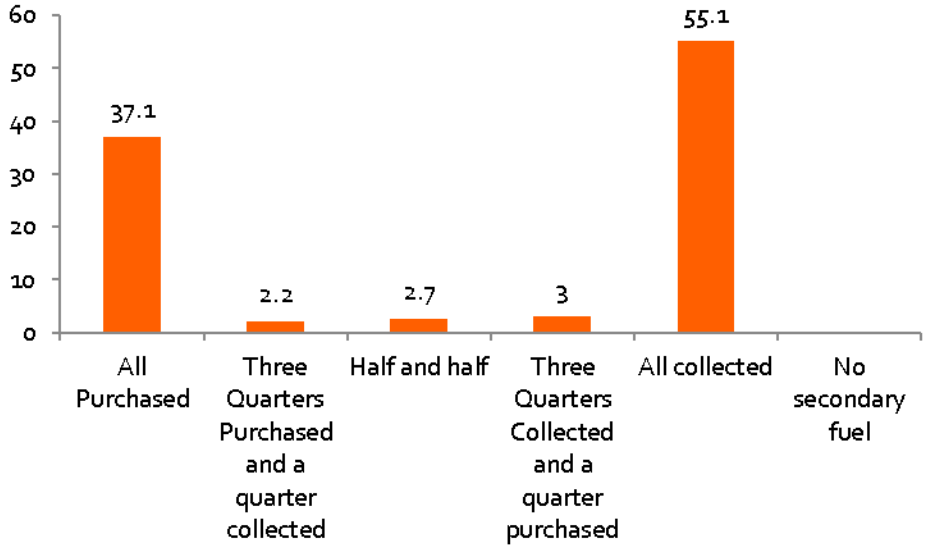

Figure 10-11: Proportion of Main Fuel Purchased during the Wet Season

Households were asked about the proportion of the main fuel used by households that was purchased versus that which was collected. The findings show that most of the households (56.6%) collected all the fuel they used for cooking during the dry season, while 37.1% of the households purchased all the main fuel they use for cooking during the dry season, see Figure 10-12.

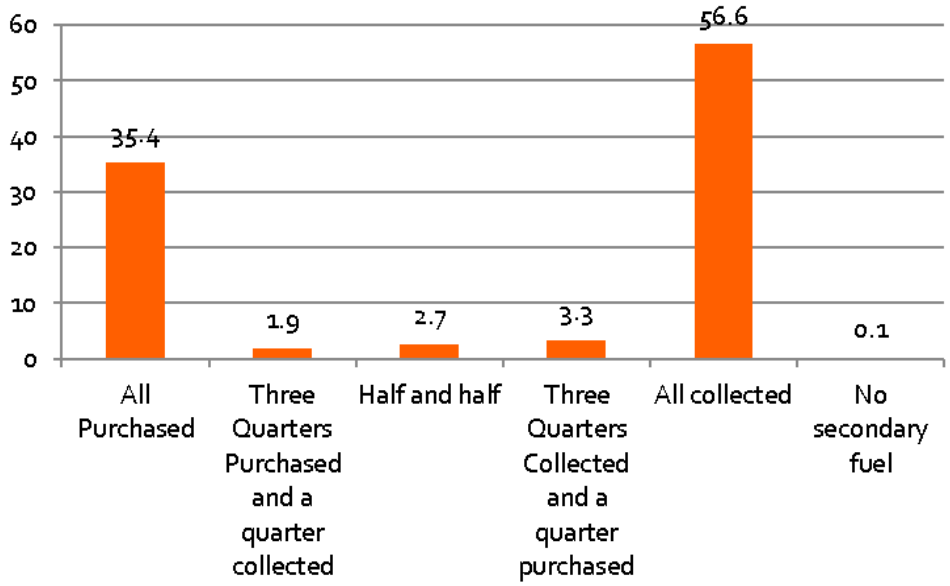

Figure 10-12: Proportion of Main Fuel Purchased during the dry Season

Households were asked about the amount of money spent on cooking fuel per day in both the wet and dry seasons. Table 10-2 shows that overall households spent on average UGX. 2,015/= on the main cooking fuel per day during the wet season. In terms of statistical regions, households in West-Nile spent the least amount of money (UGX. 1,183/=) Uon the main cooking fuel per day in the wet season.

Table 10-3 shows that overall households spent on average UGX. 1,942/= on the main cooking fuel per day during the dry season. In terms of statistical regions, households in West-Nile spent the least amount of money on the main cooking fuel per day in the dry season. Households in West-Nile spent on average UGX. 1,180/= on the main cooking fuel per day in the dry season.

Table 10-2: Money Spent on the Main Cooking Fuel per Day during the Wet Season

Sub Region	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	2,114.0	122.471	1,873.8	2,354.2
Central I	1,932.3	183.760	1,571.9	2,292.7
Central II	1,438.7	85.347	1,271.3	1,606.1
East-Central	1,966.6	91.734	1,786.6	2,146.5
Eastern	3,059.7	465.706	2,146.3	3,973.1
Mid-Northern	1,591.8	110.531	1,375.0	1,808.6
North-East	1,537.8	145.087	1,253.2	1,822.3
West-Nile	1,182.9	63.563	1,058.3	1,307.6
Mid-Western	1,913.5	148.109	1,623.0	2,204.0
South-Western	1,906.6	106.898	1,696.9	2,116.2
Uganda	**2,015**	**2.000**	**2,012.0**	**2,018.0**

Table 10-3: Money Spent on the Main Cooking Fuel Per Day during the Dry Season

Sub Region	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	2147.4	125.859	1900.6	2394.3
Central I	1883.8	184.222	1522.5	2245.1
Central II	1403.1	83.725	1238.9	1567.3
East-Central	2005.5	95.254	1818.7	2192.4
Eastern	2891.9	390.392	2126.2	3657.6
Mid-Northern	1671.1	151.177	1374.6	1967.6
North-East	1528.1	146.097	1241.5	1814.6
West-Nile	1180.0	66.209	1050.2	1309.9
Mid-Western	2054.9	200.689	1661.3	2448.5
South-Western	1931.8	138.659	1659.8	2203.8
Uganda	**1,942**	**2.000**	**1,939.0**	**1,945.0**

Figure 10-13 shows that most of the households in Uganda (45.9%) do not purchase the main cooking fuel, 18% of the households purchase the main cooking fuel from the shop (Kibanda), while 15.6% of the households purchase the main cooking fuel from mobile sellers. Further analysis shows that most of the households purchase the main cooking fuel in tins (64.2%), while the rest (35.8%) purchase the main cooking fuel in terms of bags.

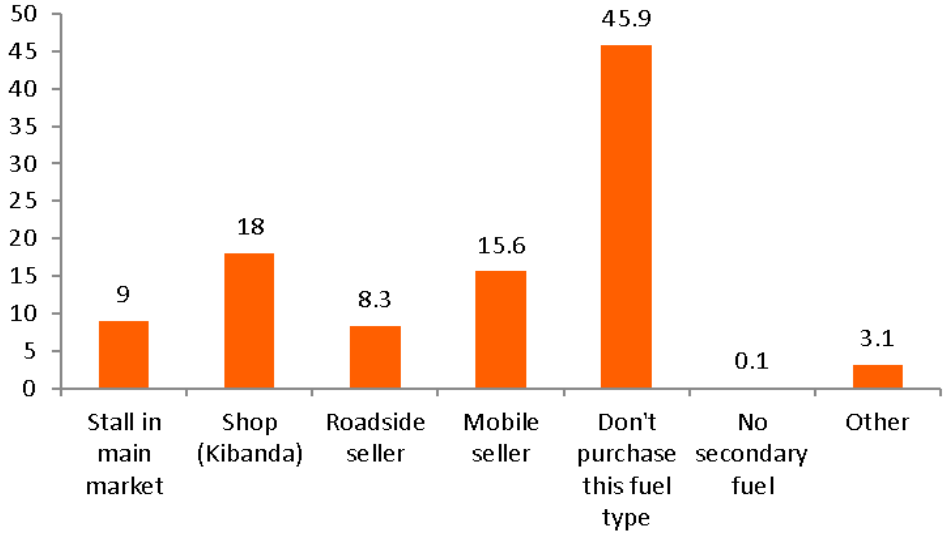

Figure 10-13: Place Where Main Cooking Fuel is Usually Purchased

Households were asked about the price at which they buy either a tin or bag of charcoal. Table 10-4 shows that households purchased a bag of charcoal at an average price of UGX. 27,470/= per bag. The findings show that the average price of a bag of charcoal in Kampala was UGX. 56,600/=, while the average price of a bag of charcoal in North-Eastern Uganda (Karamoja region) is UGX. 8,180/=.

Table 10-4: Average Price of a Bag of Charcoal

Sub Region	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	56,600	46	56,509	56,691
Central I	28,379	46	28,289	28,470
Central II	24,780	33	24,715	24,845
East-Central	38,819	131	38,562	39,076
Eastern	27,198	64	27,072	27,324
Mid-Northern	27,931	124	27,689	28,173
North-East	8,180	61	8,060	8,300
West-Nile	18,214	53	18,110	18,318
Mid-Western	21,602	29	21,545	21,659
South-Western	20,060	19	20,023	20,097
Uganda	**27,470**	**20**	**27,430**	**27,510**

Table 10-5 shows that households purchased a tin of charcoal at an average price of UGX. 2,184/= per tin. The highest price was recorded in West-Nile while the lowest was recorded in Central I.

Table 10-5: Average Price of a Tin of Charcoal

Sub Region	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Kampala	1,774	7	1,761	1,787
Central I	1,237	2	1,234	1,241
Central II	2,156	6	2,144	2,167
East-Central	1,451	3	1,444	1,457
Eastern	2,867	8	2,852	2,882
Mid-Northern	3,026	10	3,005	3,046
North-East	2,301	12	2,278	2,325
West-Nile	3,866	4	3,858	3,875
Mid-Western	2,214	11	2,193	2,236
South-Western	1,812	4	1,805	1,819
Uganda	**2,184**	**2**	**2,180**	**2,189**

Households were also asked whether they knew the tree species used to make the charcoal they usually use, about a fifth of the households (21.6%) reported to know the tree species from which the charcoal they usually use is made.

Households were asked about the amount of money spent on kerosene per day, week and/or month. The results show that households that use kerosene spend on average UGX. 5,796/= per month on kerosene, see Table 10-6.

Table 10-6: Amount of Money Spent on Kerosene by Duration

Duration	Number of Households	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Day	144,960	356	2	353	359
Week	144,046	1,352	5	1,342	1,363
Month	122,373	5,796	39	5,720	5,873

The average amount of money spent on electricity per month was estimated to be UGX. 5,952/=, see Table 10-7.

Table 10-7: Average Amount Spent on Briquettes, Electricity and Other Fuels

Expenditure Item per month	Number of Households	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Electricity	559,271	5,952	22	5,909	5,995
Other Fuel	576,555	3,434	18	3,398	3,469

Households were asked to estimate the total quantity of fuel used for cooking per day. Households using either charcoal or firewood were requested to provide the estimated quantity of charcoal and/or firewood used for cooking per day for weighing. The weights of the amount of charcoal and/or firewood used per day were taken and recorded by the researchers (Figure 10-14). The survey findings were as follows: Households that use charcoal for cooking use on average 2.2Kg of charcoal per day. Households that use firewood for cooking use on average 8.9Kg of firewood per day as shown in Table 10-8.

Table 10-8: Average amount of fuel used per day

Fuel Type	Number of Households	Mean (kg)	Std. Err.	[95% Conf.	Interval]
Charcoal	2,291,210	2.17	0	2.16	2.17
Firewood	4,563,436	8.87	0	8.86	8.87
Kerosene	491,886	0.03	0	0.03	0.03
LPG	480,678	0.02	0	0.01	0.02
Other Fuel	475,922	0.46	0	0.45	0.47

Figure 10-14: Measuring charcoal used by a household in a day.

Table 10-9 gives a summary of the total amount of fuel used by households in Uganda in metric tonnes. The results show that households in Uganda use an estimated total of 4,961 metric tonnes of charcoal per day. The results also show that households in Uganda use an estimated total of 40,500 metric tonnes of firewood per day.

Table 10-9: Fuel used per day in Metric Tonnes

Fuel Type	Number of households	Fuel used per day (Tonnes)	Std. Err.	[95% Conf.	Interval]
Charcoal	2,291,210	4,961	3.8	4,954	4,969
Firewood	4,563,436	40,500	16.0	40,400	40,500
Kerosene	491,886	13.4	0.1	13.1	13.7
LPG	480,678	7.4	0.2	7.0	7.7
Other Fuel	475,922	218.5	1.5	215.6	221.3

The survey sought information on the amount of charcoal used by households per day in Uganda. The results show that about 4,961 Metric Tonnes of charcoal are used by households in Uganda per day, see Table 10-10.

Table 10-10: Charcoal used per day by Sub Region in Metric Tonnes

Sub Region	Charcoal used per day (Tonnes)	Std. Err.	[95% Conf.	Interval]
Kampala	803.9	1.339	801.3	806.5
Central I	702.4	1.482	699.5	705.3
Central II	647.0	1.224	644.6	649.4
East-Central	336.8	0.823	335.1	338.4
Eastern	811.2	1.696	807.9	814.5
Mid-Northern	383.4	1.102	381.2	385.5
North-East	20.2	0.319	19.6	20.8
West-Nile	319.3	0.725	317.8	320.7
Mid-Western	450.7	1.043	448.7	452.8
South-Western	486.5	1.323	483.9	489.1
Uganda	**4,961.3**	**3.849**	**4,953.8**	**4,968.9**

The survey sought information on the amount of firewood used by households per day in Uganda. The results show that about 40,500 Metric Tonnes of firewood are used by households in Uganda per day, see Table 10-11.

Table 10-11: Firewood used per day by Sub Region in Metric Tonnes

Sub Region	Wood used per day (Tonnes)	Std. Err.	[95% Conf.	Interval]
Kampala	266.3	1.861	262.6	269.9
Central I	6,135.1	5.457	6,124.4	6,145.8
Central II	5,599.6	4.803	5,590.2	5,609.0
East-Central	3,348.2	4.433	3,339.5	3,356.9
Eastern	6,603.5	5.228	6,593.3	6,613.8
Mid-Northern	4,953.0	4.648	4,943.9	4,962.1
North-East	1,309.1	3.379	1,302.4	1,315.7
West-Nile	2,361.9	3.774	2,354.5	2,369.3
Mid-Western	5,592.2	7.055	5,578.4	5,606.0
South-Western	4,300.2	6.122	4,288.2	4,312.2
Uganda	**40,500.0**	**15.973**	**40,400.0**	**40,500.0**

10.2 Institutional charcoal consumption

Institutions located in the Enumeration Areas and/or Sub Counties and districts in which the household survey was conducted were also interviewed during the charcoal survey. The purpose of interviewing the institutions was to ascertain the consumption of charcoal and firewood in these industries since industries are major consumers of charcoal and firewood. The results of the institutional interviews are presented below.

Figure 10-15 shows the distribution of institutions by industrial classification. The results show that most of institutions were classified under Accommodation & Food Services (82.9%), followed by those classified under Education, Health & Social Work (15.1%).

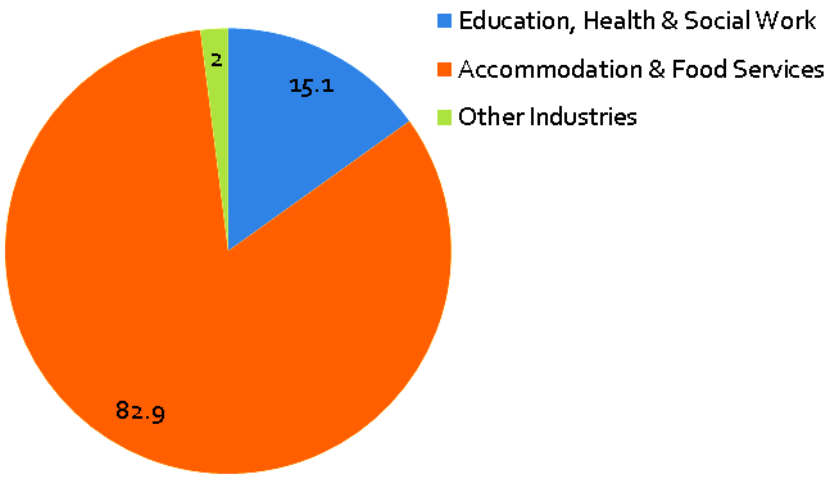

Figure 10-15: Distribution of Institutions by Industrial Classification

Institutions were asked about the stove type currently used most of the time. About a fifth of the institutions (21.7%) reported to be using the metal charcoal stove, 15.2% were using the three stone fire, 14.1% reported to be using the improved charcoal stove, see Figure 10-16.

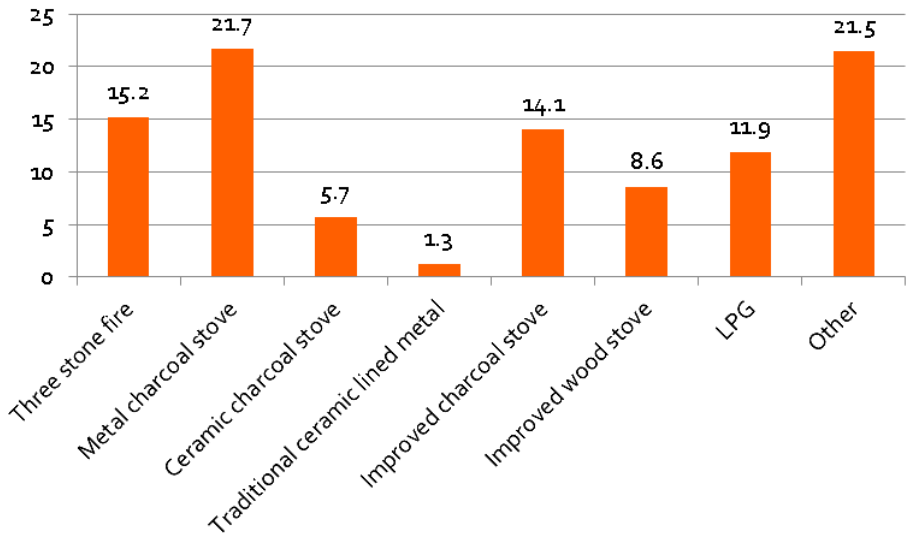

Figure 10-16: Stove Type Used Most of the Time

Figure 10-17 shows the main cooking fuel during the wet season. Overall, 48.5% of the institutions in Uganda, use charcoal as the main fuel for cooking during the wet season. About a fifth of the institutions (21.2%) use firewood as the main fuel for cooking during the wet season.

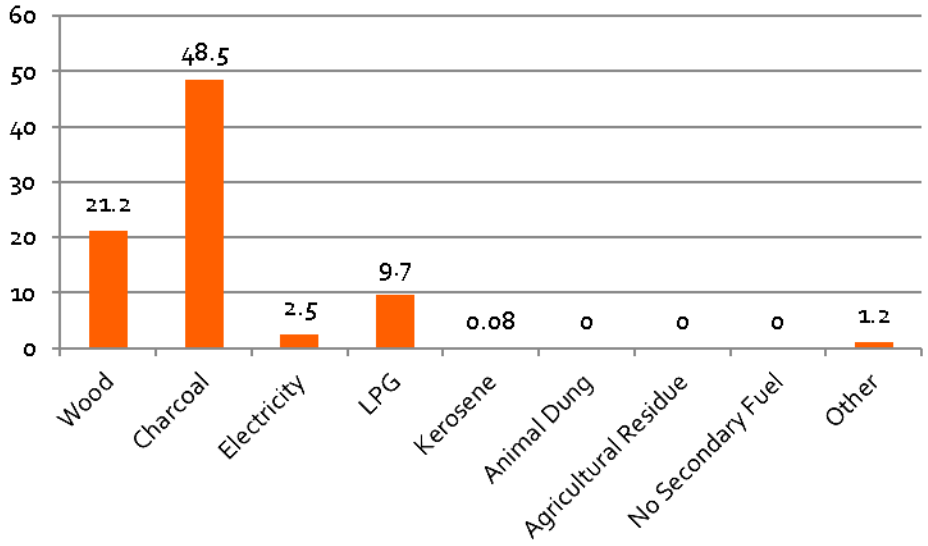

Figure 10-17: Main Fuel for Cooking During Wet Season

Figure 10-18 shows the main cooking fuel during the dry season. Overall, 49% of the institutions in Uganda, use charcoal as the main fuel for cooking during the wet season. About a fifth of the institutions (21.2%) use firewood as the main fuel for cooking during the dry season.

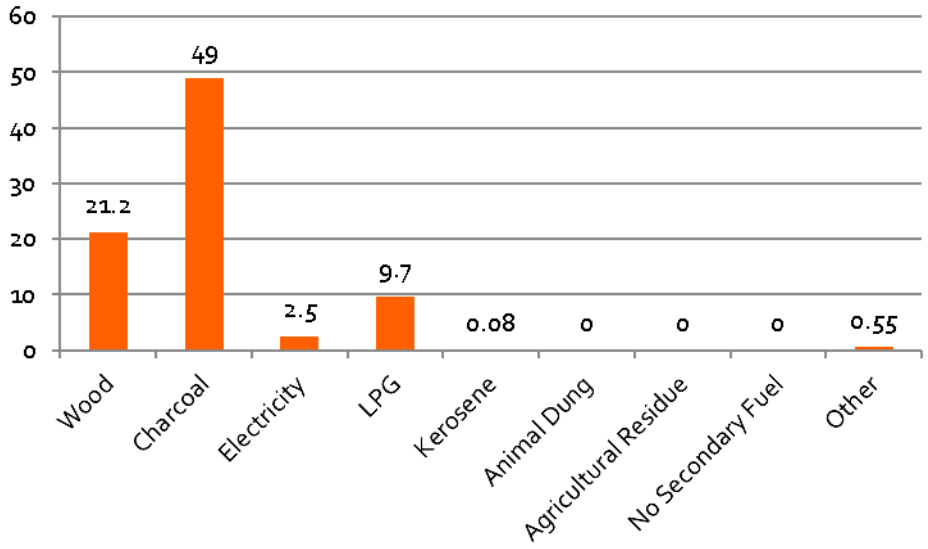

Figure 10-18: Main Fuel for Cooking During Dry Season

The findings show that most of the institutions located in rural areas (54.4%) use charcoal as the main fuel for cooking during the dry season, followed by those that use firewood as the main source of fuel for cooking (43.3%). Likewise, most of the institutions located in urban areas (47.8%) use charcoal as the main cooking fuel during the dry season, followed by those that use firewood as the main cooking fuel (16.3%). About a tenth of the institutions located in urban areas (11.9%) use LPG as the main cooking fuel during the dry season. Only 3% of the institutions located in urban areas reported to be using electricity as the main cooking fuel during the dry season, see Figure 10-19.

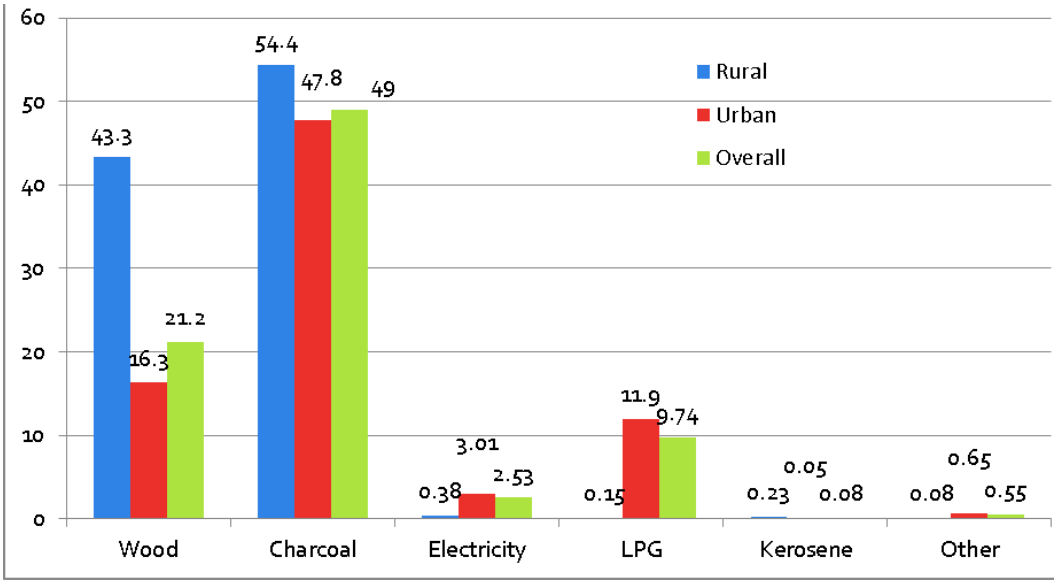

Figure 10-19: Main Fuel for Cooking During Dry Season by Location

The findings also show that most of the institutions located in rural areas (54.4%) use charcoal as the main fuel for cooking during the wet season, followed by those that use firewood as the main source of fuel for cooking (43.3%). Likewise, most of the institutions located in urban areas (47.2%) use charcoal as the main cooking fuel during the wet season, followed by those that use firewood as the main cooking fuel (16.3%). About a tenth of the institutions located in urban areas (11.9%) use LPG as the main cooking fuel during the wet season. Only 3% of the institutions located in urban areas reported to be using electricity as the main cooking fuel during the wet season, see Figure 10-20.

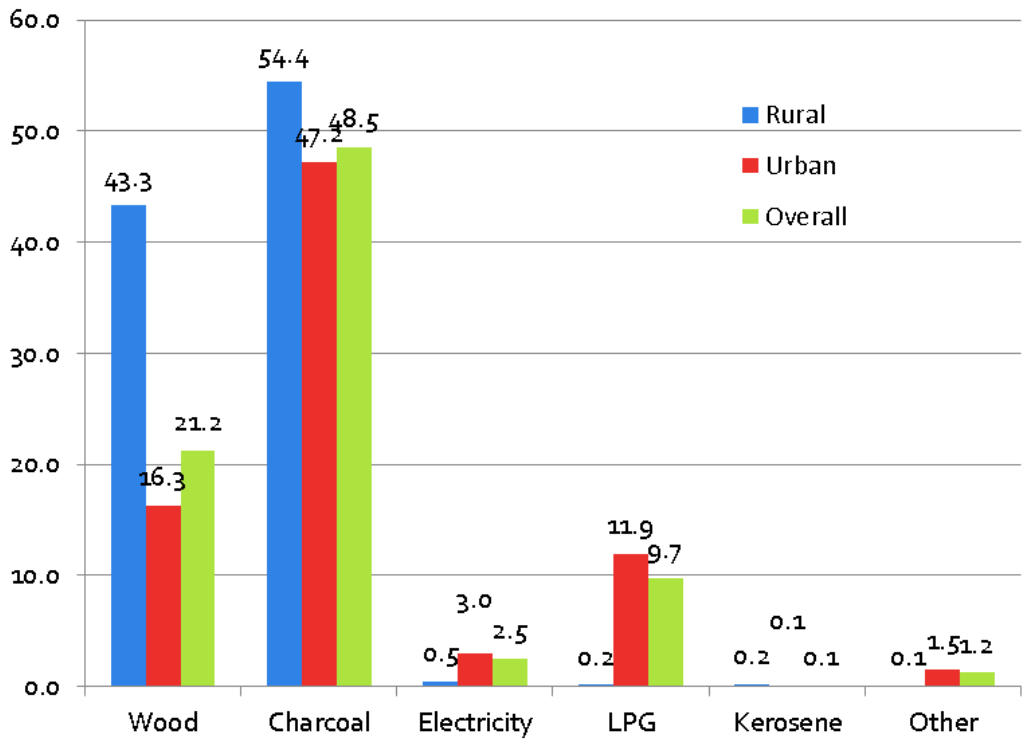

Figure 10-20: Main Fuel for Cooking During Wet Season by Location

Institutions were asked about the proportion of the main fuel used by institutions that was purchased versus that which was collected. The findings show that almost all institutions (95.4%) purchased all the main fuel used for cooking during the wet season, see Figure 10-22.

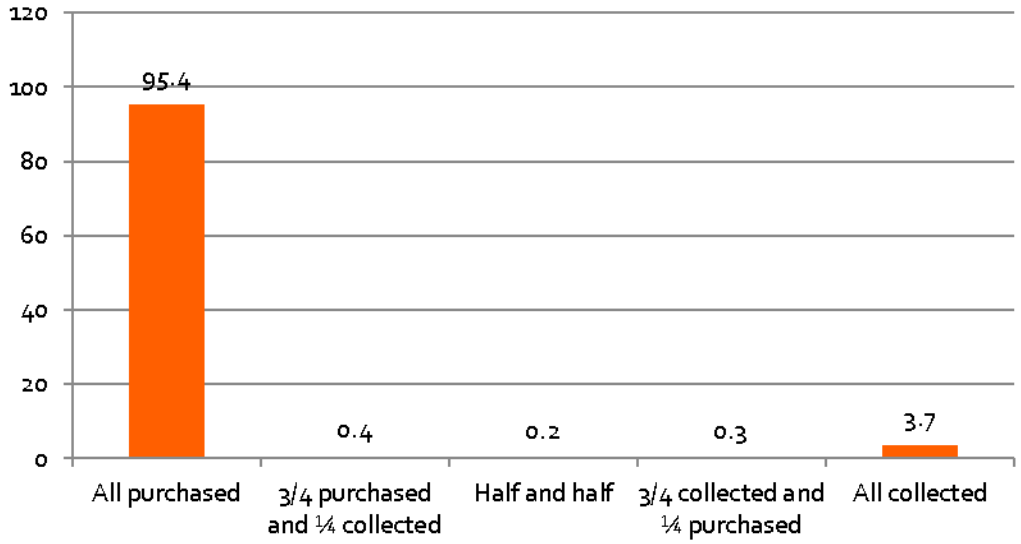

Figure 10-21: Sourcing of Main Fuel during Wet Season

Institutions were asked about the proportion of the main fuel used by institutions that was purchased versus that which was collected. The findings show that almost all institutions (95.4%) purchased all the main fuel used for cooking during the dry season, see Figure 10-22.

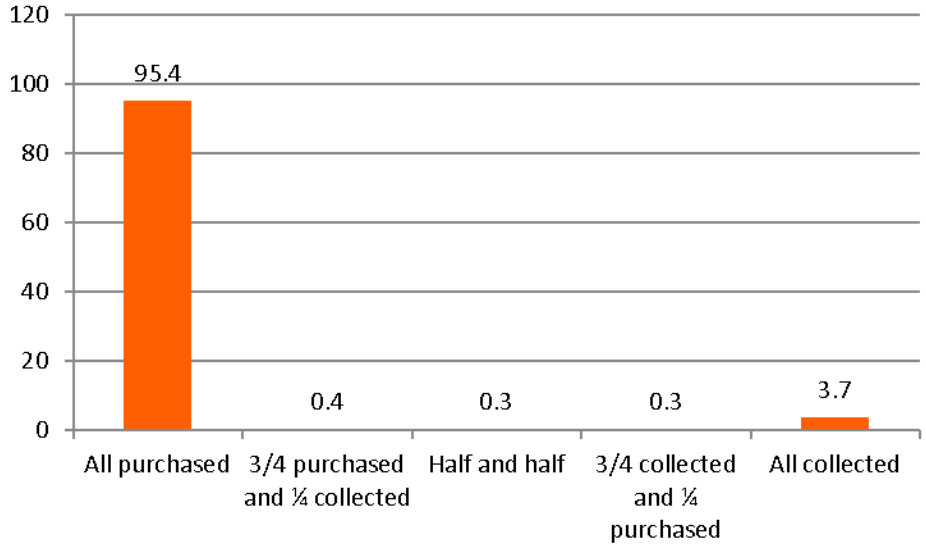

Figure 10-22: Sourcing of Main Fuel during Dry Season

Figure 10-23 shows that most of the institutions in Uganda (38%) purchase the main cooking fuel from mobile sellers, 13.5% of the institutions purchase the main cooking fuel from the a stall in the market, while 11.1% of the institutions purchase the main cooking fuel from a charcoal shop (Kibanda).

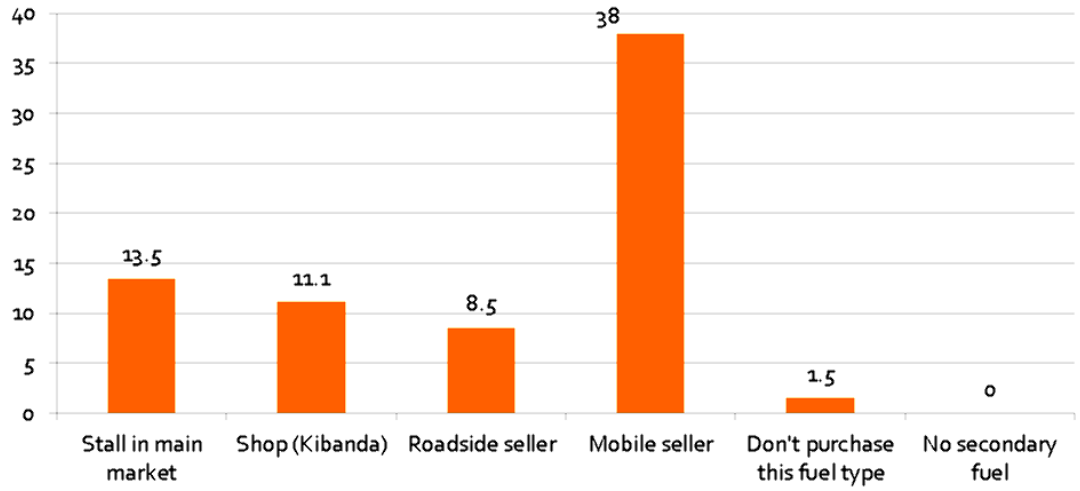

Figure 10-23: Place of Purchase of Main Cooking Fuel

Institutions were asked about the price at which they buy either a tin or bag of charcoal. Table 10-12 shows that institutions purchased a bag of charcoal at an average price of UGX. 32,067/= per bag. The results also show that institutions purchased a tin of charcoal at an average price of UGX. 7,713/= per tin.

Table 10-12: Average Cost of each Measure of Charcoal Purchased

Unit of Measure	Mean	Std. Err.	[95% Conf.	Interval]
Bags	32,067.1	77.492	31,915.2	32,219.0
Tins	7,713.3	117.600	7,482.8	7,943.8

The survey results show that the average amount of money spent by institutions on electricity per month was estimated to be UGX. 926,930/=. The average amount of money spent on LPG per month was estimated to be UGX. 561,353/=. The average amount of money spent on briquettes per month was estimated to be UGX. 26,142/=, see Table 10-13.

Table 10-13: Average amount spent on selected fuels

Type of Fuel (per month)	Mean (UGX)	Std. Err.	[95% Conf.	Interval]
Briquettes	26,142.0	6,154.0	14,065.0	38,219.0
Electricity	926,930.0	25,783.0	876,389.0	977,470.0
LPG	561,353.0	11,908.0	538,010.0	584,696.0

Institutions were asked to estimate the total quantity of fuel used for cooking per day. The survey findings were as follows: Institutions that use charcoal for cooking use on average 26.2Kg of charcoal for cooking per day. Institutions that use firewood for cooking use on average 60.8Kg of firewood for cooking per day. Institutions that use kerosene for cooking use on average 16.1 litres of Kerosene for cooking per day. Institutions that use LPG for cooking use on average 13.7Kg of LPG for cooking per day, see Table 10-14.

Table 10-14: Average Amount of Fuel used per day

Type of Fuel	Mean (kg)	Std. Err.	[95% Conf.	Interval]
Charcoal	26.2	1.05	24.1	28.2
Firewood	60.8	0.81	59.2	62.3
Kerosene	16.1	0.58	15.0	17.2
LPG	13.7	0.2	13.3	14.0
Other Fuel	55.5	11.11	33.4	77.6

Table 10-15 gives a summary of the total amount of fuel used by institutions in Uganda in metric tonnes. The results show that institutions in Uganda use an estimated total of 887.3 metric tonnes of charcoal per day. The results also show that households in Uganda use an estimated total of 947.6 metric tonnes of firewood per day.

Table 10-15: Total Amount of Fuel Used by Institutions per Day in Metric Tonnes

Type of Fuel	Total (Tonnes)	Std. Err.	[95% Conf.	Interval]
Charcoal	887.3	35.7	817.4	957.3
Firewood	947.6	12.6	922.9	972.2
Kerosene	16.0	0.6	14.9	17.1
LPG	115.1	1.7	111.9	118.4
Other Fuel	4.7	0.9	2.8	6.5

The survey sought information on the amount of charcoal used by institutions per day in Uganda. The results show that about 887.3 Metric Tonnes of charcoal are used by institutions in Uganda per day, see Table 10-16.

Table 10-16: Total Amount of Charcoal used per day by industry in Metric Tonnes

Industry	Total	Std. Err.	[95% Conf.	Interval]
Accommodation & Food Services	7.1	0.738	5.6	8.5
Education, Health & Social Work	780.0	4.420	771.3	788.6
Other Industries	100.3	35.186	31.3	169.2
Overall	**887.3**	**35.693**	**817.4**	**957.3**

The survey sought information on the amount of firewood used by institutions per day in Uganda. The results show that about 947.6 Metric Tonnes of firewood are used by institutions in Uganda per day, see Table 10-17.

Table 10-17: Total Amount of Firewood used per day by industry in Metric Tonnes

Industry	Total	Std. Err.	[95% Conf.	Interval]
Accommodation & Food Services	497.4	11.1	475.7	519.2
Education, Health & Social Work	445.2	3.5	438.3	452.2
Other Industries	4.9	0.5	3.9	6.0
Overall	**947.6**	**12.6**	**922.9**	**972.2**

The survey also sought information on the amount of kerosene used by institutions per day in Uganda. The results show that about 16.0 Metric Tonnes of kerosene are used by institutions in Uganda per day, see Table 10-18.

Table 10-18: Total Amount of Kerosene used per day by industry in Metric Tonnes

Industry	Total	Std. Err.	[95% Conf.	Interval]
Accommodation & Food Services	0.1	0.010	0.0	0.1
Education, Health & Social Work	15.9	0.543	14.9	17.0
Overall	**16.0**	**0.577**	**14.9**	**17.1**

The survey further sought information on the amount of LPG used by institutions per day in Uganda. The results show that about 115.1 Metric Tonnes of LPG are used by institutions in Uganda per day, see Table 10-19.

Table 10-19: Total Amount of LPG used per day by industry in Metric Tonnes

Industry	Total	Std. Err.	[95% Conf.	Interval]
Accommodation & Food Services	1.5	0.2	1.1	1.8
Education, Health & Social Work	113.7	1.6	110.5	116.9
Overall	**115.1**	**1.7**	**111.9**	**118.4**

10.3 Charcoal per capita consumption

The total firewood and charcoal consumed by household and institutions was converted to tonnes of oil equivalent (toe)[4], see Table 10-20. The results show that the total firewood and charcoal consumed per annum was 11,727,416 toe. The estimated household fuelwood & charcoal consumption per capita was 306 kgoe.

The total firewood and charcoal consumed by households in Kampala was converted to tonnes of oil equivalent (toe)[5], see Table 10-21. The results show that the total firewood and charcoal consumed per annum in Kampala was 974,606 toe. The estimated household fuelwood & charcoal consumption per capita was 647 kgoe.

[4] 1 tonne of fuelwood=0.3215 toe: www.unece.org/forests/mis/energy/guide.html#m2
[5] 1 tonne of fuelwood=0.3215 toe: www.unece.org/forests/mis/energy/guide.html#m2

Table 10-20: Fuelwood and Charcoal Consumption in tonnes of oil equivalent (toe) per annum

Sector	Fuelwood	Charcoal[11][6]	Total
Household	4,752,574	5,821,609	10,574,183
Accommodation & Food Services	58,369	8,332	66,700
Education, Health & Social Work	52,243	916,015	968,258
Other Industries	575	117,700	118,275
Total	4,863,761	6,863,655	11,727,416
Total Population	34,600,000		
Household Fuelwood & Charcoal Consumption per capita (kgOE)	137	168	306

Table 10-21: Fuelwood and Charcoal Consumption per annum for Kampala

Sector	Fuelwood	Charcoal[11][7]	Total
Household	31,250	943,357	974,606
Total Population	1,507,114		
Household Fuelwood & Charcoal Consumption per capita (kgOE)	21	626	647

10.4 Projected Charcoal demand

The survey data was used to estimate the projected demand for charcoal by households in Uganda. The results show that about 2.1 Million Metric Tonnes of charcoal will be required for cooking by households in Uganda in 2020, see Table 10-22.

Table 10-22: Projected Annual Charcoal Demand in Metric Tonnes

Year	Estimated Total Demand	[95% Confidence Interval]	
2015	1,810,765	1,808,210	1,813,685
2016	1,865,088	1,862,456	1,868,096

[6] Wood to charcoal conversion efficiency was estimated to be between 10-15% maximum
[7] Wood to charcoal conversion efficiency was estimated to be between 10-15% maximum

2017	1,921,041	1,918,330	1,924,138
2018	1,978,672	1,975,880	1,981,863
2019	2,038,032	2,035,156	2,041,318
2020	2,099,173	2,096,211	2,102,558

The survey data was also used to estimate the projected demand for firewood by households in Uganda. The results show that about 17.1 Million Metric Tonnes of firewood will be required for cooking by households in Uganda in 2020, see Table 10-23.

Table 10-23: Projected Annual Firewood Demand in Metric Tonnes

Year	Estimated Total Demand	[95% Confidence Interval]	
2015	14,782,500	14,771,185	14,793,815
2016	15,225,975	15,214,321	15,237,629
2017	15,682,754	15,670,750	15,694,758
2018	16,153,237	16,140,873	16,165,601
2019	16,637,834	16,625,099	16,650,569
2020	17,136,969	17,123,852	17,150,086

11 Charcoal pricing and marketing

11.1 Charcoal marketing

The majority of charcoal transporters (66%) mainly buy charcoal from charcoal burners at the production sites compared to 34% who buy the charcoal from collection areas, see Figure 11-1.

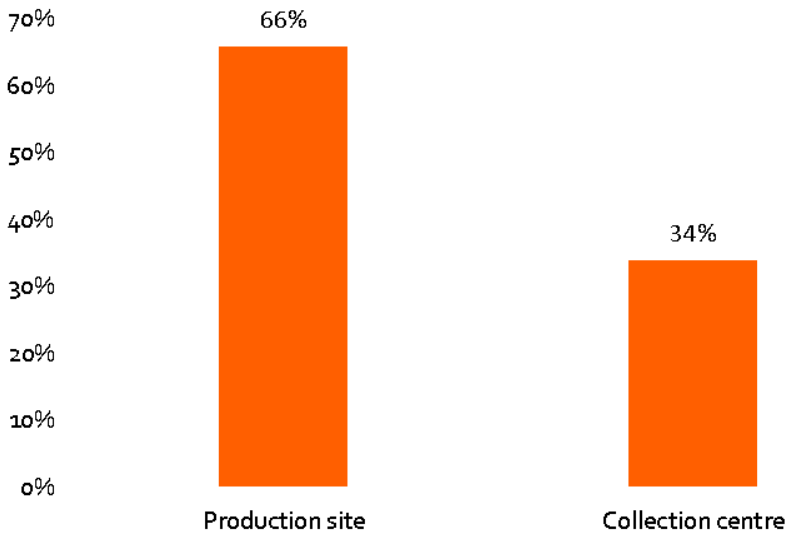

Figure 11-1: Purpose of charcoal from production sites vs collection centres

It has been noted that charcoal marketing is developed with multiple vendors located in urban areas of country. As shown in Figure 11-2, 60% of the transporters sell their charcoal to a network of charcoal vendors distributed across the urban areas in Uganda while 38% indicated to sell charcoal directly to end users.

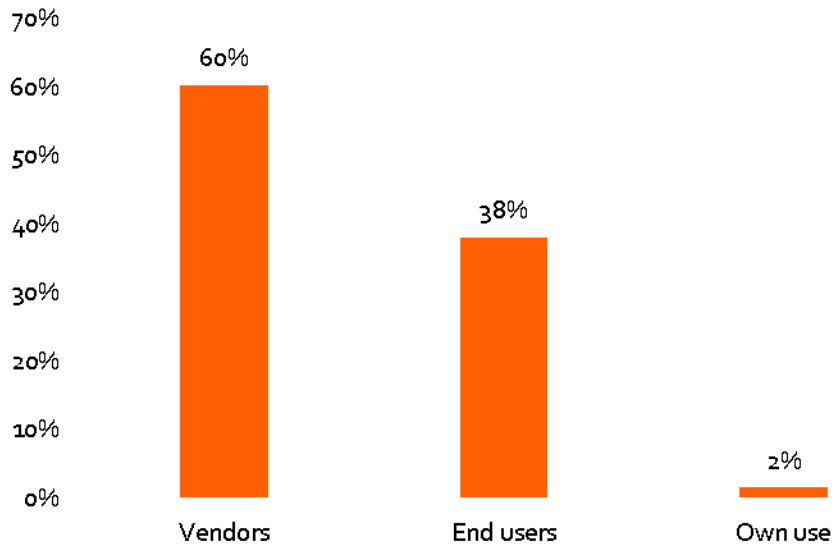

Figure 11-2: Charcoal sales to vendors vs end users

Asked how they get the charcoal they sell, majority of the vendors (77%) indicated that they are supplied by transporters, as shown in Table 11-1. The other sources of charcoal sold by vendors are burners (10%), market centers (7%) and whole sellers (2%). Important to note is that some vendors (5%) burn their own charcoal.

Table 11-1: Sources of charcoal for vendors

Supplier of charcoal	Frequency	Percentage
Transporters	95	77%
Burners	12	10%
Market	9	7%
Whole sellers	2	2%
Burn own charcooal	6	5%
Total	**124**	**100%**

Vendors indicated that they purchase a bag of charcoal averagely at UGX 35,000- and sell it at an average price of UGX 36,000-. When a bag is sold in small quantities (e.g. of tins), vendors indicated to get a total of UGX 37,000- per bag averagely. This is part of the reasons why most vendors prefer to sell their charcoal in small quantities in addition to the consumer purchasing preferences.

On average, a vendor sells about 1.9 bags per day (min = 0.25bags and Maximum is 10 bags).

11.2 Charcoal pricing

The starting price is largely influenced by charcoal transporters who eventually influence the final price the consumer pays. It was noted that charcoal prices vary significantly from one sub-region to another. There market does not have a standard packaging for both large charcoal bags and tins/containers used in selling charcoal. In most of the sub-regions, bags of charcoal are essentially two standard bags joined together (Figure 11-3) while others have extensions made from grass and other biomass materials, mainly aimed at increasing the quantity of charcoal being sold. A standard bag of charcoal is generally regarded as a "piece" throughout the value chain.

Figure 11-3: Double bag, bag extended with biomass, standard bag called "piece"

Tins or containers used in vending charcoal in Uganda vary in sizes and prices (Figure 11-4)

Figure 11-4: Some of the different containers used by vendors to sell charcoal

The average price of charcoal in Uganda was found to be 650 UGX/kg as determined from Table 11-2.

Table 11-2: Unit price of charcoal in Uganda

	Average Charcoal price (UGX/kg)	St. deviation (UGX/kg)	N
Charcoal sold in Tins	737	243	547
Charcoal sold in bags	565	234	206
Charcoal price - General	**650**	**239**	**753**

11.2.1 Cost of charcoal sold in tins

Charcoal is sold in tins or containers of various sizes and prices at different vending places and markets across the country. The survey found that the prices

of charcoal range from UGX 200 to UGX 9,000- depending on the size of the container as well as the location. The commonly used charcoal tins are for UGX 1,000, followed by tins of charcoal sold at UGX 2,000 and those sold at UGX 5,000 as shown in Figure 11-5. On average, a tin of charcoal worth UGX1000- weighs 1.46kg while that of UGX2000- weighs 2.98kg as shown in Figure 11-6

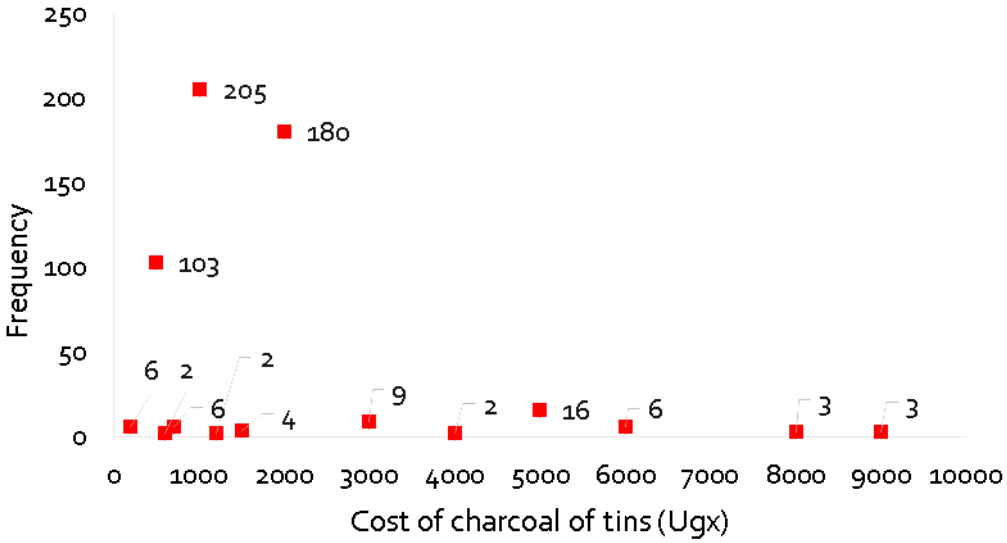

Figure 11-5: Cost of charcoal in tins in Uganda

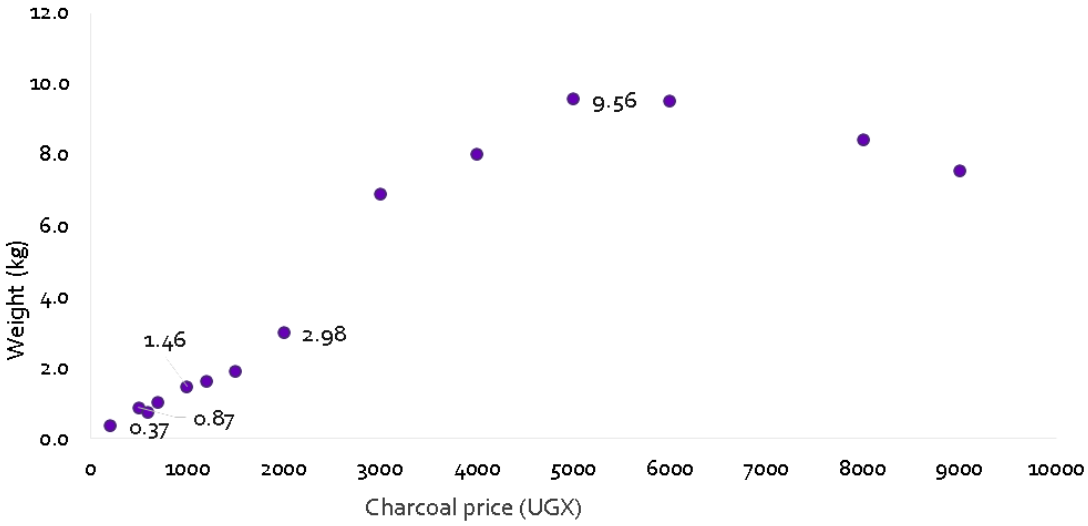

Figure 11-6: Weights of charcoal in tins in Uganda

11.2.2 Cost of charcoal sold in bags

The survey found that on average, the price of a bag of charcoal in Uganda costs UGX 32,000 as shown in Table 11-3. The average weight of a bag of charcoal was found to be 61 kg as shown in Table 11-4. The smallest bag weighed 7.6kg and costs UGX 10,000 in Central 1sub-region awhile the heaviest bag (164kg) costs UGX 60,000 in Eastern sub-region. The bags of charcoal sold in Kampala sub-region have highest costs UGX 70,000-in Kampala region. As seen in Table 11-3, charcoal in Kampala region is generally more expensive than all the other regions to the extent that the lowest cost of a bag in the region is higher than the highest cost of bag in some regions.

Table 11-3: Prices of bags of charcoal in Uganda

Statistical Sub-Region	N	Average Cost of bag (UGX)	Standard deviation	Min. Cost of bag (UGX)	Max. Cost of bag (UGX)
Kampala	28	58,786	12,527	35,000	70,000
Central I	20	47,550	18,089	10,000	65,000
Central II	22	30,500	16,460	5,000	60,000
East-Central	19	43,263	12,114	20,000	65,000
Eastern	7	41,429	10,690	30,000	60,000
Mid-Northern	41	22,780	3,609	14,000	25,000
North-East	3	10,000	-	10,000	10,000
West-Nile	15	19,200	7,514	10,000	30,000
Mid-Western	17	26,235	7,702	5,000	38,000
South-Western	34	23,118	9,499	15,000	45,000
Uganda	206	32,286	9,820	15,400	46,800
	St dev.	14,987	5,485	10,135	20,390

Table 11-4: Weights of bags of charcoal in Uganda

Statistical Sub-Region	N	Average Weight of charcoal bag (kg)	Standard deviation (kg)	Min. Weight of charcoal bag (kg)	Max. Weight of charcoal bag (kg)
Kampala	28	74.6	22.2	34.6	105.8
Central I	20	74.4	26.7	7.6	107.8
Central II	22	50.7	23.7	9.7	22.0
East-Central	19	60.8	10.5	34.6	75.0
Eastern	7	97.0	53.4	48.8	164.4
Mid-Northern	41	54.2	13.2	20.1	75.6
North-East	3	34.7	0.3	34.4	35.0
West-Nile	15	63.4	21.8	32.9	104.0
Mid-Western	17	52.2	18.2	8.1	78.0
South-Western	34	48.9	8.2	38.3	78.3
Uganda	206	61.1	19.8	26.9	84.6
	St. dev.	17.4	14.3	14.5	40.0

11.3 Charcoal fines

In the charcoal value chain, charcoal fines (dust) are generated during the transportation (loading, movement, unloading), storage and vending processes due to the breaking of large charcoal pieces in smaller ones. Vendors estimated that from each bag of charcoal, about 1 basin-full of charcoal fines are collected as shown in Table 11-5. Others estimated about 2 tins of charcoal fines from every bag.

Table 11-5: Charcoal fines generated by charcoal vendors

	Bags	Basins	Tins	Kilograms
Average	0.4	1.1	1.8	1.8
Min	0.3	0.5	0.5	0.5
Max	0.5	2.0	4.0	5.0
St. dev	0.1	0.6	0.9	1.6
N	4.0	38.0	28.0	6.0

The majority of charcoal vendors (40%) reported that they sell the charcoal fines while 31% reported to dump or throw it away, see Figure 11-7. Also important to note is that 23% of the vendors use the charcoal fines while 5% give it for free to whoever wants it.

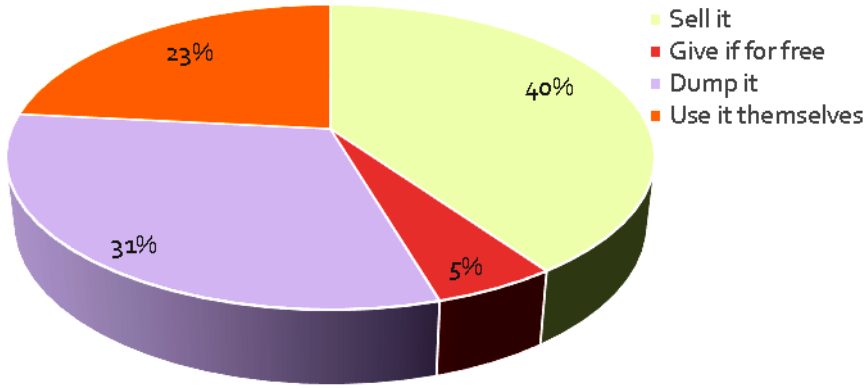

Figure 11-7: What vendors do with charcoal fines

The fines are mainly sold for electrical purposes, particularly in earth wiring (70%) while 13% is sold for farming purposes, as shown in Figure 11-8. As shown in Figure 11-9, Charcoal vendors themselves use the charcoal fines mainly for cooking purposes such as warming and steaming food (59%), cleaning cooking utensils such as saucepans (18%), and smell control (12%) by pouring it in bathrooms etc.

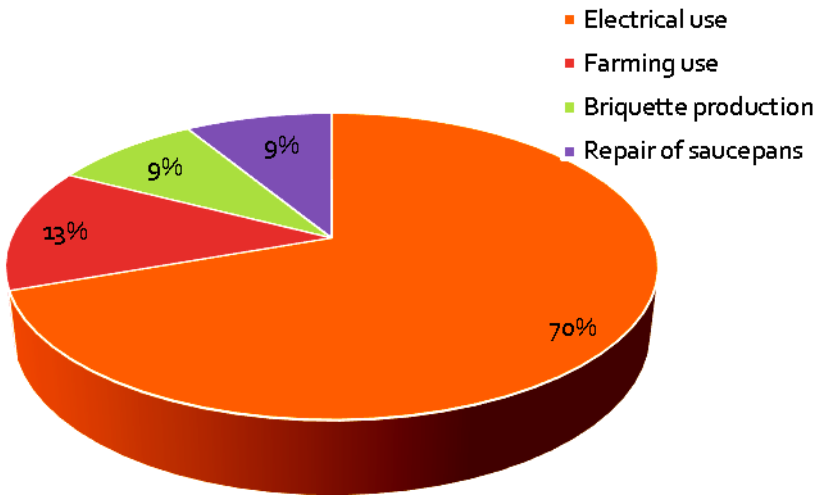

Figure 11-8: Uses of charcoal fines sold by vendors

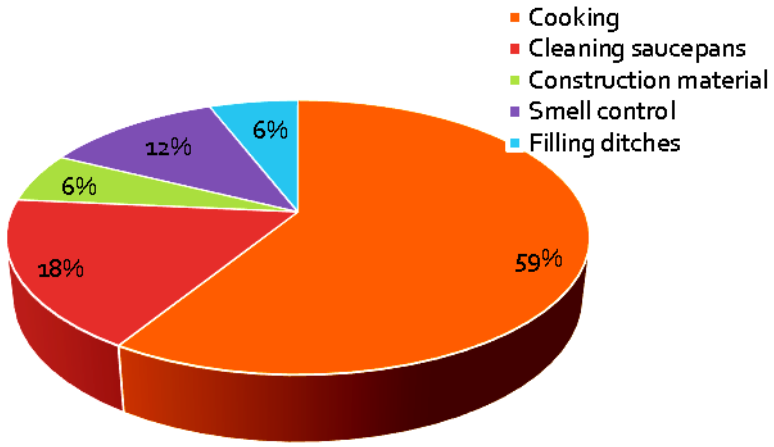

Figure 11-9: Uses of charcoal fines by vendors

12 Charcoal quality

All the charcoal samples were collected from Earth mound kilns in 25 out of 28 districts. No charcoal samples were collected from Kampala, Kasese and Mbarara districts. This chapter discusses the test results and their significance.

The overall results of the tests are summarized as below.

12.1 Physical properties

The average moisture content of the tested samples was found to be 5.5 % (standard deviation of 1.1%) as shown in Table 12-1. Charcoal generally has a relatively low moisture content of around 3 to 10%[34]. Samples from West Nile and Central 1 sub regions had the highest moisture content of 7.2% while the samples of South Western region had the lowest moisture content of 4.0%. The effect of high moisture content is to lower the percentage of carbon content, thereby lowering the HHV of the fuel.

The average Hardness value of 2.3 obtained from the scratch hardness test is above the average hardness for the reference (carbon graphite) on the Mohs scale. Therefore, the charcoal tested has a high resistance to crushing and scratching and hence is of high quality. The implication is that the charcoal can be handled and transported without much damage to it, i.e. without being crushed into powder.

Bulk density data is useful in estimating the fuel tank size or parking volume. The average bulk density was found to be 399kg/m^3 (Table 12-1).

Table 12-1: Physical properties of charcoal tested

Statistical Sub-Region	Moisture content, %	Bulk density, kg/m^3	Hardness
Kampala	-	-	-
Central I	6.1	354.7	2.2
Central II	5.7	363.1	2.1
East-Central	4.4	354.5	2.4
Eastern	5.8	414.7	2.3
Mid-Northern	7.2	437.5	2.3
North-East	5.1	410.2	2.4
West-Nile	7.2	390.4	2.6
Mid-Western	4.4	446.2	2.2
South-Western	4.0	421.0	2.6
Uganda	**5.5**	**399.1**	**2.3**
St. dev.	**1.1**	**33.1**	**0.2**

12.2 Chemical properties

The samples exhibited an average fixed carbon content of 69.9% as shown in Table 12-2. A high value for the percentage of fixed carbon and a low ash content in the samples is a sign of a good quality charcoal and is evident with its higher heating value. The high ash content in the sample is a sign of high quantity of non-combustible binders used in some fuels, e.g. in charcoal briquettes.

Regarding the volatile matter, the range obtained in the tests is 15.6– 22.8% with an average of 19.1%. It has been stated that a good quality charcoal should have volatile matter in the range of 20 – 30% (with a value of 40% being marginally accepted) if it is for domestic use; and10 – 15% for metallurgical applications.

Ash content ranges from 3.5% to 6.1%, with the average being 4.7% which is within the acceptable limit of 5.0% for high quality charcoal. Ash content becomes crucial in case of industrial charcoal (in which case the cost of ash removal and disposal becomes significant), but can be tolerated in domestic use.

Table 12-2: Chemical properties of charcoal tested

Statistical Sub-Region	Volatile matter, %	Ash , %	Fixed carbon, %
Kampala	-	-	-
Central I	17.3	6.1	69.5
Central II	18.8	5.1	70.5
East-Central	15.6	4.2	70.4
Eastern	22.2	4.7	66.4
Mid-Northern	15.3	5.0	72.7
North-East	22.8	4.7	67.5
West-Nile	18.2	5.5	69.1
Mid-Western	19.3	3.5	72.8
South-Western	22.7	3.6	70.0
Uganda	**19.1**	**4.7**	**69.9**
St. dev.	**2.7**	**0.8**	**2.0**

12.3 Heating values

The heating values of the all samples are above the expected range of 10 - 20 MJ/kg for most raw and dried biomass fuels; and the average value of29.7 MJ/kg is within the range of 27 - 33 MJ/kg for a good quality charcoal. Charcoal from North East sub-region had the lowest heating value which is attributed to the type of tree species.

Table 12-3: Heating values of charcoal tested

Statistical Sub-Region	LHV (MJ/kg)
Kampala	-
Central I	28.9
Central II	30.5
East-Central	29.3
Eastern	29.3
Mid-Northern	29.6
North-East	28.3
West-Nile	30.0
Mid-Western	30.9
South-Western	30.5
Uganda	**29.7**

St. dev.	**0.8**

The conclusion from the tests is that the charcoal produced from different areas of Uganda do not significantly defer in terms of charcoal quality. The charcoal is generally of acceptable quality irrespective of the wood species used in its production.

12.4 Main tree species used

The District Forestry Officers, the charcoal burners, charcoal transporters and charcoal vendors were asked the most common trees species that are used for charcoal production in the respective districts as shown in Table 12-4.

A total of 101 major tree and shrub species were mentioned as the trees used for producing charcoal. The major tree species/shrubs used for charcoal production in Uganda are Acacia hockii, Ficus natalensis, Albizia coriaria, Eucalyptus grandis, Combretum molle, Maesopsis eminii, Mangifera indica and Milicia excels. Twenty eight FGD groups of charcoal burners indicated that they mix the tree and shrub species when burning charcoal while eight of them reported that they also sort them so as to determine the quality of charcoal which they require.

Figure 12-1: Combretum molle and combretum collinum species in Gulu district

Table 12-4: The major tree species used in charcoal production by sub region

Statistical Sub- Region	Botanical names of tree species
Kampala	-
Central I	Milicia excels, maesopsis eminii, albizia zygia, acacia hockii, phoenix reclinata, albizia coriaria, grewia mollis, sapium ellipticum, eucalyptus grandis, ficus natalensis, mangifera indica
Central II	Combretum molle, acacia hockii, albizia coriaria, ficus natalensis, terminalia brownii, tamarindus indica, acacia senegal, maesopsis eminii, eucalyptus grandis, pseudospondias microcarpa, maigaritaria discoidlus.
East-Central	Milicia excelsa, ficus mucuso, maesopsis eminii, markhamia lutea, ficus natalensis, mangifera indica, albizia coriaria, combretum molle, combretum collinum, acacia hockii, senna spectabilis, eucalyptus grandis
Eastern	Albizia coriaria, cordia africana, markhamia lutea, croton macro stachyus, eucalyptus grandis, milicia excels, vitellaria paradoxum, tamarindus indica, combretum molle, ficus glumosa, combretum collinum, ficus mucuso, mangifera indica, terminaria superba, milicia excels
Mid-Northern	Combretum collinum, combretum molle, butyrospermum paradoxum, terminalia superba, bauhinia thonningii, terminalia brownii, acacia siebariana, acacia hockii, bauhinia thonningii, albizia grandibracteata, terminalia brownie, ficus sur, acacia tortilis, albizia spp, piptadeniastrum africana, lovea trichillioides, margaritaria discoideus
North-East	Balanites aegyptiaca, acacia mellifera, acacia nilotica, acacia seyal, faidherbia albida, acacia senegal, terminalia superba, combretum collinum, terminalai macroptera, vitalaria paradoxa, acacia gerrardii, steganotaenia araliacea
West-Nile	Ficus natalensis, philostgma thonningii, terminalia macroptera, butyrospermum paradoxum, khaya anthotheca, grewia mollis, combretum molle, mixed acacia species.
Mid-Western	Antiaris toxicaria, combretum molle, ficus natalensis, sapium elliptic, acacia hockii, spathodia campanula, eucalyptus grandis, grevellia robusta, terminalia brownii, cynometra alexandri, ficus mucuso, antiaris toxicaria, prunus africana, combretum collinum, acacia sieberiana, albizia coriaria, cynometra alexandrei, blighia unijugata, albizia zygia
South-Western	Eucalyptus grandis, acacia mearnsii, acacia gerrardii, acacia hockii, albizia gumifera, acacia abyssinica, millettia dura, grewia mollis, sapium ellipticum, acacia sieberiana, maesopsis eminii, albizia coriaria

13 Economic impact of the charcoal industry

13.1 Economic impact

The study revealed that the current level of production is 2.144338 million metric tons of charcoal. At an estimated weight of 62.2 kgs of charcoal per bag, this is estimated to be equivalent to 34,474,888 bags of charcoal. Considering the vendor selling price of UGX 27,470 this translates to UGX 947, 025,173,360.

13.1.1 Landowners

Land owners are either employed in management of their woodlots, woodlands or forests. This therefore occupies them as if they are in employment. Using estimates for plantation employment, it is estimated that one Hectare will create two fulltime jobs. All the charcoal produced currently is in the traditional kiln and the estimated required plantation area to produce this quantity is 89,347 ha. The full time jobs created by wood production therefore is 178,694.

13.1.2 Charcoal burners

Charcoal burners reported to produce most frequently between 0.5 – 10 bags of charcoal for one firing cycle. However on average, the estimate considering all the respondents was 15 bags. One cycle from cutting of the wood to removing the charcoal from the kiln takes an average of 10-15 days. It is therefore estimated that with the traditional kiln, a charcoal burner can produce two cycles per month. This gives an estimate of 30 bags of charcoal per month or 360 bags of charcoal per year. For the total charcoal of 34,474,888 bags that is produced annually, considering an average full time charcoal producer, this level of production can employ up to 95,764 charcoal producers. Considering the income, the charcoal burners sold their charcoal at an average price of UGX – 18,488. This translates to UGX 6,655,680 per individual per year.

Vendors: Vendors buy between 0.5 – 200 bags of charcoal at a time. The average is 10.7 bags of charcoal per vendor at a time. They sell on average 1.4 bags of charcoal per day. In a year it translates to 511 bags per vendor. If all the charcoal was to be sold through the vendors, the sector would employ about

67,466 vendors. The average charcoal buying price by vendors was reported as UGX 30,118 while the selling price was UGX 34,383. The margin is 4,265 per bag. Each vendor therefore gets about UGX 2,179,415 per year.

13.1.3 Transporters

For transporters, 39% of the charcoal is transported using Fuso Trucks, 5% by trailers and 21% by others that include motorcycles, private cars, boats, head loads etc as shown in Table 13-1. The total number of bags of charcoal transported annually is 35,153,081[8] which translates into 2.1 million tons considering a bag weight of 61 kg.

Table 13-1: Total number of charcoal bags transported annually

Vehicle type	Percentage of vehicles	Average Number of bag	Total No. of Bags
1. Forward	3%	40	1,054,592
2. Elf	14%	35	4,921,431
3. Fuso	39%	56	13,709,702
4. Magulu-kumi	1%	30	351,531
5. Pickup	6%	7	2,109,185
6. Trailer	5%	15	1,757,654
7. Bicycle	11%	1	3,866,839
8. Other	21%	6	7,382,147

Total number of jobs created in the transportation sector is 21,642 as shown in Table 13-2. The estimation of the jobs created within the transport sector was based on the following procedure.

- The % of vehicle column gives the total number of bags transported by the type of vehicle (Y x T = B) in a year
- The average number of bags per trip helps to get the number of trips made by the type of vehicle (B /T) in a year
- The number of trips gives the total number of man days for the type of vehicle if it was only one person in the vehicle (MD).

[8] Denoted by *T*

- Assuming that the charcoal transporters rest one day in a week, out of 52 weeks, they rest 52 days. A year has 365 days. The man days worked are 365-52 = 313.
- MD worked divided by 313 days gives the man-years worked (JY)
- The man years per vehicle multiplied by the number of persons in each vehicle gives the total number of man years per type of vehicle.

Table 13-2: Job creation for the transport sector of the Uganda charcoal value chain

Vehicle Type	% of Vehicles (Y)	Average No. of bags per trip (T)	No. of Persons per trip	Total No. of bags (B)	Total Man Days (J)	Man Years (JY)	Total man years
Forward	3%	40	3	1,054,592	26,365	84	252
Elf	14%	35	3	4,921,431	140,612	449	1,347
Fuso	39%	56	3	13,709,702	244,816	782	2,346
Magulu-kumi	1%	30	2	351,531	11,718	37	75
Pickup	6%	7	1	2,109,185	301,312	963	963
Trailer	5%	15	1	1,757,654	117176	374	374
Bicycle	11%	1	1	3,866,839	3,866,839	12,354	12,354
Others	21%	6	1	7,382,147	1,230,357	3,931	3,931
Total	**100%**	**-**	**-**	**35,153,081**			**21,642**

The gross monetary value per job created in the transportation sector is UGX …. as shown in Table 13-3. The total number of jobs created is XXXXXX.

Table 13-3: Employment and monetary value of the charcoal industry

Charcoal Value Chain Actor		No. Jobs Created	Gross Monetary Value (UGX)/job
Land owners/Wood production		178,694	*
Charcoal burners		95,764	637,374,539,520
Transporters	Truck transporters	1,572	208,292,384.
	Trailers	1,512 (estimate)	200,342,293
	Others	9,972	124,749,720
	Sub-total transport	13,036	*
Vendors		67,466	147,036,412,390
Total		**344,960**	*

*Will be incorporated in the final draft

Parameters	10% efficiency kiln	30% Efficiency Kiln	Savings from adopting efficient kilns
Total Metric Tons of Charcoal Produced Annually	2,144,338	714,779	1,429,559
Wood Requirement (Metric Tons)	21,443,380	7,147,793	14,295,587
Land Area Required Under Plantation (Ha)	89,347	29,782	59,565
Required Production Investment Cost (US $)	58,969,295	19,656,431	39,312,864

13.2 Charcoal production as a cash crop

Studies in Kenya, Zambia, Sudan and Namibia (See Case Studies) have demonstrated that charcoal is a profitable business. Currently, it is in high demand both in East Africa and even globally. Besides the actual monetary benefits, trees for charcoal can be harvested at any time. If the market gets unfavorable, the trees can be harvested for other products including firewood, timber and posts. The trees can also be left to continue growing and are harvested when the market environment improves. Once established, trees have very little demand on labor and other management species. Species like eucalyptus can regenerate for up to 42 years meaning that at seven cycles can be harvested from one planting. Charcoal itself once produced can stay for a long time in storage suggesting that it can actually be harvested and stored until when market conditions are suitable.

13.3 Cross cutting issues

13.3.1 Gender

Generally, men dominate the different segments of the charcoal value chain. Out the land owners we interviewed, 90% were males. Regarding charcoal burners and transporters, 96% of the respondents were males as shown in

Figure 13-1. However, women dominate the vending (87%) and usage (75%) aspects of the charcoal business.

The limited engagement of women in the land ownership, charcoal burning and transportation could be attributed to the land/property ownership contexts in most Uganda's cultures and the nature of activities which limits women's involvement. These include long distances for sourcing wood or transporting charcoal, length of time spent tending to kilns, the intensity of work such as ferrying and chopping of wood, lifting of wood logs and charcoal bags and insecurity that characterize the charcoal transportation and burning businesses.

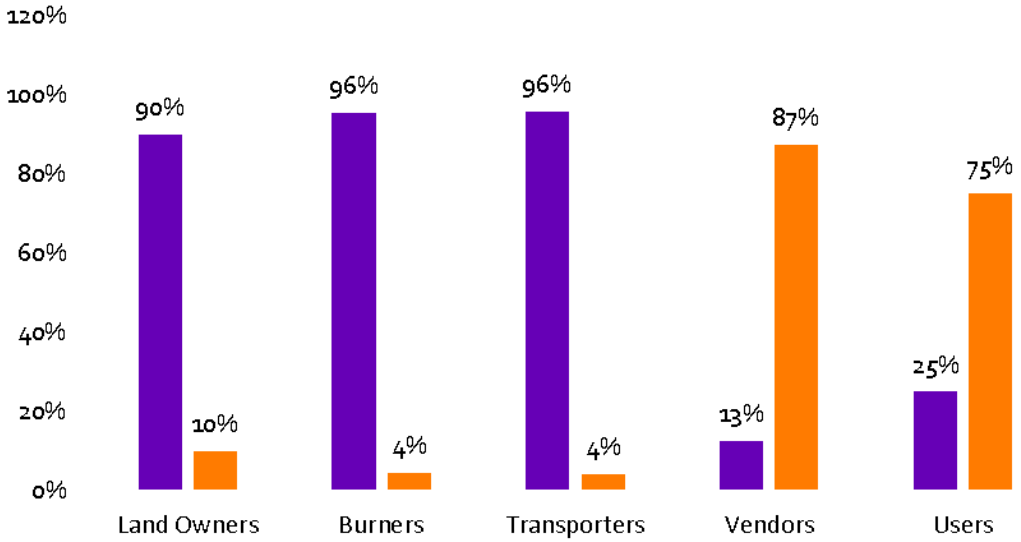

Figure 13-1: Gender analysis in the value chain

13.3.2 Environment

The charcoal business poses serious impacts to the environment. Generally, there are no forests planted specifically for charcoal production currently. Mostly, charcoal is produced from naturally growing forests. In harvesting wood for charcoal, clear ferrying of trees is largely exercised, which will lead to unsustainable wood supply. While there are efforts by NGOs-CBOs and other support stakeholders in promoting tree planting activities, the competition for land for agriculture also makes it difficult for any tree planting to be carried out. Furthermore, the technologies used in both charcoal burning and charcoal use

are inefficient. Therefore, it can be said that charcoal burning contributes significantly to deforestation and land degradation in Uganda.

13.3.3 HIV and AIDS

HIV/AIDS is an issue in some segments of the charcoal value chain. Female charcoal burners reported occurrences of rape and other forms of sexual harassment that take place during the charcoal burning activities. These incidents happen because charcoal burners spend a lot of time in the forests either cutting/chopping wood or tending to the kiln. This exposes them to sexually transmitted diseases including HIV/AIDS.

Long distance truck drivers are generally known to exercise high risk sexual behavior in the process of executing their duties[35, 36]. Charcoal transporters traverse long distances in search of charcoal and in some instances it takes several days for transporters to deliver charcoal to the intended market destinations. Some charcoal collection centers are located in trading centers or towns which are active with sexual activity. It can therefore be said that there is high HIV/AIDS risk with charcoal transporters in Uganda.

14 Stakeholders in the charcoal value chain

In the charcoal industry, there are multiple stakeholders that participate in the value chain. Broadly, they include land owners/wood suppliers, charcoal burners, charcoal transporters, charcoal vendors as well as charcoal users as shown in Figure 14-1 and Figure 14-2. The value chain players are supported by policy makers/regulations, financial services institutions, research institutions and NGOs among others.

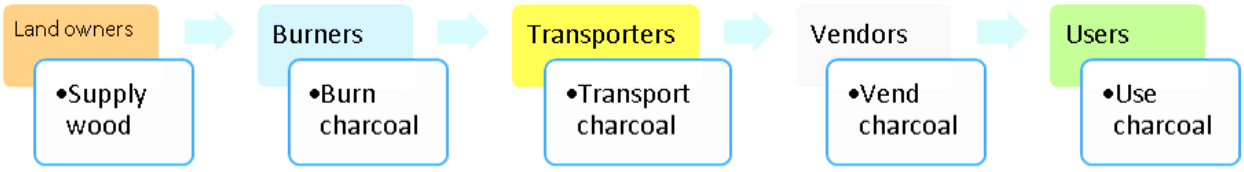

Figure 14-1: Main charcoal value chain players

Figure 14-2: Main charcoal value chain players

14.1 Land Owners

There are multiple players that play critical roles in the supply of wood for charcoal production. They include land owners who are mainly individuals, National Forestry Authority, Local district authorities (District Natural Resources Officer or District Forestry Officer), Research institutions such as Nabyeya Forestry College and Makerere University as well as CSOs many of which are community based. The key roles of the players are summarized in Table 15-1.

Table 14-1: Stakeholders involved in supply of wood for charcoal production

No	Stakeholders	Roles
1	Land owners	○ Plant, manage /own tree plantation ○ Sell or cut the trees
2	National Forestry Authority	○ Manage central forest reserves ○ Policy and regulation
3	Local district authority	○ Policy and regulation (issue charcoal burning permits, movement permits)
4	Research Institutions	○ Study improved wood production and forest management techniques ○ Train students in wood production techniques and forestry management
4	CSOs	○ Support tree planting and management programs ○ Inform policy and regulations

There are gaps in the sector that need to be addressed. There is lack of knowledge amongst land owners about forest management which casts doubt about the sustainability of wood supply. For example, when harvesting trees for charcoal, both young and old trees are cut hence clearing the land. Fast growing tree species are not yet embraced by many land owners yet indigenous trees take long to regenerate once cut down. Hence there is need to ensure improved wood production and management techniques are adequately shared with rural tree/forest planters.

Lack of consistency in enforcing existing policy framework and relevant regulations. For example, wood is cut down for charcoal production without a charcoal burning permit in many areas of the country. Districts have different fees on charcoal burning permits. In some instances, charcoal is burned in central forest reserves without the knowledge of Forestry officers. Robust and holistic policy regulations and enforcement mechanisms need to be put in place.

14.2 Charcoal burners

The charcoal burning stage of the value chain involves the following players; charcoal burners, local district authorities and research institutions. The roles of each of the players are shown in Table 14-2.

Table 14-2: Stakeholders involved in charcoal burning

No	Stakeholders	Roles
1	Charcoal burners	○ Buy or cut the trees ○ Burn the charcoal ○ Pack the charcoal ○ Sell the charcoal to mainly transporters
2	Local district authority	○ Policy and regulation (issue charcoal burning permits)
3	Ministry of Energy and Mineral Development	○ Policy and regulation ○ Technical support to the sector
4	Research Institutions	○ Study improved/efficient charcoal production technologies ○ Studying optimization of charcoal burning process

This stage faces challenges and gaps. Traditional and inefficient charcoal production technologies are still widely used in the burning of charcoal. While efficient charcoal production technologies exist in Uganda and elsewhere, most charcoal burners do not know them. There is need for awareness creation about alternative charcoal production technologies. Technical support is vital in aiding charcoal burners to acquire/build improved charcoal production technologies.

The charcoal burning process, right cutting down trees to harvesting charcoal is still inefficient. E.g. some charcoal burners do not properly dry the wood; there is no effort made in sorting tree species prior to carbonizing them; charcoal is cooled by pouring water or soil, all of which affect the quality of charcoal. Knowledge about optimizing the charcoal production process need to be translated to the charcoal burners.

As mentioned already, there is a weakness in enforcing policy regulations on charcoal burning. Most charcoal burners do not get the permits prior to burning charcoal.

14.3 Charcoal transporters

The main stakeholders in the transportation section of the charcoal value chain are the transporters and or middlemen, local district authorities and the Uganda Police Force (traffic). Their roles in the value chain are shown in Table 14-3.

Table 14-3: Stakeholders involved in charcoal transportation

No	Stakeholders	Roles
1	Charcoal transporters	○ Buy charcoal from charcoal burners ○ Transport the charcoal ○ Sell the charcoal to mainly charcoal vendors
2	Local district authority	○ Policy and regulation (issue charcoal movement permits)
3	Uganda Police Force	○ Enforce policy regulation on charcoal transportation ○ Ensure road safety

The section of the charcoal value chain experiences numerous challenges that must be addressed in order to help the charcoal sector grow.

Charcoal transporters majorly collect charcoal from the burning sites, which are usually sited in remote areas. Due to bad roads, it becomes very difficult to transport charcoal especially during the rainy seasons. Local district authorities, using funds generated from fees for charcoal production and movement permits as other sources, should ensure that access roads to charcoal burning sites are maintained.

Due to overloading of transportation vehicles, coupled with poor loading and offloading mechanisms as well as rains, the charcoal quality is compromised during its transportation. Charcoal is broken into fines and is wetted by the rain hence affecting its heating value. Charcoal transportation vehicles should have covered cabins to protect the charcoal from rain and also reduce on possibility of overloading. The intervention would also require the need to adopt smarter ways of packing charcoal than is currently done.

The enforcement of policy on charcoal transportation is inconsistent and wanting. Movement permits are issued differently depending on the district in question. Some districts consider the number of bags of charcoal being

transported while others consider the type of vehicle used irrespective of how many bags of charcoal are transported.

Most of the transporters apply for movement permits before loading charcoal on their vehicles. This gives them room to under-declare the bags of charcoal they transport or overload their vehicles before once they receive the movement permit, no regulation enforcer at the district of origin will bother them. Other transporters do not even bother to apply for movement permits so they prefer to travel at night in an effort to dodge local district officials. A holist and robust policy that addresses these gaps is necessary.

Transporters accuse traffic police of extorting money from them during charcoal transportation, irrespective of whether the transporters have all necessary documents to transport charcoal. More-so, instead of impounding the charcoal which does not have proper documents or impounding overloaded vehicles, it is alleged that the traffic police take some bribes and let them go. This problem can be reduced by Uganda Police Force conducting more close and clandestine supervision of its traffic staff and taking stringent punitive action against both the transporters and officers caught in this action.

14.4 Charcoal vendors

In charcoal vending, the main stakeholders are charcoal vendors, local district authorities and local markets and landlords. The specific roles of each of the stakeholders are shown in Table 14-4.

Charcoal vending, like the other sections of the value chain, has its own challenges. Charcoal storage is very poor as many vendors do not have shelters. Charcoal is exposed to rain which affects its quality, in addition to poor handling. There is need for sensitization on the charcoal for charcoal vendors to store their charcoal properly.

Table 14-4: Stakeholders involved in charcoal vending

No	Stakeholders	Roles
1	Charcoal vendors	○ Buy charcoal from charcoal transporters ○ Store charcoal ○ Sell the charcoal to end users

2	Local district authority Local market authority	○ Policy and regulation (issue charcoal selling license) ○ Charges fees on charcoal vending
3	Land lords	○ Charge ground rent for the charcoal vending business

There are no standards in charcoal vending. Vendors use different containers to sell charcoal. More-so, charcoal bags are sized differently depending on the source. There is need to standardize the vending business, for example using charcoal weight (rather than volume) as a standard measure.

Trading licenses and market fees also vary depending on the local district or local market. In most of the cases, charcoal vendors did not have trading licenses. In some districts, charcoal vendors use trading licenses of their other business to run the charcoal business while in other places, the charcoal vending is treated as a separate business. There is need for a consistent policy that eliminates these ambiguities.

14.5 Charcoal users

In this section, charcoal users are the main stakeholders. They are supported by technology suppliers (stove manufacturers) and Ministry of Energy and Mineral Development. The specific roles of each of the above are shown in Table 14-5 below.

As with charcoal vending, charcoal users face the dilemma of lack of standardization in charcoal trade. Different sizes of charcoal selling containers or bags are used as well as varying prices of charcoal from one vendor to another. Users also get poor quality charcoal as a result of poor storage practices by some vendors. Hence standardization of the trade needs to be done.

Table 14-5: Stakeholders involved in charcoal consumption

No	Stakeholders	Roles
1	Charcoal users	○ Buy charcoal from charcoal vendors ○ Use charcoal

2	Stove manufacturers	○ Provide cooking technologies
3	Ministry of Energy and Mineral Development	○ Policy and regulation ○ Sensitization and awareness

Inefficient cooking technologies (traditional metallic/ceramic) stoves are still highly used in the country. This is mainly because improved cookstoves are more expensive that traditions stoves and are not accessible or known in some parts of the country. There is need for sensitization and awareness of the benefits of using improved cookstoves on the economic and health aspects of the users in the country.

14.6 Improving the charcoal value chain

In order to improve the charcoal value chain, it is critical that an all-round charcoal policy be put in place to address the challenges and gaps that currently exist. The policy needs to be developed with the full participation from all relevant stakeholders. A detailed analysis of the opportunities and challenges in the value chain needs to be done by engaging more closely all the relevant value chain players. The stakeholders then should set operational objectives with detailed macro activities that must be undertaken to take advantage of the existing opportunities and address the challenges the value chain faces through clear and properly coordinated action plans.

15 Case Studies

15.1 Case Studies: Kenya

A. Tree planting Lucrative Trade

Growing trees for charcoal production is a lucrative trade if an example of one scholar is anything to go by. Dr Maxwell Kinyanjui (RIP), a former Statistician at the University of Nairobi in 2000 grew fast-maturing varieties of the thorny acacia trees on 27 acres in Kajiado County specifically for charcoal production. After six years, many people who had dismissed him realised that he was in huge business when he harvested at least 1,000 bags of charcoal per acre. At Kenya Shillings 1,500 ($15) per 40kg bag, the scholar made as much as Sh40 million ($398,000) in just six years from a piece of land where nothing else was growing due to tough climatic conditions.[37]

B. Contract Growing Of Acacia Trees for Charcoal in Bondo County – Kenya By Thuiya Enterprises Ltd.

Driven by the high demand for charcoal in urban areas and the search for an afforestation model that could motivate farmers to plant numerous trees for income, Thuiya Enterprises Ltd. supported the initiation of the Charcoal Contract Farming Project in 2002. Youth to Youth Action Group[9] (YYAG) sensitized and mobilized farmers interested in planting trees for charcoal on a commercial basis.

They were then contracted and paid by Thuiya Enterprises Ltd. to raise *Acacia xhanthophloe and polyacantha* tree seedlings at Ksh. 5 (US $0.07) per seedling. The seedlings were then given to farmers on loan at no interest. Farmers were given between 500-2000 seedlings to plant as woodlots for charcoal with the agreement that the money for seedlings would be recovered from the tree revenues at the end of four years. Farmers were also given 40 kgs/ha of interest free beans or groundnuts seeds to intercrop with the trees as a nurse crop and for short season food and income in years one and two. Farmers were also expected to repay equal quantities of seed at harvest. YYAG were trained on tree nursery establishment and management, all the farmers were trained on

[9] Youth to Youth Action Group is a Community Based Organization (CBO) that mobilizes youth for development.

how to plant and manage the trees and the women trained on how to make and use maendeleo stoves and fireless cookers. All the farmers were visited once or twice every year, a picture of their trees taken and their performance documented. Farmers were to sell the wood or charcoal to the company after six years and the company was to recover its money from farmers' payments.

After three years of project implementation, the quality of the wood for charcoal was assessed by Moi University Forest Department and it emerged that although the trees were large in size (7.5- 12 cm diameter at breast height), the wood was immature hence the trees required more time to mature. A six-year cycle was recommended (Senelwa and Okikero, 2006). The trees reached the six-year maturity in the year 2008. Meanwhile, after seeing the final product and believing that it works, more farmers are now interested in planting trees for charcoal.

The market focus and integrated design of the project is a self-sustaining project. Farmers get income from the short season crop for the first and second year. During the third to sixth year, they get income from honey, poultry and dairy goats. When the tree canopy closes, in the third year, farmers are issued with one beehive on loan for every 500 acacia trees they have planted. With suitable conditions, this produces honey within three months. This provides interim income for the farmer as the trees continue to grow. The farmer repays RAID for the beehive with 2 kg (US $ 6) of honey from every harvest (US $ 24 per year) for three years.

Dairy goats and poultry will also be introduced in 2009 as short-term sources of income and food for the small-scale farmers. The money paid to RAID is used as a revolving fund for buying beehives for new farmers. In this project, the youth benefit mainly from raising tree seedlings, the women from trading in efficient wood stoves, fireless cookers, beans and groundnuts while the men are mainly involved in tree planting, management and processing into charcoal. Women also get firewood for their households from the tree tops.[38]

Figure 14-1: Masanga Women Group in Bondo County – Contract Production of Seedlings

C. Kakuzi Model

Kakuzi Company[39] has about 1,282 Hectares of Eucalyptus, grandis, E. saligna and E. camaldulensis plantings of which 905 Hactares are commercial plantations and 377 Hectares are non-commercial plantations. They plant between 20 to 30 Hectares per year on commercially high yielding sites. Kakuzi has developed a wood-processing yard where timber and poles are treated. Timber is milled, pallets manufactured, "eco-friendly" charcoal produced and firewood sold, all in the same yard. Charcoal is majorly processed from trees that are not suitable for poles, timber and posts. Like the Githumbuini Estate, Kakuzi make use of brick kilns - an improved technology that permits bulk charcoal production and enhances wood recovery rate. One Cubic Meter of Wood – Eucalyptus camaldulensis produces (5.3 bags of 40 kg each). The Farm gate price of charcoal at Kakuzi is Ksh 260.00, Transport cost (Ksh 50) Cost up to depot (310.00) and Current retail price Ksh (400.00).

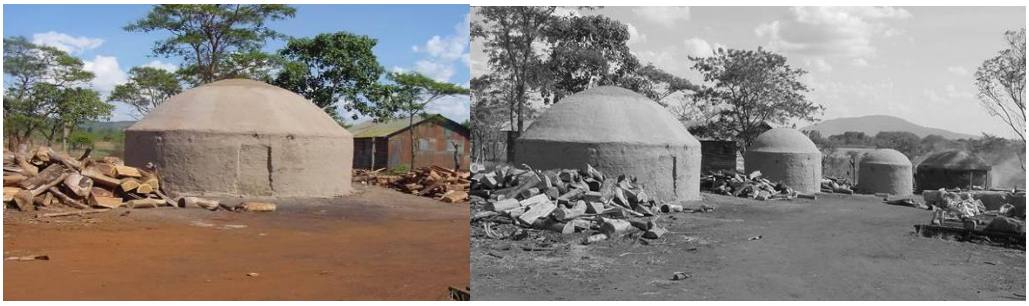

Figure 14-2: Beehive Kilns used by Kakuzi Ltd for sustainable charcoal production (28% efficiency)

15.2 Case study: Brazil

In Brazil, charcoal is a highly valuable resource and contributes much to its economy particularly in the pig-iron and steel manufacturing industry. The rate of charcoal consumption is parallel to the Pig iron production. The demand for fuelwood to supply the charcoal consumed in Carajás alone, is estimated to be at 12 million cubic meters per year. This translates to clearing around 200 thousand hectares of forests every year. Most industries engage third parties to produce their charcoal and some like the Companhia Vale do Rio Doce – CVRD which produces 5% of total pig iron has planted forests to supply its charcoal demand.

A number of CDM projects exist in charcoal production[40]. The Plantar project consists of the maintenance of charcoal-based production of pig iron in its mills in Minas Gerais, Brazil, funded through the sale of carbon credits. This is the first investment of the World Bank PCF in Brazil, who retained EcoSecurities to determine the potential GHG emission reductions to be generated by the project. The project involves the planting of over 23 000 ha with sustainably managed (certified to the Forest Stewardship Council standards) forests of high yielding clonal Eucalyptus trees. Additionally, Plantar will initiate a pilot project of landscape-scale management of biodiversity based on the regeneration of native vegetation in an area previously covered with plantation forests. It was estimated that the project has the capacity to generate 12 million tonnes of CO_2 emission reduction equivalents over a 28-year timeframe. The PCF is particularly interested on replicating this investment and its effect on the iron & steel sector as a whole.

The project is currently being independently verified by DNV, prior to completion of the deal. EcoSecurities is also assisting other companies on similar initiatives. One of them is being developed by V&M Tubes do Brazil (a joint venture between the French group Vallourec and the German company Mannesmannrohren- Werke). V&M Tubes is the only steel pipe manufacturer in the world to use 100% renewable energy for the production of pig iron and steel. Its forestry division, V&M Florestal, is responsible for the production of all charcoal required by its mills, from its 120 000 hectares of plantation forests (certified as sustainably managed according to the standards of the Forest Stewardship Council). The project consists of investments to ensure the use of sustainably-produced charcoal for steel manufacture in Brazil, avoiding the use

of coke from coal. It is estimated that this will result in the reduction of 45 million tonnes of CO_2 emissions during the next 27 years.

Figure 14-3: Pig iron charcoal production in Brazil-Amazo 008

Figure 14-4: Charcoal Kiln slave labourer

15.3 Case Study: The Sudan

The charcoal industry

Sudan derives 71% of its energy from wood fuel. The remaining 29% is from petroleum and electricity. Out of all the wood harvested, 88% is used for wood fuel and the remaining 12% for poles, posts and timber. The government has

recognized charcoal as an important source of energy and vested the power to regulate it in the Forest National Corporation. The agency is responsible for planning and organizing production from natural and planted forests. Natural forest in Sudan represents 68% of the total forested area, while plantations account for the remaining 32%. The corporation has a management plan for natural forests. Forest land is first leased to farmers for five years.

At the beginning, charcoal producers are contracted to clear the land for crop production and use the wood to make charcoal. The land is then farmed for five years after which it is left to regenerate for 14-20 years. For planted forests, the department sets aside land and funds to plant and manage over 100,000 ha of trees a year. The species planted for charcoal are mainly *Acacia seyal*, *Acacia nilotica*, *Acacia melifera*, *Eucalyptus microtheca* and *Prosopis chilensis.* The trees take about 14-17 years to mature for harvesting. The government has recognized charcoal producers to whom it sells the trees by tender at officially set prices.

While most of the charcoal is produced by large-scale contractors with Sudan Charcoal Producers Association, individuals also produce limited amounts. The charcoal is sold to merchants who transport it to wholesalers in urban centres for distribution to retailers and users. Overall, production costs are about 41% of the retail price. Transportation accounts for 37% and service fees (royalties, taxes, duty) 22%.

Charcoal Producers Association

The Sudan Charcoal Producers Association was started to negotiate with the government on behalf of traders. Grouping producers, transporters and traders, the association has set up its own rules in addition to those laid down by the government. For example, the association expels members who fail to pay taxes or engage in corruption. The expulsion means one cannot trade in charcoal. The organization has paid off, with some members producing between 2,000-5,000 bags of charcoal and earning up to US$50,000 a season. The association is not problem-free, however. Members complain of high taxes, unclear boundaries and conflicts due to animal routes through contracted land. They are pressing for the government to allocate them forest land to manage.

Charcoal processing in Sudan

Charcoal in Sudan is produced in earth kilns of up to 120 cubic metres. The unit of production and trade is a 40 kg bag. One cubic metre of wood produces three bags of charcoal. The country produces 1.2–1.6 million tonnes of charcoal a year from 7.8–12.3 million cubic metres of wood. On average, 7.7 cubic metres of wood produce one tonne of charcoal. Studies have shown that alternative charcoal-making technologies are neither more productive nor more economically attractive to the producer than the pit-kiln (Paddon, 1988).

Charcoal export in Sudan

Sudan banned export of charcoal in 1960 due to deforestation. However, the ban was lifted in 1995 to help eradicate *Prosopis chilensis*, an invasive species. Charcoal export is restricted to specific places and the Forest National Corporation sets the minimum price. Export of high quality charcoal, mainly acacia, is limited to 5,000 tonnes a year. However, exports could rise as the government is promoting private investment in charcoal production for foreign markets. Private forest owners are also allowed to export their charcoal and many companies are coming in to exploit the opportunity. Under this arrangement, investors meet the cost of establishing and maintaining the forests. The government is also encouraging farmers' to plant trees under the agroforestry land management system.

In 1998, consumption of charcoal was found to be 45% higher than the sustainable supply. The government then adopted policies to reduce consumption and increase the supply. One of the strategies was to promote the use of LPG by increasing the price of charcoal up to three times that of gas. However, this has not reduced the demand for charcoal, suggesting that gas is not a direct substitute for charcoal.

Lessons to learn

Considering what is happening in the countries of the region and the way the charcoal industry is run in Sudan, the following lessons can be drawn. In Sudan:

- Charcoal is recognized as a key source of energy.
- There is a specific institution, a government parastatal, to implement wood energy policies.
- Production of charcoal from plantations and natural woodlands is well planned.
- Resources are allocated yearly for establishment of plantations.
- There is strong public and private sector participation.

- Charcoal is a formal and lucrative industry.
- There are clear marketing arrangements and rules.
- Traders are organized into a formal association recognized by the government.
- The government is paid royalties and taxes, which are reinvested in establishing plantations.

16 Conclusions

16.1 General Conclusions

The main of source of wood for charcoal production in Uganda is from privately owned forests which are not replenished but are cut as a form of land clearing for other purposes such as farming and construction. Replenishment of trees is critically poor.

Charcoal production is done in almost all the districts of Uganda, with the major production districts, Nakasongola, Nakaseke and Kyakwanzi (supplying Kampala). However the process is not sustainable and is marred by unprofessional practices with only a minor number of charcoal burners knowledgeable of best production practices. Almost all charcoal burners do not sort wood according to species prior to carbonization, this sorting is key to ensuring production of high quality charcoal.

Traditional earth kilns are commonly used technologies with an efficiency of 10-15%. Adoption of improved kilns is majorly lack of knowledge on the available alternatives for charcoal production. Furthermore charcoal burners complained of scarcity of wood, labour intensity and health complications associated with the burning of charcoal as major challenges they face. This highlights the need to promote the use of improved kilns.

Nonetheless, in terms of quality, the charcoal produced from different areas of Uganda does not significantly defer in terms of charcoal quality. The charcoal is generally of acceptable quality irrespective of the wood species used in its production.

The supply of charcoal to main towns of Kampala (supplied by Central and Northern region), Mbarara (supplied by western region), Gulu (supplied by Northern region) and Mbale (Supplied by Eastern and Northern region) is done throughout the year. The means of transport include large scale (lorries, pickups etc.) and small scale (bicycles, wheelbarrows, etc.), with the majority of the transporters without movement permits. The poor transportation practices expose charcoal to quality compromise for example the wetting of charcoal by rain and breaking of charcoal during transportation, loading and offloading.

The majority of the households in urban areas still use charcoal for cooking and heating which is commonly purchased from vendors, with each household spending approximately 66,000 UGX per month approximately 32% of the average household income. Unfortunately, only a small proportion of households and institutions use improved cookstoves.

The current rate of charcoal production in Uganda, if not supplemented a commensurate increase in re-afforestation, will lead to a crisis in charcoal value chain in the near future.

16.2 Barriers identified

16.2.1 Adoption of Improved Charcoal Production Technologies

Barriers to adoption of efficient technologies	Possible interventions	Responsible institution
Lack of awareness on the type of technologies available and their benefits	-Sensitize Foresters nationally on all the available efficient charcoal production technologies -Hold sensitization seminars for charcoal burners to make them aware of the available technologies for efficient production of charcoal	-Ministry of Energy and Mineral Development -Local Government (District Council and Municipalities) -Nyabyeya Forestry College -Line NGOs and CBOs -Development Partners
Lack of detailed information on the technical performance of the different technologies	-Acquire all the available charcoal conversion technologies -Conduct research on technical performance of all the available technologies and -Identify those suitable for Uganda for different wood production systems – on-farm woodlots, on-farm single trees, natural woodlands, indigenous and exotic plantations	-Ministry of Energy and Mineral Development -NAFFORI -Makerere University Forest Department -Nyabyeya Forestry College
Lack of knowledge on and utilization skills of efficient charcoal production	-Train charcoal burners on appropriate use of the efficient charcoal production technologies	-Ministry of Energy and Mineral Development -Nyabyeya Forestry College -NAFFORI

technologies among the charcoal burners		-Makerere University – Forest Department -Development Partners -Line NGOs and CBOs
Unavailability of wood in centralized locations making charcoal production a mobile activity	-Identify appropriate mobile charcoal production technologies for adoption nationally	-Ministry of Energy and Mineral Development -NAFFORI -Nyabyeya Forestry College
Un-availability of the efficient charcoal technologies	-Initiate a kiln fabrication and construction programme -Train artisans to fabricate kilns -Train artisans to construct masonary kilns	-Ministry of Energy and Mineral Development -Nyabyeya Forestry College -Development Partners -Line NGOs and CBOs
High cost of the efficient charcoal technologies	-Support a willing micro-finance institution to loan charcoal burners to purchase the efficient charcoal production technologies	-Ministry of Energy and Mineral Development -Development partners -Micro-finance institutions
Negative image of the charcoal sector that affects the political will	-Initiate a campaign to erase the negative charcoal image	-Media Houses -Ministry of Energy and Mineral Development -Development Partners
Low priority and budgetary allocation by the government on the development of the charcoal sector	-Allocate sufficient funding for charcoal programmes -Tax charcoal trade to generate the required funding of the sector	-Ministry of Energy and Mineral Development -District Local Government

16.2.2 Sustainable Land Management Practices for Wood Production

Barriers	Possible interventions	Responsible Institution
Demand for charcoal un-necessarily high	Reduce demand for charcoal by wide scale use of household and institutional charcoal efficient stoves	-Ministry of Energy and Mineral Development -Nyabyeya Forestry College -Development Partners -Line NGOs and CBOs
Lack of knowledge on management of different feedstock production systems	-Conduct focused studies to generate information on sustainable management of different wood based	-National Forestry Resources Research Institute (NAFFORI) -Makerere University, Forest Department

	feedstock systems that include: Farm woodlots, On-farm single trees, Natural woodlands, Plantations of exotic, Plantations of indigenous tree and shrub species	-Nyabyeya Forestry College
Limited documentation on suitable species for charcoal production	-Document available information on suitable charcoal species by regions/districts	-NAFFORI -Makerere University, Forest Department
Land tenure systems inhibitive	Develop and implement a strategy of feedstock production from each land tenure system	-Ministry of Local Government -NAFFORI -Makerere University - Forest Department

17 Recommendations

17.1 Specific to value chain players

The following proposed recommendations for each player in the charcoal industry should enhance the sustainable production and supply of charcoal in Uganda:

17.1.1 Land owners

- Should be encouraged to grow trees specifically for charcoal. They should be supported to access suitable fast growing tree species to be able to meet the demand for charcoal in Uganda.
- The current species are slow growing and poorly managed therefore they are particularly vulnerable to overexploitation. There is thus a need to encourage species diversification through screening of suitable indigenous and exotic species for producing high quality dense charcoal.
- Charcoal should be marketed by weight so that denser and mature wood can fetch more as opposed to the current situation where the good and poor quality cost the same.

17.1.2 Charcoal burners

- Charcoal burners should use species that produce good quality charcoal; this should be done during the harvesting and sorting process before burning.
- Charcoal producers should show commitment by establishing tree nurseries to show their ability to increase wood supply and enhance sustainable charcoal production.
- Professionalization of the sector should be enhanced whereby charcoal makers can produce charcoal as their main activity and utilize best production practices.
- The use of mobile improved kilns (portable metal kilns) should be adopted instead of in-situ kilns. This will enable charcoal burners to use improved kilns when harvesting from a new plantation/forest where many opt for traditional mud kilns.
- Mobilize charcoal burners into associations or groups where they can easily be reached in case of training or sensitization programs and credit

provision. These associations can then lobby for friendly policies and engage Government to issue at least 20-year leases on government land for tree planting and establishment of charcoal production centres. This provides an opportunity for any individual, company or institution that may want to invest in tree growing but has no land.

- Charcoal burners should acquire license after showing a management plan for the woodland where they are harvesting that emphasizes afforestation, re-afforestation and management of regeneration.

17.1.3 Charcoal Transporters

- Most fines are produced in loading/unloading operations. To reduce this problem transport of charcoal in a single operation from charcoal kiln to main distribution/storage point is recommended.
- To reduce on the problem of cartels at the point of sale from transporters, the study recommends transporters being organized into groups where each transporter distributes to specific distribution points (or charcoal depots) in the district they supply where vendors or last mile users can easily buy charcoal.
- Charcoal easily absorbs water and, therefore, tarpaulins or other covers should be used during transport, to prevent wetting.
- Plastic sheet covers or a galvanized iron open sided storage shed can be used where large amounts accumulate prior to transport.
- Transporters through their association should ensure all transporters first acquire licenses. This document will authorize them to transport charcoal without the need to pay illegal fines and fees to traffic officers/ authorities.

17.1.4 Charcoal Vendors

- Retailers should be encouraged to have an association that they can use as a platform to bring together all charcoal vendors to harmonize charcoal market across, access credit and advocate for discipline.
- Vendors should start selling by weight such as measured in terms of kilograms e.g. 1kg, 5kg, 10kg, 20kg, 30kg, 40kg, 50kg etc. depending on what the market demands.

- In addition to charcoal, vendors should sale eco-friendly fuels such as briquettes. This will enhance awareness raising and accessibility to briquettes.

17.1.5 Charcoal users

- Charcoal users should use energy-efficient charcoal stoves that save charcoal as the traditional stoves currently used are wasteful not really suitable for charcoal from lightweight species, burning it too quickly and vigorously for consumers' needs.
- Households should adopt alternative eco-friendly fuels such as briquettes to lower demand on charcoal.

17.2 Specific to sector players

17.2.1 Government

- The Government of Uganda through the Ministry of Energy and Mineral Development (MEMD) should set up plantations/ woodlots deliberate for charcoal production in order to meet huge demand for the fuel. The size of each plantation should be 15,000 hectares per district. Fast growing tree species should be planted to allow for harvesting after at least 6 years.

- In addition to creating awareness of several investment opportunities and charcoal business, Government should in partnership with private (Microfinance institutions) provide financial products and incentives to enable investment in wood growing. The programme should follow the three models of wood production e.g. (i) Small Scale Growers (SSG) – e.g. 0.1 – 10 acres, Medium Scale Growers (MSG) 10.1 – 50 acres and Large Scale Growers – 50.1 and above.

  In addition, the Government should help investors make the necessary documentation, provide guidelines and regulations that favour green charcoal. This will create a conducive operating environment where by cheap non-green charcoal does not out compete the green charcoal on account of high cost of production. Specialized units in government agencies should work with and help private sector to tap resources in

existing carbon financing mechanisms and Payment for Ecosystem Services (PES) like REDD, NAMAs, CDM, POAs and VCS.

- The Government should promote the use of improved kilns in all charcoal producing sub-counties for example mobile steel kilns should be located at the LC1 Chairpersons home for hire by the small scale producers. Large scale producers should then acquire masonry kilns in their plantations.

- Charcoal trade should be professionalized through continuous capacity building of charcoal value chain players. In addition, standardization of measurement units should be done so that when one says a bag of charcoal, it means the same in the whole country. Charcoal should be measured in terms of kilograms e.g. 1kg, 5kg, 10kg, 20kg, 30kg, 40kg, 50kg etc. depending on what the market demands.

- The Government should encourage the use of alternative fuels such as biogas, briquettes and LPG. Firstly, Tax exemptions should be given to SMEs/ Individuals engaged in the making and marketing of briquettes. In addition, their use can be increased through creation of innovative financing mechanisms like carbon Payment for Ecosystem Services (PES). Secondly, promote increased use of LPG in urban areas (wealthier households) by provision of better distribution mechanisms and access to appliances through a credit scheme. Furthermore, Government can lower taxes on LPG so that the adoption and continued use becomes affordable. Thirdly, promote use of biogas especially in institutions and in cattle keeping areas which at same time improves agricultural production by use of slurry as high quality fertilizer.
- Information Management and flow. An active database should be updated yearly. Every Government agency e.g. NFA, UBOS, NEMA, URA, MEMD should make contributions to the charcoal business and land management database.
- The Government should foster a multidisciplinary and multi-stakeholder (Line ministries, NGOs, CSOs, religious and cultural leaders) engagement in the awareness creation and intervention programmes for example MEMD and MOH should work closely in promoting clean stoves that lower/ eliminate indoor air pollution.

17.2.2 Research Institutions

- Research institutions should conduct long term research studies on fast maturing tree species suitable for charcoal production. In addition, research should also focus on best ways to promote the shift to use of LPG and other fuels.
- Research institutions in partnership with private firms should design mobile improved kilns to ensure charcoal burners move kilns to sites of charcoal production.

17.2.3 Local council leaders

- Improve monitoring and records management: LC1 chairpersons should collect and manage charcoal production activities from wood harvesting to quantity of charcoal produced in each village every month.
- Reforestation activities: LC1 Chairpersons (through the secretary for development and production at LC council) should promote tree planting activities and record how many trees are planted every year in their area of jurisdiction.

17.2.4 District Forestry Offices

- The study recommends that each district should have a proportion of the district land (e.g. 20% of the total land area) set aside for charcoal forests as a cash crop or an area of forests dedicated to charcoal production e.g. 15,000 hectares established or set aside for commercial production of charcoal.
- Sensitization of charcoal burners to raise the awareness of the existence and advantages of utilizing improved charcoal kilns.
- Capacity building of charcoal burners on ways to acquire/construct and maintain efficient charcoal technologies. This would involve training and imparting skills as well as financial support (through government partnerships with microfinance institutions). Furthermore DFOs should organize routine demonstrations to enhance adoption of sustainable charcoal production, supply and utilization practices.

17.3 Investment in the value chain

The charcoal industry in Uganda is not formally organized in associations like in other sectors, but rather players in the value chain operate individually, hence lacking a collective voice and bargaining power to push for their agenda within the government. Charcoal burners in general suffer from the price dictate of charcoal traders, especially those in "remote" areas due to bad road conditions. The creation of cooperatives or associations would enforce the negotiating power of charcoal burners vis-à-vis the traders.[41] Increasing income will open up the possibilities of engaging in direct marketing by entering into contracts with large consumers.

Currently, in Uganda, charcoal producers encroach on forest reserves or harvest from private or individually owned land. What is required is sustainable management of the available wood resources and planned new planting of fast maturing tree species so that the supply of wood for charcoal can be higher than the demand. Demand may also be moderated by the adoption of more efficient charcoal burning technologies – requiring investment on the part of producers or producer cooperatives/associations. If this is achieved, the charcoal industry can contribute positively to environmental conservation and clean air, thus greatly minimizing the potential negative effects on climate.

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