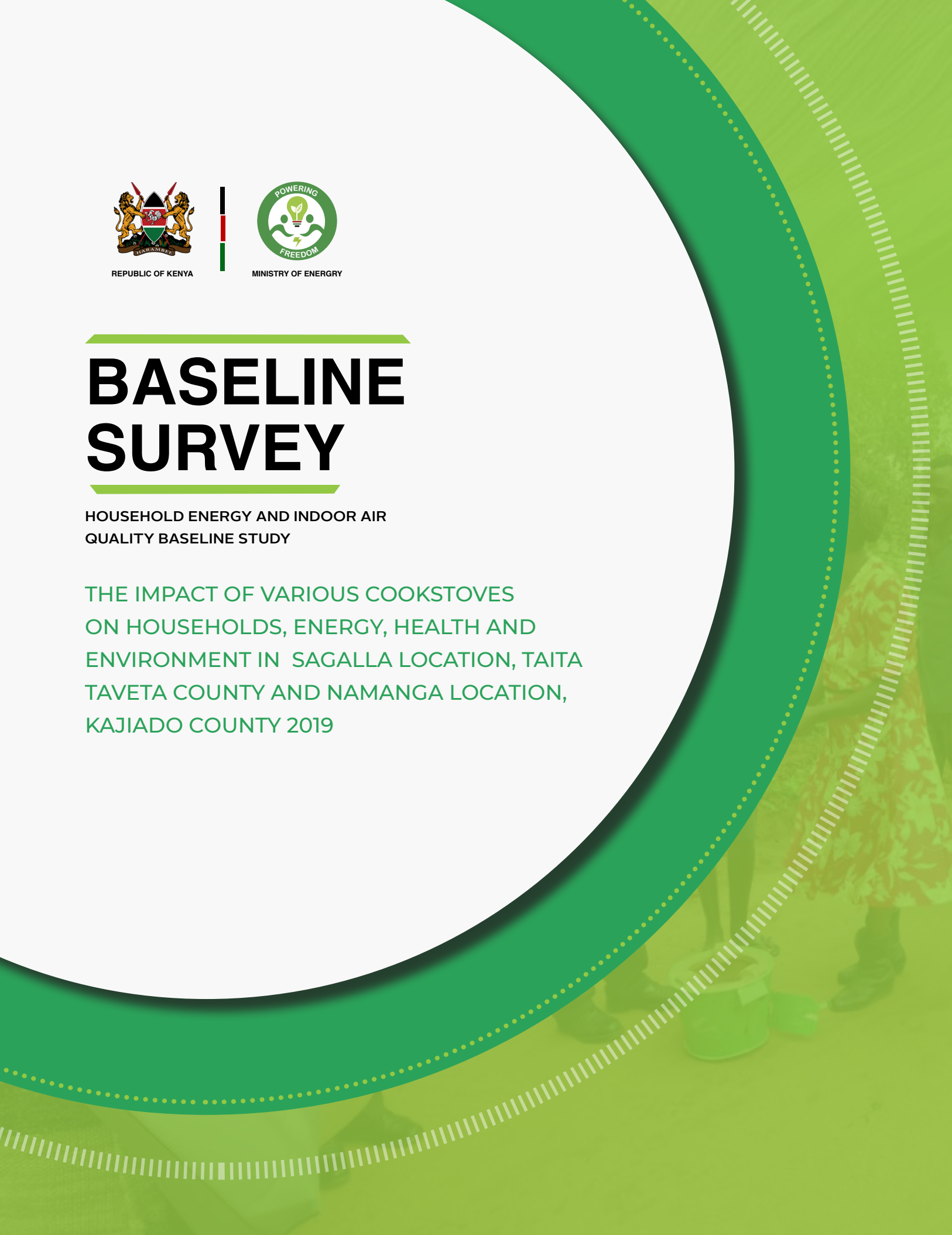
REPUBLIC OF KENYA

MINISTRY OF ENERGRY

BASELINE SURVEY

HOUSEHOLD ENERGY AND INDOOR AIR QUALITY BASELINE STUDY

THE IMPACT OF VARIOUS COOKSTOVES ON HOUSEHOLDS, ENERGY, HEALTH AND ENVIRONMENT IN SAGALLA LOCATION, TAITA TAVETA COUNTY AND NAMANGA LOCATION, KAJIADO COUNTY 2019



BASELINE SURVEY

FOREWORD

Energy is a dominant contributor to climate change as it accounts for close to 60% of global greenhouse gas emissions. Bioenergy provides 10% of world's primary energy supply in which an estimated 3 billion people rely on the use of wood, coal, charcoal and animal waste for cooking and heating in spite of Sustainable Development Goal (SDG) number seven on Affordable and Clean Energy. The SDG goal aims to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. This ties very well with our own Kenya Vision 2030 whose objective is to propel Kenya into becoming a globally competitive, newly industrialised, middle income country by 2030.

The Ministry of Energy has the mandate of facilitating the provision of clean, sustainable, affordable, reliable and secure energy for national development. In the Kenya Vision 2030, Energy is identified as a key enabler in the realization of Vision 2030 objectives and the Big 4 Agenda. The Ministry therefore aims to ensure, Kenyans are able to access competitively priced, reliable, quality, safe and sustainable energy. Among its programmes, the Ministry implements projects that promote clean cooking solutions.

Support for clean-cooking technologies in the cooking sub-sector aims to bring the sector to a low carbon development pathway. As it is, 68 per cent of Kenyans rely on traditional biomass fuels. Cooking in Kenya is dominated by firewood (64.9%), Liquefied Petroleum Gas (LPG) (18.9%), Charcoal (10.3%) and Kerosene (5.6%) with more than half the households using multiple fuels and technologies for cooking. Currently, 30% of rural households and 54% of urban households use clean cooking technologies and fuels.

For the Ministry to attain the 100% clean cooking solutions for all Kenyans by 2028, it is

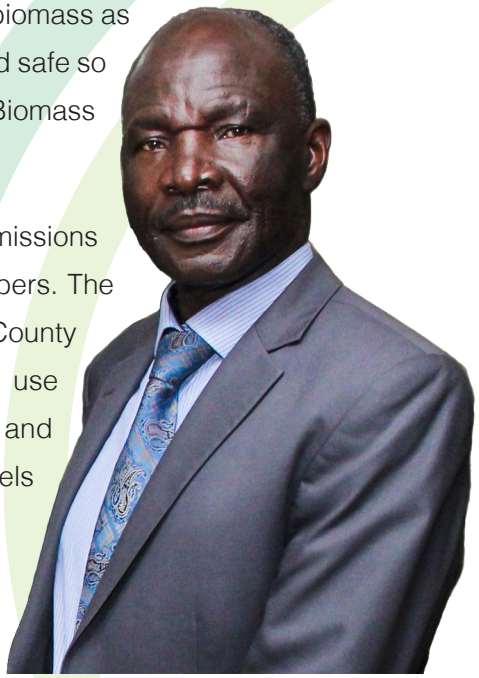
imperative that clean technologies in the cooking sub-sector became the norm. As an initial, step, the Ministry aims to ensure the transition of 50% of households currently using traditional 3-stone cook stoves to improved cook stoves. Strategic interventions are therefore being put in place to enable the country move towards the sustainable-energy-for-all pathway.

One of these intervention is multi-stakeholder consultations around innovative platforms that provide critical learning and feedback mechanisms as shown by the 'Household Energy and Indoor Air Quality Study' that the Ministry hereby presents.

Amb (Dr.) MONICA K JUMA, OXON, EGH
CABINET SECRETARY
MINISTRY OF ENERGY

PREFACE

By promoting clean cooking solutions, the Ministry of Energy aims to attain 100% clean cooking solutions for all Kenyans by 2028 by embracing clean technologies in the cooking sub-sector. Presently, the Ministry underscores the importance of biomass as a source of energy and recognizes the need for its efficient and safe so as to protect our forests, environment and health of Kenyans. Biomass represents 68% of the primary energy use in Kenya.



The Ministry therefore undertook a study on the dangers of emissions from cook stoves and fuels on the health of household members. The study was carried out in Sagalla Location in Taita Taveta County and Namanga location in Kajiado County. It examined the use of improved cook-stoves, solar lamps, improved ventilation and awareness of the dangers of emissions from stoves and fuels posed by the usage of biomass change.

Through our Renewable Energy Directorate and in collaboration with the University of Nairobi, the study team examined emissions from various cook stoves with the overall aim of assessing the impact of household emissions on the health of women and children. It also endeavoured to compare the performance of traditional cooking-stones to improved cook stove by measuring their use in real time and real time energy performance. The study particularly targeted the use of the three-stone stove vis-a-vis Maendeleo liners, portable Maendeleo jikos, Kenya Ceramic Jikos and multipurpose stoves.

During the study, teams investigated the performance of traditional cook-stoves as compared to improved stoves by measuring the levels of Carbon monoxide (CO), Particulate Matters (PM2.5) and Carbon dioxide (CO2) emissions to acceptable global levels of indoor air quality. It documented emissions data from various stoves for the purpose of informing interventions

that aim to: reduce household emissions; protect the health of women and children; build on the knowledge to inform further research on technology development; and advocate for support mechanisms for the conservation of energy and mitigation of climate change as a social responsibility.

The Ministry hereby presents to you the results of the study whose recommendations we believe will be useful in the formulation of interventions that directly address the challenges faced by communities especially in arid and semi-arid areas.

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Maj. Gen. (Rtd) Dr. Gordon O. Kihalangwa, CBS
PRINCIPAL SECRETARY
MINISTRY OF ENERGY

ACKNOWLEDGEMENT

The Renewable Energy Directorate is responsible for coordinating Renewable Energy efficiency, conservation and integration of climate change. In fulfilment of its mandate, the Directorate undertook a study on Energy, Health, Environment and Emissions from cook-stoves in two locations in Kenya. The study sites were in Namanga, Kajiado County and Sagalla in Taita – Taveta County carried out over a two week period.

Special thanks goes to members of the community drawn from Sagalla and Namanga Counties who graciously accepted to participate in the study and allowed us in their homes to examine air quality over a 24 hour period. Much gratitude also goes to the enumerators who had to translate the questionnaires from English to Kiswahili and to the local language to create greater understanding.

The coordination and cooperation received from the National Government Administrative Officers (NGAOs), County Government and Community leaders greatly facilitated the work of the research team.

My utmost gratitude goes to the Department of Chemistry, University of Nairobi for allowing Prof. Jacob Kithinji to assist in the design and management of the research project. I thank the University for enabling the research team access knowledge resources that complemented the research.

In a special way, I wish to thank the Ministry for facilitating the research team to undertake the exercise in the two study areas. More specifically, I wish to thank Esther Wang'ombe, OGW, Francis Nderitu, Viviene Simwa, Elizabeth Odongo and Pamela Lyavoga who dedicated their time and energy to ensure the research materials were collated and published.

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Eng. Benson M. Mwakina, HSC
Ag. SECRETARY RENEWABLE ENERGY

MINISTRY OF ENERGY

ACRONYMS

ASALs	Arid & Semi -Arid Lands
CO	Carbon monoxide
CO_2	Carbon dioxide
EU	European Union
GHG	Green House Gas
HH	Household
IAP	Indoor Air Pollution
IAQ	Indoor Air Quality
KCJ	Kenya Ceramic Jiko
KPT	Kitchen Performance Test
LPG	Liquid Petroleum Gas
MOE	Ministry of Energy
µm	Micrometer
µg	Microgram
$PM_{2.5}$	Particulate Matter with less than 2.5 µm diameter
PIC	Product of Incomplete Combustion
PPM	Parts per million
RMS	Rocket Mud Stoves
WHO	World Health Organization

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EXECUTIVE SUMMARY

This study was undertaken in Sagalla and Namanga locations in Taita- Taveta and Kajiado Counties respectively. Both sites had rural and peri-urban setups which ensured that the study outcome gave a proper representation of Kenya. Land was communal and most of the houses were mud-walled and grass thatched. A few were mud-walled and iron-roofed.

The objective of carrying out this study was to demonstrate the impact of improved stoves on; energy, health and environment. Selection of households was done using the random sampling technique. The questionnaires administered contained both open-ended and close-ended questions. They targeted information that expounded on the general condition of households, from the household size, age of the youngest child, to the age of the respondent. It was essential for respondents to be the main cook for the family. The study explored the use of various cook-stoves, fuel consumption and compared the efficiency of the conventional stoves versus the improved stoves.

Kitchen Performance Tests as well as monitoring of Indoor Air Pollution were also done. In Namanga, the average fuel consumed in kilograms per day was calculated to be 8.20kg (firewood) while in Sagalla it was 0.59kg (Charcoal) and 4.38kg (firewood). The pollutants investigated were Carbon monoxide (CO), Carbon dioxide ($CO_{2)}$ and Particulate Matter ($PM_{2.5}$). According to the WHO guidelines on CO exposure, the study showed that 61% and 92% of households in Sagalla and Namanga respectively had CO concentrations above the allowable levels (6ppm in 24 hour) while the concentration of CO_2 were considered acceptable in both areas. For $PM_{2.5,}$ the study revealed a mean of at least 100 µg/m^3 for most of the cook stoves used in the sampled households. The value is five-fold more than the stipulated maximum permissible of 20 µg/$m^{3.}$ which could be responsible for the various ailments observed amongst the households.

The results indicated that a substantial number of children in both study sites suffered from breathing difficulties, eye problems, headache and burns. It also revealed that 68% of the women in Sagalla and 51% of women in Namanga usually coughed at the onset of cold/wet seasons. Firewood and charcoal were the main sources of fuel for the two study areas with some respondents stating that they sourced fuel from their own farms. However, majority of the respondents stated that they sourced fuel from Community land.

The study found out that the level of awareness in the choice of cooking stoves was based on what stove was easily available. The stoves were used for cooking, heating and lighting. Fuel consumption of various types of cook-stoves was also sought. Comparison of the efficiency of the conventional stoves versus the improved

stoves was done. Majority of the respondents in both study sites reported that the improved stoves were expensive and a few respondents had no idea where to purchase these stoves.

It was observed that most of the houses evaluated in both locations had poor ventilation exposing the household members to high level of pollutants. This calls for urgent interventions such as the use of solar lamps, improved cook-stoves, improved ventilation by installation of chimneys and creating awareness on the dangers of emissions from stoves and fuels.

Considering that Kenya is not near eradicating biomass use as a primary energy, it is therefore imperative to increase research on improved cook-stoves, grow more trees and other biofuels on the farms to arrest forest degradation and ensure sustainability of wood fuel resources This calls for intervention by the Ministry of Energy, Ministry of Environment, Ministry of Health, Inter-Ministerial Agencies, Research Institutions and Development Partners to address environmental health and energy issues observed.

CHAPTER ONE

INTRODUCTION

The Ministry of Energy underscores the importance of biomass as a source of energy representing 68% of the primary energy used in Kenya and more than 80% of primary energy used in the rural areas. The Ministry also recognizes the need to use biomass efficiently and safely; to protect our forests, environment and health of Kenyans.

The rural households in Kenya are facing a deterioration of Indoor Air Quality (IAQ) due to the inefficient use of biomass to meet their cooking and heating energy needs. Traditional cook stoves have been evidently found to emit a number of Products of Incomplete Combustion (PIC) which have a direct or indirect impact on both climate and human health. Monitoring IAQ is a crucial step in order to establish the actual level of toxic pollutants present in the indoor air, which can then be mitigated through the introduction of improved cook stoves. The high demand of biomass particularly for cooking, heating and drying is the key cause of degradation of the country tree cover. This concern has made research on kitchen performance of various cook stoves a key portion of this study.

The Ministry has undertaken to intervene by carrying out a study to compare the traditional stoves with the improved stoves with the aim of promoting adoption of the latter or proposing more stove improvements to achieve the desired goal. The goal is to promote clean cooking technologies for reduced Greenhouse Gas (GHG) emissions, as well as controlling biomass harvesting for wood-fuel. This will contribute towards maintaining the country tree cover, good health to mothers and children; and to improve protection of hydro dams' catchments for sustained power supply. The Ministry of Energy study team supported by researchers from University of Nairobi undertook a survey to assess the general conditions of women and children's health and household energy use in Sagalla and Namanga locations in Taita Taveta and Kajiado Counties respectively. This was followed with a scientific study to assess the indoor air quality in selected households and carrying out Kitchen Performance Tests (KPT) to compare the energy saving potential of the different cook stoves in use.

The objective of the study was to assess the performance of traditional as well as improved cook stoves by measuring CO, CO2 and PM2.5 indoor emissions in real-time and determining real-time energy performance

of these stoves. The study particularly targeted 3-stone stoves as baseline stove vs Maendeleo liners, Portable Maedeleo jikos, Kenya Ceramic Jikos and Multipurpose stoves.

The study involved: carrying out a scoping study to identify areas to do the research; selecting the population to engage using a given criteria; conducting a survey on the general health conditions of select households and their energy status using local enumerators; measuring emissions for the households stoves; carrying out stoves' KPT; recommending suitable improved stove to pilot; supplying and installing the selected HHs with the recommended improved stoves; leaving the HHs to use the stoves for a year or two before the team carries a repeat measurements with the improved stoves in place and in use. Finally, the results were analyzed, compared and recorded.

Criteria for selection of respondents: The selected HHs had to fulfill the following criterion: i) household with at least one child below the age of five years and ii) presence of HH members who regularly ate in that home. This criterion followed the assumption that households with children and other family members were likely to be engaged regularly in cooking activities.

The general energy and health conditions of the HHs were collected through direct interviews using structured questionnaires. CO, CO2 and PM2.5 were measured using specialized meters which were activated and placed strategically in the cooking area. KPT was determined by: weighing the fuel necessary for use in the HH for 24 hours using a rope and a digital spring balance; measuring the average fuel moisture content using a pin-type moisture meter; the consignment was left to be used for 24 hours after which the remaining fuel was weighed and recorded.

CHAPTER TWO

METHODOLOGY

2.1. Introduction

In this study, the choice of method was influenced by the data collection strategy, the collection point, the accuracy required and the skill of the enumerator. This section illustrates how the research study was carried out and outlines the step-by-step process used to achieve the results needed to draw a conclusion.

2.2. Location of the Study

This baseline study was carried out in April and May, 2019 in Sagalla and Namanga Locations. The choice of the locations was vital due to the nature of the study. The two locations were chosen since they met the criteria needed. They both had rural and Peri-urban setups which would ensure that the study gave a proper representation of ASAL areas.

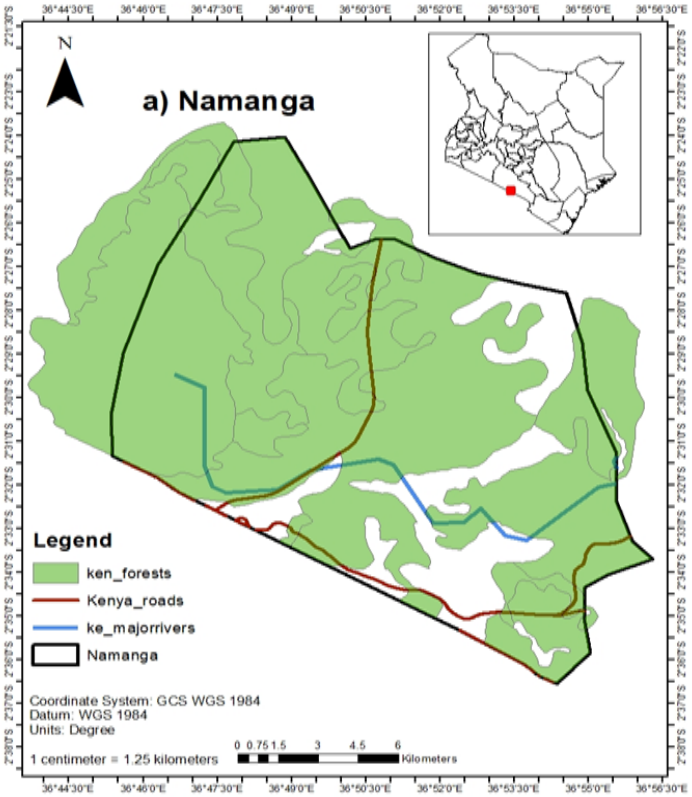
In both study areas, the communities were settling in recently demarcated communal lands with most of the houses were mud-walled and grass thatched; a few were mud-walled and iron-roofed, reflecting the level of poverty. The surveys were carried out in a similar manner and the results reported. The figure 1 below shows the two study areas.

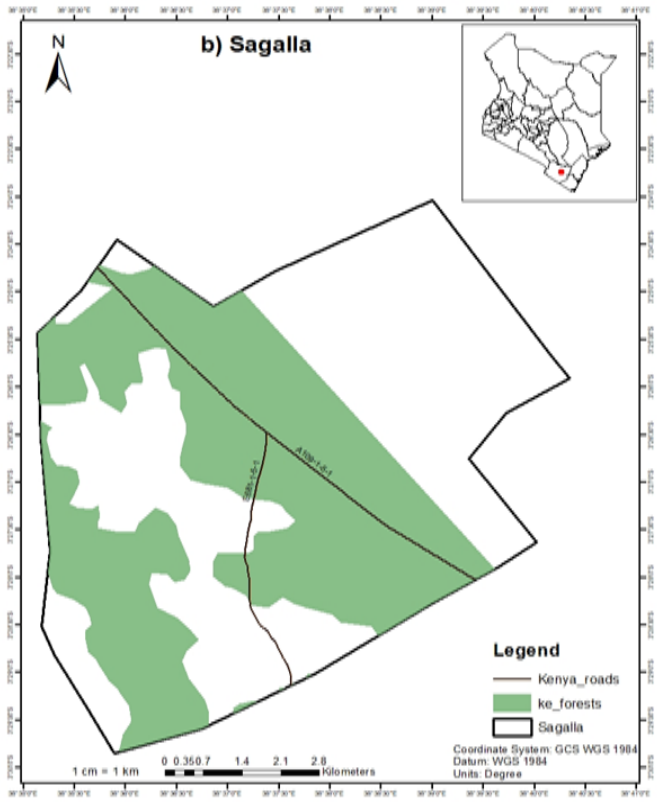
A house in Namanga

A house in Sagalla

Figure 1: Study area maps (a; Namanga location, b; Sagalla location)

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations





2.3. Selection of Households (HHs)

This study purposely chose the two areas to demonstrate the impact of improved stoves on; energy, health, environment and Kitchen Performance Test (KPT) with emissions. The selection of households (HHs) was done using the random sampling technique. However, the identified HHs had to meet the following criteria; i) Household with at least one child below the age of five years ,and ii) Presence of HH members who regularly ate in that home. These criteria followed the assumption that households with children and other family members are likely to be engaged regularly in cooking activities.

2.4. Administration of Questionnaires

The general households' health, energy and environmental conditions were assessed using a structured questionnaire. The questionnaire contained both open-ended and closed-ended questions. They targeted information that expounded on the general condition of households. This ranged from the household size, age of the youngest child, to the age of the respondent. The choice of enumerators was crucial for the study hence, all the enumerators had to be literate (Form four leavers) and be drawn from the local community since the questions had to be read and translated to the respondents.

The survey was designed and administered only to households using firewood, charcoal, kerosene and/or agricultural waste as fuel. It was essential for respondents to be the main cook of the family. Moreover, the

study stipulated that the respondents be female. The study's focus also adhered to get a clear picture of perception of their health (cough, breathing difficulties, burns, eye problem, ear discharge and headache) of the mother/guardian and children below five years in these HHs. The questionnaire also sought to capture the energy sources and types of fuel used in these HHs. In some instances, direct observation was employed in the survey by the enumerators. 52 and 51 questionnaires were administered in Sagalla and Namanga Locations respectively.

2.5. Monitoring of Indoor Air Pollution

Particulate matter (PM2.5) carbon-monoxide (CO,) carbon-dioxide (CO2) emissions were measured inside the cooking area for 24 hours using portable PM2.5, CO, and CO2 meters arising from the stove use. The 24 hours' emissions were taken every half-a-minute and their averages calculated.

2.6. Kitchen Performance Tests

Kitchen Performance Tests were carried out in 30 households in Sagalla and Namanga Locations to evaluate the effect of cook-stove's impact on fuel consumption and cooking behavior in participating households. KPT was determined by: weighing the fuel necessary for use in the HH for 24 hours using a rope and a digital spring balance; measuring the average fuel moisture content using pin-type moisture meter; the consignment was left to be used for 24 hours after which the remaining fuel was weighed and recorded. KPT also involved collecting information on the type of foods, stoves, number of people cooked for and their age.

2.7. Distribution Improved Cook Stoves

KCJ, Maendeleo portable stove and Multi-purpose Maendeleo Portable stove are the improved stoves being piloted by the Ministry of Energy.

CHAPTER THREE

RESULTS AND DISCUSSIONS

3.1. Introduction

This section covers the respondents' general information, the households' health, energy (stoves and fuels), 24-hour real time indoor air emission data and Kitchen Performance Test.

3.2. Respondents' General Information

The survey was designed and administered only to households using firewood, charcoal, kerosene and/or agricultural waste as fuel. A total of 52 and 51 households participated in the survey in Sagalla and Namanga respectively. Table 1 shows the distribution of respondents by age for the two study areas.

Table 1: Distribution of households by respondents' age

Age Bracket (years)	N (Sagalla)	%	N (Namanga)	%
15-19	0	0	10	20
20-25	7	13	13	25
26-30	10	19	7	14
31-35	10	19	9	18
36-40	8	15	5	10
41-45	5	10	1	2
46-50	5	10	1	2
51 and above	7	13	5	10
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The survey mainly targeted persons who were responsible for cooking in the households. The findings revealed that all respondents in Sagalla were above the age of 20 years while in Namanga the respondents were at least

15 years of age. It was observed that early marriages were practiced in Namanga. In Sagalla, most of the respondents (38%) were adults aged between 26 and 35 years. On the other hand, the study revealed that in Namanga a higher percentage (25%) of respondents were aged between 20 to 25 years. Table 2 below shows the household members who regularly take meals from the same pot.

Table 2: Household distribution by the number of regular household members

No. of Household members	N (Sagalla)	%	N (Namanga)	%
1 - 3	7	13	4	8
4 - 6	26	50	21	41
7 - 9	16	31	19	37
10 - 12	3	6	6	12
13 - 15	0	0	1	2
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

$$\text{Average} = \frac{\sum(\textit{regular household members})}{\sum(\textit{number of households})} \frac{\sum(\textit{regular household members})}{\sum(\textit{number of households})}$$

..... (1)

Average= 296/52 =5.6 members (Sagalla)

Average= 343/51= 6.7 members (Namanga)

According to the household members who regularly take meals together, the survey results indicated a higher percentage (50%) for households with 4 to 6 members, 7 to 9 members at 31% and the least being 10 to 12 members at 6%. On average, the household members are six in Namanga. These results are not comparable with the national rural household census of 2019, which indicated an average of four.

3.3. Households' Health

The study was set out to explore the health of children under the age of five years as well as the female respondents. Further investigations were carried out to explore the relationship between smoke emanating from cooking stoves and children's health. One of the study objectives was to explore the perception of health (cough, breathing difficulties, burns, eye problem, ear discharge and headache) by respondents relating to children under the age of five years as shown in figure 1 below.

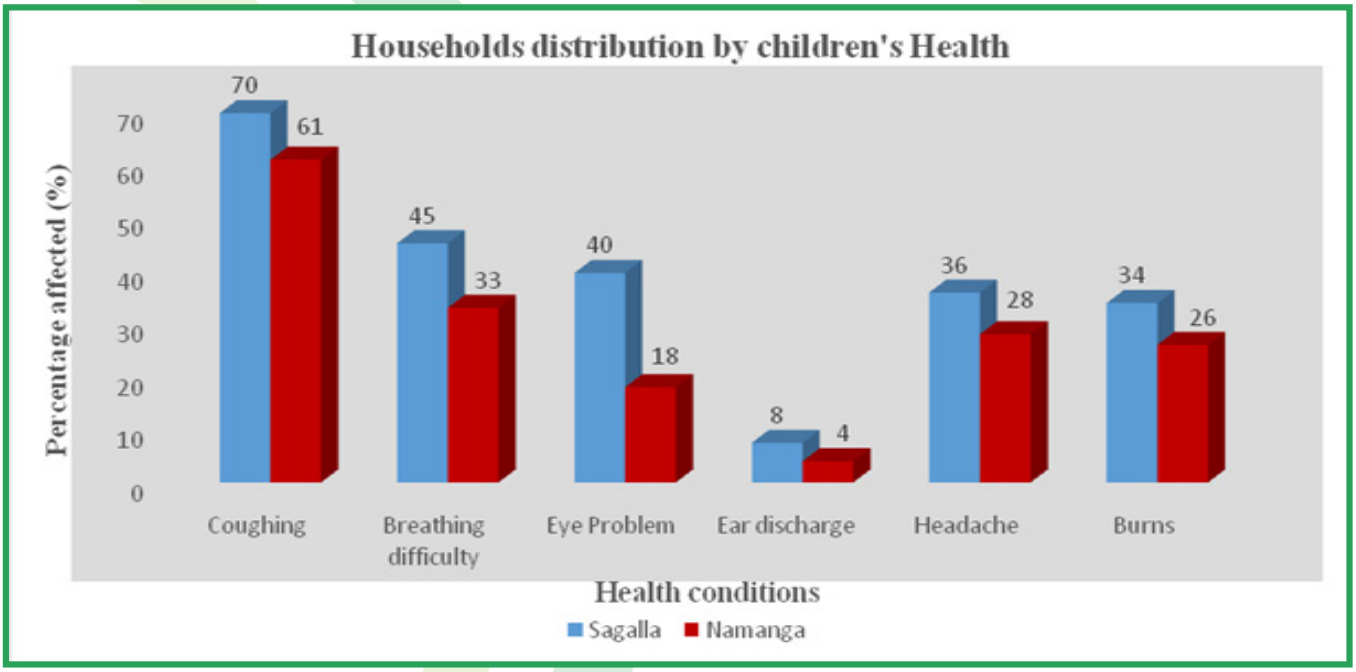


Figure 2: Distribution of households by children's health.

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The study explored the various health issues experienced by children below 5 years in the last one month. It emerged that, most children in this age group experienced coughing (70%), while a small number of children experienced discharge coming out of their ears (8%) as observed in figure 1. These results also indicated a substantial number of children in Sagalla suffered from breathing difficulty, eye problem, headache and burns, 45%, 40%, 36%, and 34% respectively. The results showed a similar trend for Namanga where a majority of the children (61%) experienced coughing, while 4% experienced ear discharge. These are the most prevalent diseases in the localities.

Figure 3 below shows multiple responses on the distribution of households by children's exposure to smoke and its effects.

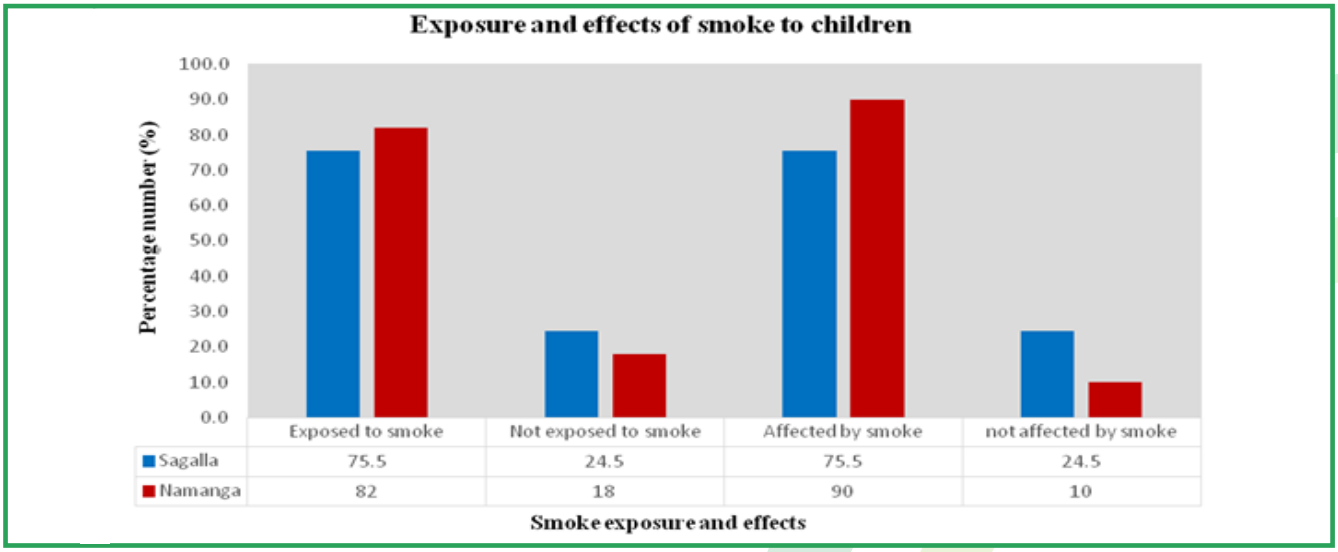


Figure 3: Distribution of Households by Children's Exposure to Smoke and its effects

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Given the high prevalence of kitchen accidents and smoke related conditions, two parallel studies were set out to explore the effect this has on children below 5 years. With regard to exposure of children to smoke during cooking, it emerged that over three quarters of the children were inside the kitchen when cooking was ongoing. It also indicated that 75.5% of respondents in Sagalla and 90% in Namanga said exposure to smoke had an effect on children. These figures were very high and calls for intervention by public health to educate communities to improve ventilation in the households. It is important for the community to be encouraged to use dry firewood.

In figure 3 below, the study endeavoured to establish the extent to which women coughed during the cold/ wet season.

Question: Do women cough during the beginning of the wet/cold seasons?

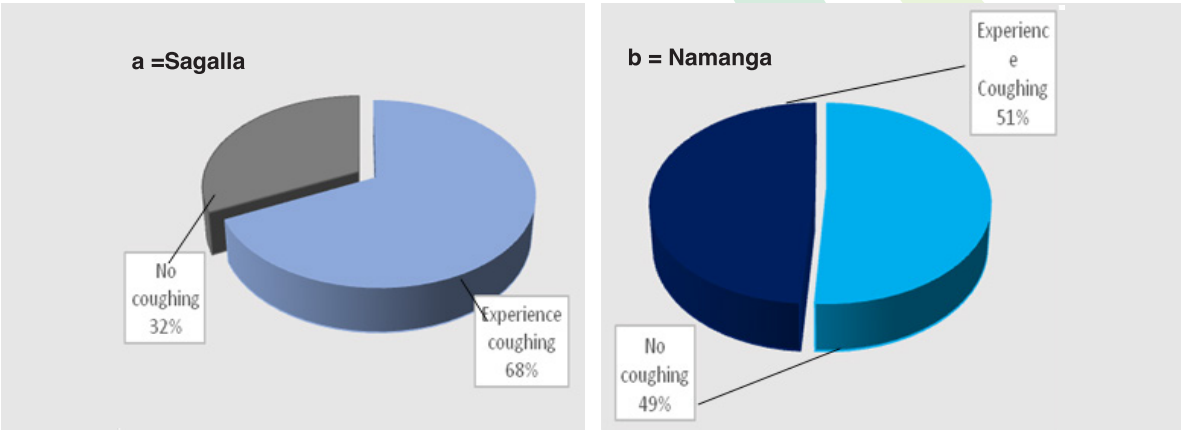


Figure 4: Distribution of households by whether the women cough during the wet/cold season.

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

The study found out 68% of the women in Sagalla usually cough during the onset of cold or wet seasons, while 32% of the women have no issues related to coughing under similar conditions. This was also supported by the results obtained in Namanga, which showed that 51% of women experience coughing during the onset of the cold/wet season. The high level of coughing could be attributed to smoke as a result of high moisture content in the firewood. This calls for intervention by inter-ministerial agencies to address the situation.

In Figure 4 below, the study also endeavoured to establish the occurrence of eye related problems experienced by the women.

How often do you experience eye problems?

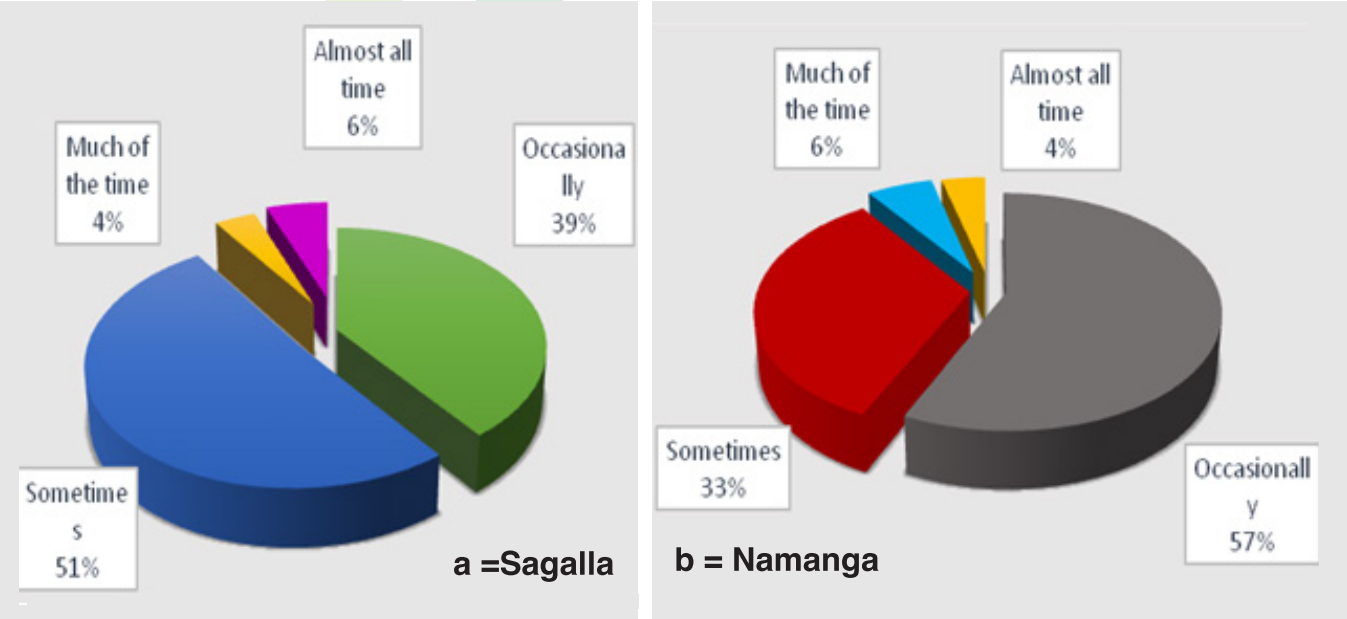


Figure 5: Distribution of households by analysing eye problems experienced by women.

Source: Ministry of Energy Survey Data 2019, Sagalla &Namanga Locations.

The study set out to investigate the occurrence of eye related problems experienced by the women. What emerged from the surveys indicated that 51% of the women in Sagalla sometimes experienced eye complications, while 39% had little or no complications. On the other hand, 10% of the women in Namanga experienced persistent eye complications. A similar survey indicated that 57% occasionally experienced eye related issues and 33% sometimes experienced eye problems. This could be associated to the high levels of smoke in households when women are cooking.

3.4. Energy: Cook-Stoves and Fuel Use

The study was interested in perception pertaining to the types and uses of cook-stoves including fuel consumption and efficiency of the traditional stoves versus the improved stoves.

Table 3: Distribution of households by which cook stoves the respondents are aware of

Knowledge of stoves	N (Sagalla)	%	N (Namanga)	%
3-stones	4	8	13	25
Rocket Mud Stoves (RMS)-1 pot	0	0	0	0
Rocket Mud Stoves (RMS)-2 pot	1	2	0	0
Maendeleo	6	12	0	0
3-stones & maendeleo	27	52	28	55
3-stones &RMS-1	2	4	0	0
3-stones, RMS-1 & Maendeleo	3	6	0	0
3-stones & RMS-2	1	2	1	2
3-stones, RMS-2 & Maendeleo	1	2	1	2
RMS-1 & Maendeleo	2	4	0	0
RMS-2 & Maendeleo	4	8	0	0
3-stones, KCJ & sawdust	1	2	0	0
Others	0	0	1	2
Maendeleo & others	0	0	1	2
3-stones, Maendeleo and others	0	0	6	12
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

From Table 3 above, the study found out that the level of awareness in the choice of cooking stoves is based on what stove is easily available. Most of the respondents were aware of the traditional three stones-stoves, which has been in use since time immemorial. The Maendeleo stove was relatively known, followed by the RMS-1 pot and RMS-2 pot. The awareness of the type of improved stoves among the households is low and calls for intervention by the Ministry of Energy. The Ministry aims to attain 100% clean cooking solutions to all Kenyans by 2028.

3.5. Distribution of Households by the Respondents' Main Cook-stoves

Figure 5 below shows the distribution of main cook stoves in the households.

What is your main cook stove?

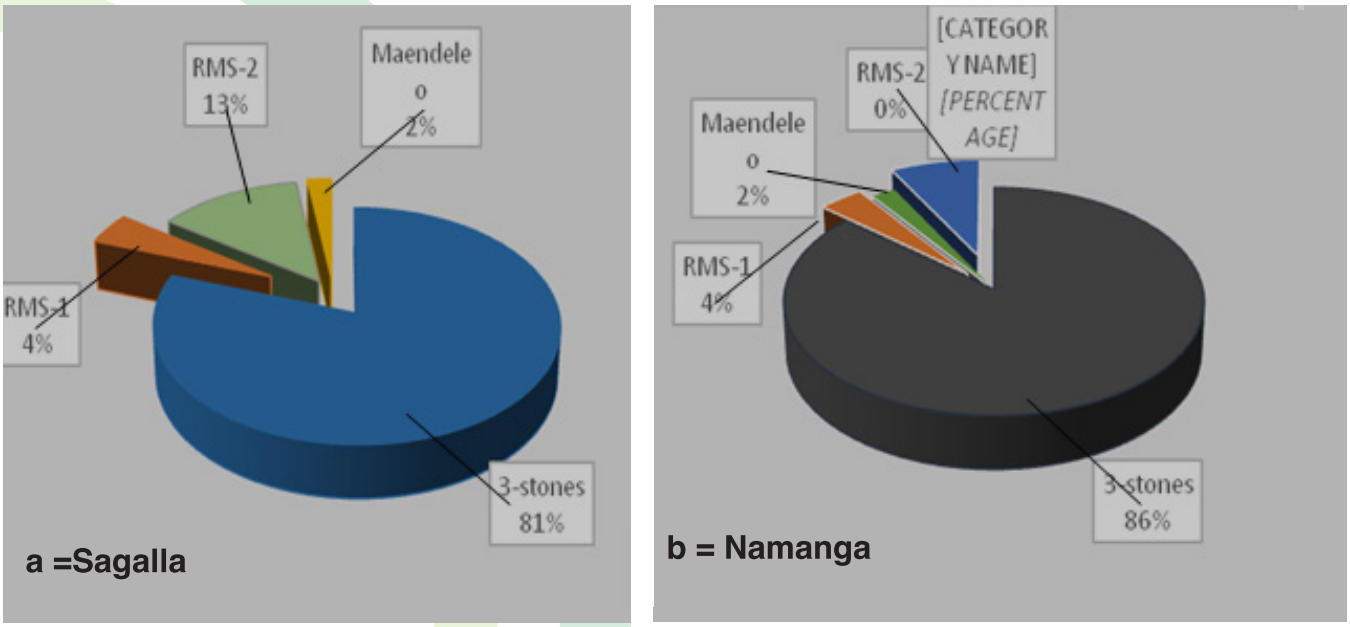


Figure 5: Distribution of households by main cook stoves used.

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

The study carried out in Sagalla revealed that 81% of households use 3-stone stoves as their main cook stove, while RMS-2 usage is 13%, RMS-1 4% and Maendeleo 2%. On the other hand, in Namanga 86% of households use 3-stones stove, followed by KCJ stove at 8%. It was observed that the most known stove (3-stones) had the highest use percentage which was attributed to being affordable to set up. Interventions by Inter-ministerial agencies to do further research on the same is needed.

Figure 6 below shows the distribution households by the Main Purpose of the Cook-stoves Question: What do you use the cook stove for?

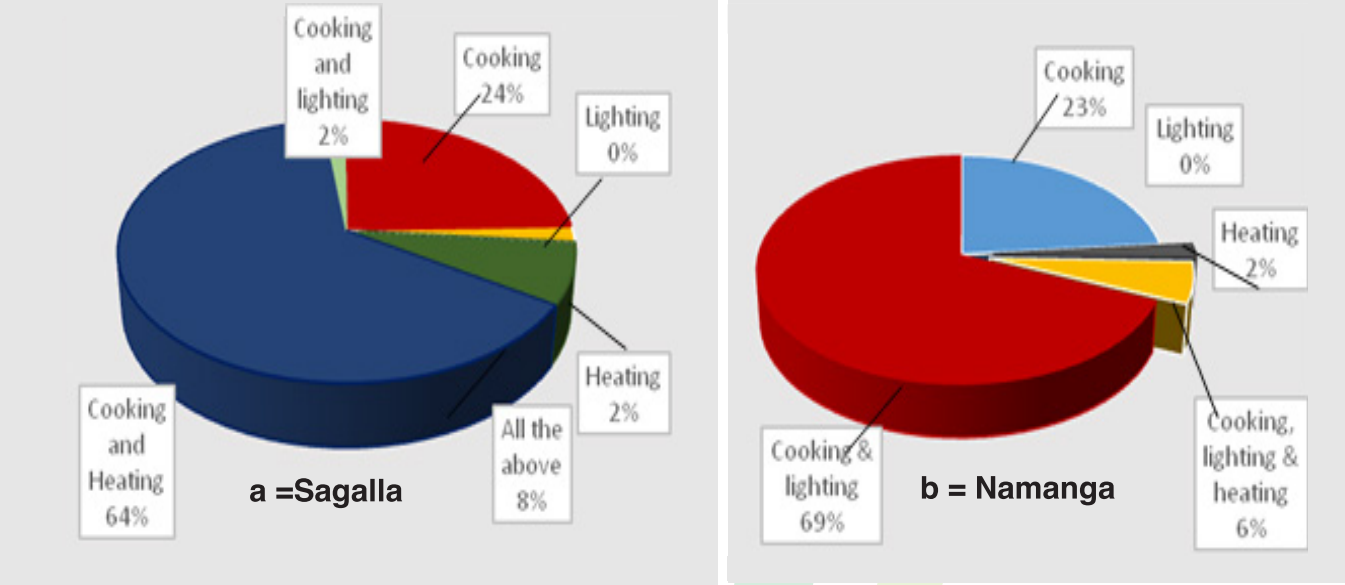


Figure 6: Distribution of households by the main uses of the stoves

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

The study found out that the majority of the households employed the stoves for cooking. From the study, 64% of the households in Sagalla used the stoves for both cooking and heating, while in Namanga 69% of households used the stove for cooking and lighting. In addition, the study revealed that no households used the stoves for lighting purposes only. Therefore, it can be concluded that most stoves are primarily used for cooking and heating while the other purposes are supplementary.

Table 4 below shows the Distribution of Households by Type of Fuel used

Table 4: Distribution of households by types of fuel

Firewood	38	73	39	76
Charcoal &firewood	8	15	10	20
Agricultural waste	0	0	0	0
Paraffin	0	0	0	0
Sawdust	0	0	0	0
Gas, charcoal & firewood	0	0	1	2
Electricity	0	0	0	0
Firewood & Others	0	0	1	2
Charcoal	3	6	0	0

Fuel types	N (Sagalla)	%	N (Namanga)	%
Firewood, charcoal & others	1	2	0	0
Charcoal & Paraffin	1	2	0	0
Agricultural waste, paraffin & gas	1	2	0	0
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The study found out that 73% and 76% of the households in Sagalla and Namanga respectively use firewood as cooking fuel. 6% of households in Sagalla used charcoal, while 15% used firewood and charcoal. The tabulated results revealed that 20% of households in Namanga used both firewood and charcoal as fuel. Following these results, it can be concluded that firewood is easily accessible for most of the surveyed households. There is need for inter-ministerial intervention, if Kenya is to achieve the clean cooking by 2028, according to the Energy Sector draft white paper (2021).

Figure 7 below shows the distribution of household by Sources of Firewood

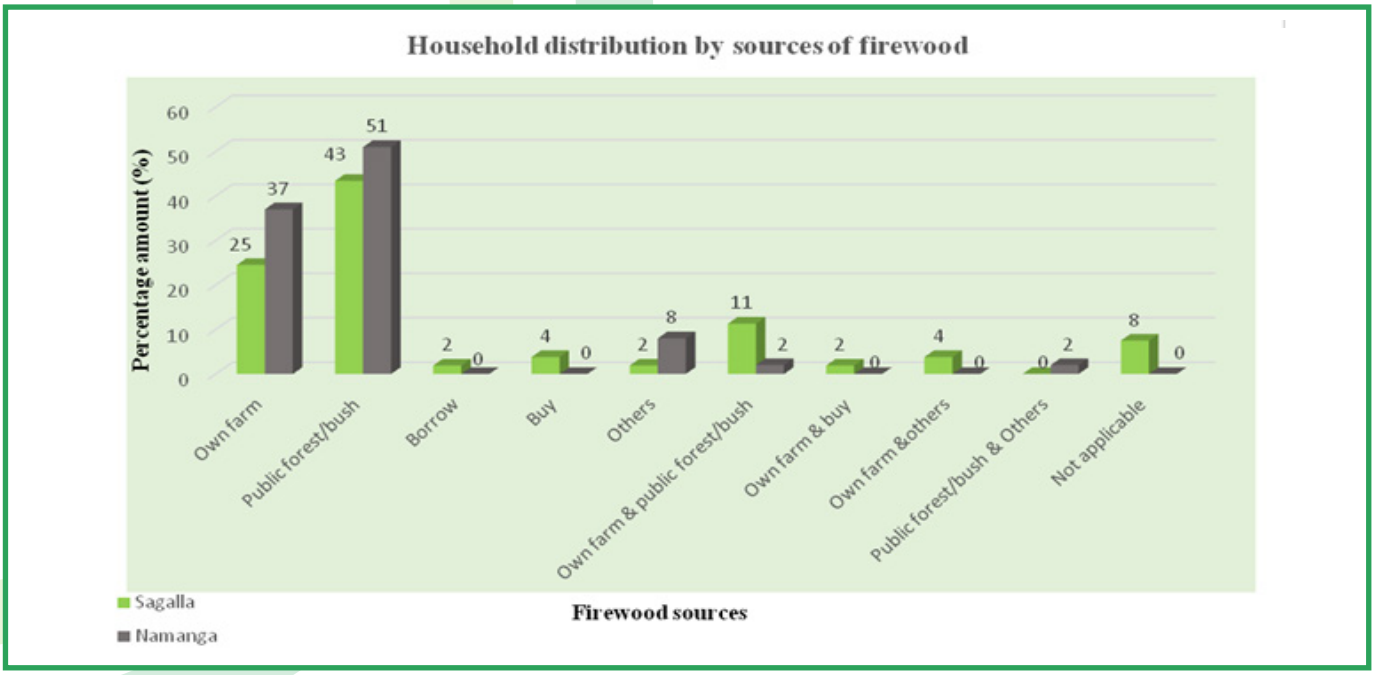
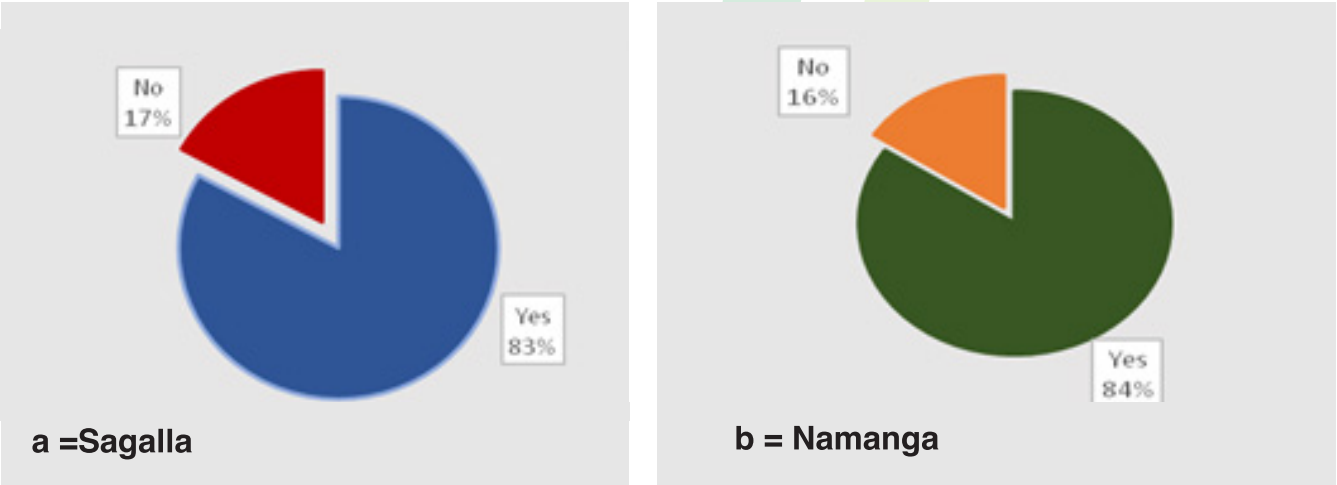


Figure 7: Distribution of households by the source(s) of firewood

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

In Sagalla, the study found out that 43% of the households collected firewood from public/communal land, 25% from own private farms, 11.3% from both own farm and public/ communal land and 3.8% bought firewood, whereas a small number (2%) of the households borrowed firewood. On the other hand, 8% of the households did not use firewood as a fuel hence their answers were not applicable. In Namanga, 51% of the households firewood was collected from public/communal land, 37% collected from own farms and 8% from other sources. These results imply that public/communal land are in danger of extinction if there is no regulation on firewood collection by the relevant authorities.

Figure 8 below shows the Distribution of Households by whether Respondents use Fuel Saving devices



Question: Do you use any fuel saving devices?

Figure 8: Distribution of households by whether respondents use fuel saving devices.

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga

The study showed that 83% and 84% of households respectively use energy saving devices in Sagalla and Namanga. These devices included flasks, hotpots, and covering food while cooking. This shows that the respondents were well informed on the use of energy saving devices.

Table 5 below shows the distribution of households by the types of fuel saving devices used

Table 5: Households' distribution by the type of fuel saving devices used

Types of fuel saving devices	N (Sagalla)	%	N (Namanga)	%
Fireless cooker	0	0	0	0
Thermos flask	2	5	3	7
Covering food while cooking	16	37	16	37
Others	1	2	0	0
Thermos flask &covering food	16	37	20	47
Thermos flask, covering food& others	5	12	3	7
Thermos flask & others	1	2	0	0
Covering food& others	2	5	0	0
Thermos flask, covering food &fireless cooker	0	0	1	2
Total	**43**	**100**	**43**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Covering Food When Cooking 1

It emerged that, covering food while cooking was a common practice in most households since it was one way of ensuring food cooks faster due to heat retention effect inside the cooking pot. Additionally, flasks were found to be a common household kitchenware as it was used to keep beverages warm, especially tea for long period. The communities were commended for use of energy saving devices.

Figure 9 below shows the distribution of Households by Respondents' Knowledge of Improved Stoves

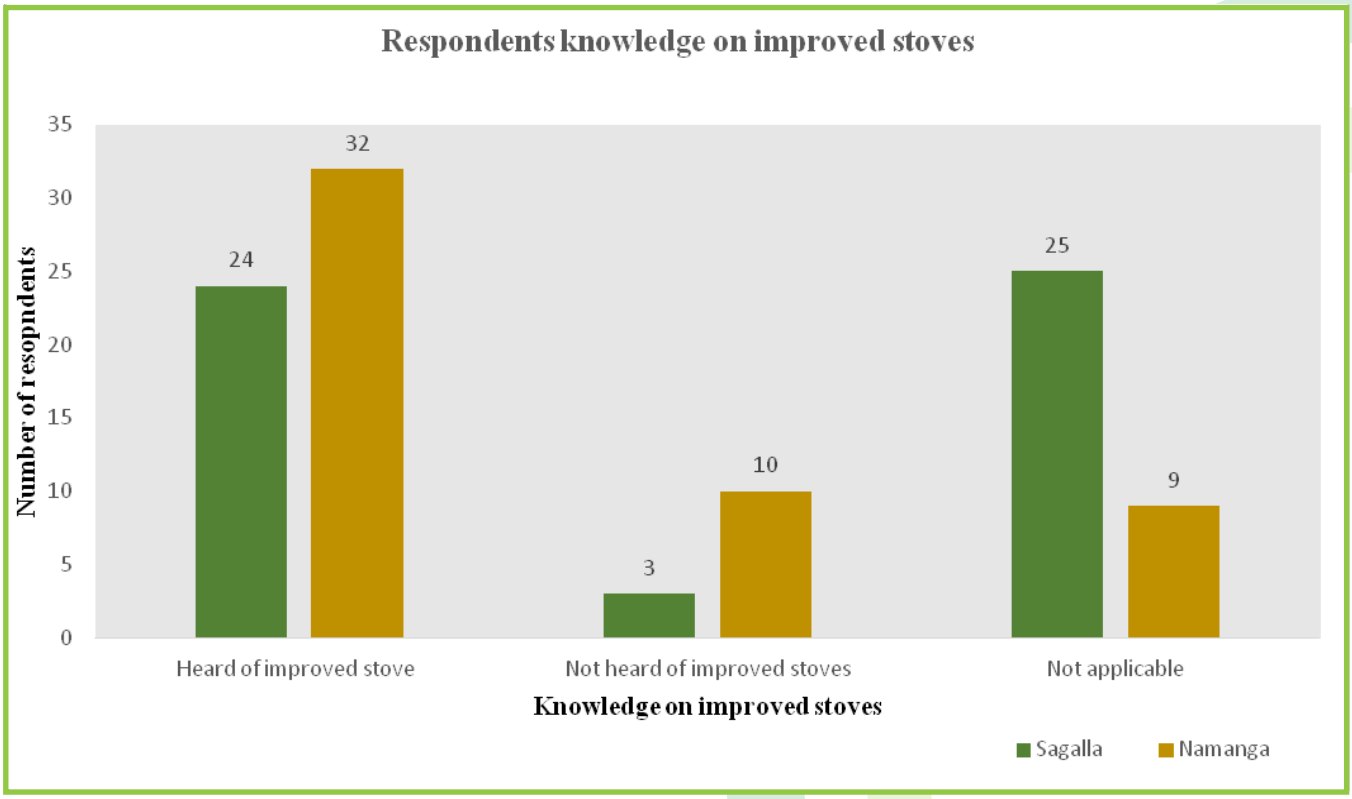


Figure 9: Distribution of households by respondents' knowledge of improved stoves

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

From the study, 24% of respondents in Sagalla had heard of improved stoves, 3% had not heard, and 25% did not respond, hence the results were captured as not applicable. On the other hand, studies from Namanga showed that 24% of the respondents had heard of improved stoves, 3% had not heard and 9% did not respond. This implied that of the households that did not use improved stoves, a higher percentage knew of the improved stoves and due to various reasons, they had not purchased the stove as captured in table 6 below.

Table 6 below shows distribution of Households not Owning Improved

Table 6: Reasons for not owning an improved stove

Reasons for not owning an improved stove	N (Sagalla)	%	N (Namanga)	%
Expensive	16	31	19	37
Can't find one to buy	6	12	3	6
Complex to use	1	2	1	2
Enough supply of firewood	0	0	1	2
Enough Supply of firewood & expensive	0	0	3	6
Others	1	2	3	6
Not applicable	28	54	20	39
Expensive &others	0	0	1	2
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

From the study, it emerged that 31% of respondents in Sagalla found the improved stoves to be expensive, 12% had no idea where to find and purchase an improved stove, while 1% did not own one since they believed it was complex to use. In Namanga, 37% of the households did not own an improved stove because the stove was expensive, 8% said that firewood was easily accessible and therefore, saw no need to purchase an improved stove which they also said was expensive. Intervention by the Ministry of Energy and other Partners is needed to increase the uptake of improved stoves by communities.

Figure 10 below shows distribution of households by the expected purpose(s) of the improved stove

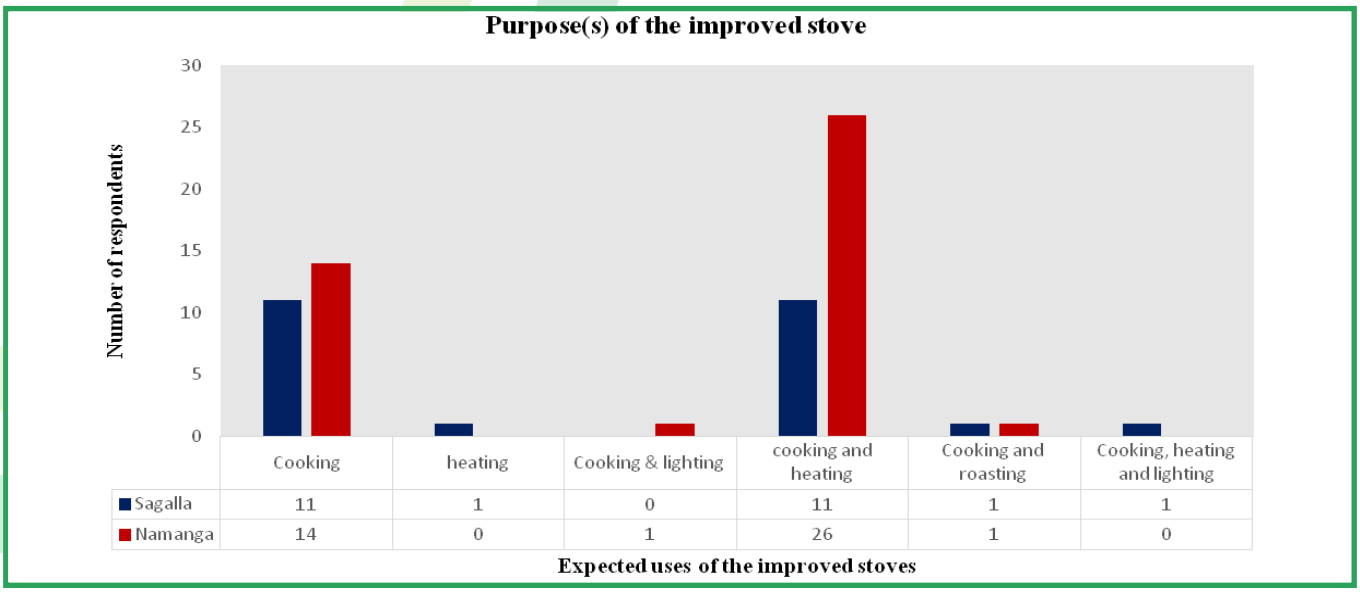


Figure 10: Distribution of households by the expected purpose(s) of the improved stove

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

Having established that approximately 48% and 18% of all the surveyed households in Sagalla and Namanga locations respectively did not have or own an improved stove, it emerged that all these households were willing to purchase an improved stove. Out of these respondents, 11 in Sagalla expected to use the stove for cooking purposes, while another 11 respondents planned to use the stove for cooking and heating purposes, 3 of the remaining respondents planned to use the stove for heating, cooking, roasting and lighting. The study in Namanga found out that 14 respondents anticipated using the improved stove for cooking, whereas another 26 respondents planned to employ the improved stove for the purposes of cooking and heating.

Figure 11 below shows residents' Response on whether to continue using their old stoves after acquiring an improved one

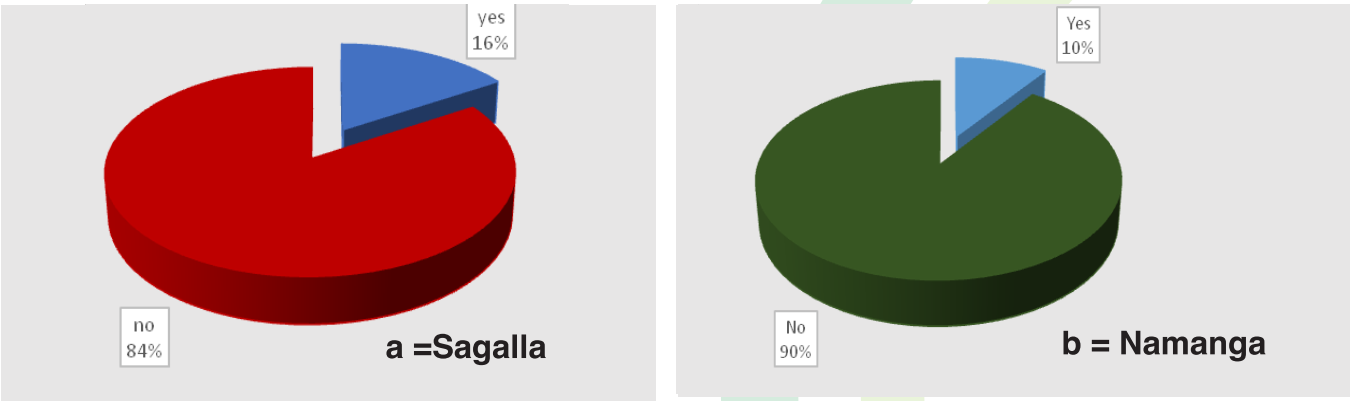


Figure 11: Distribution of households by whether they would continue using their old stoves after acquiring an improved stove.

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

From the survey, it emerged that a majority of households in both locations do not plan to continue using their old stoves once they acquired the improved stoves.

Figure 12 below shows response to whether there are foods the household cannot cook using the improved stoves

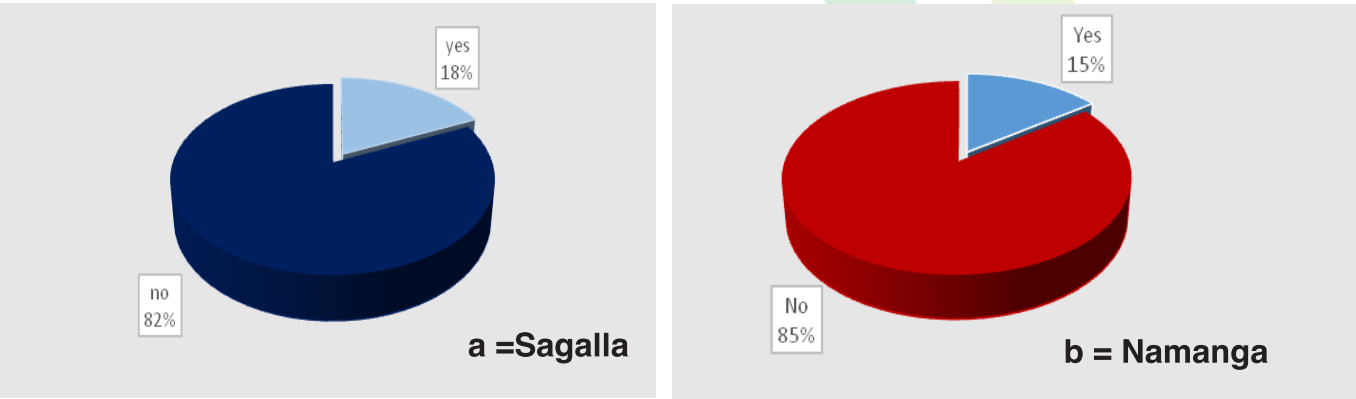


Figure 12: Distribution of households by whether there are foods the respondents cannot cook using the improved stove.

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

The above question and the next two follow up questions were asked to respondents who owned an improved stove(s). The results revealed that a higher percentage of the households use the improved stove to cook all foods (Figure 12). Foods like cereals and 'githeri', for instance, are known to take long to cook, therefore, having more than 80% of households using the improved stoves means that the stoves are efficient and affordable in terms of fuel consumption.

Figure 13 below shows the advantages of improved stoves

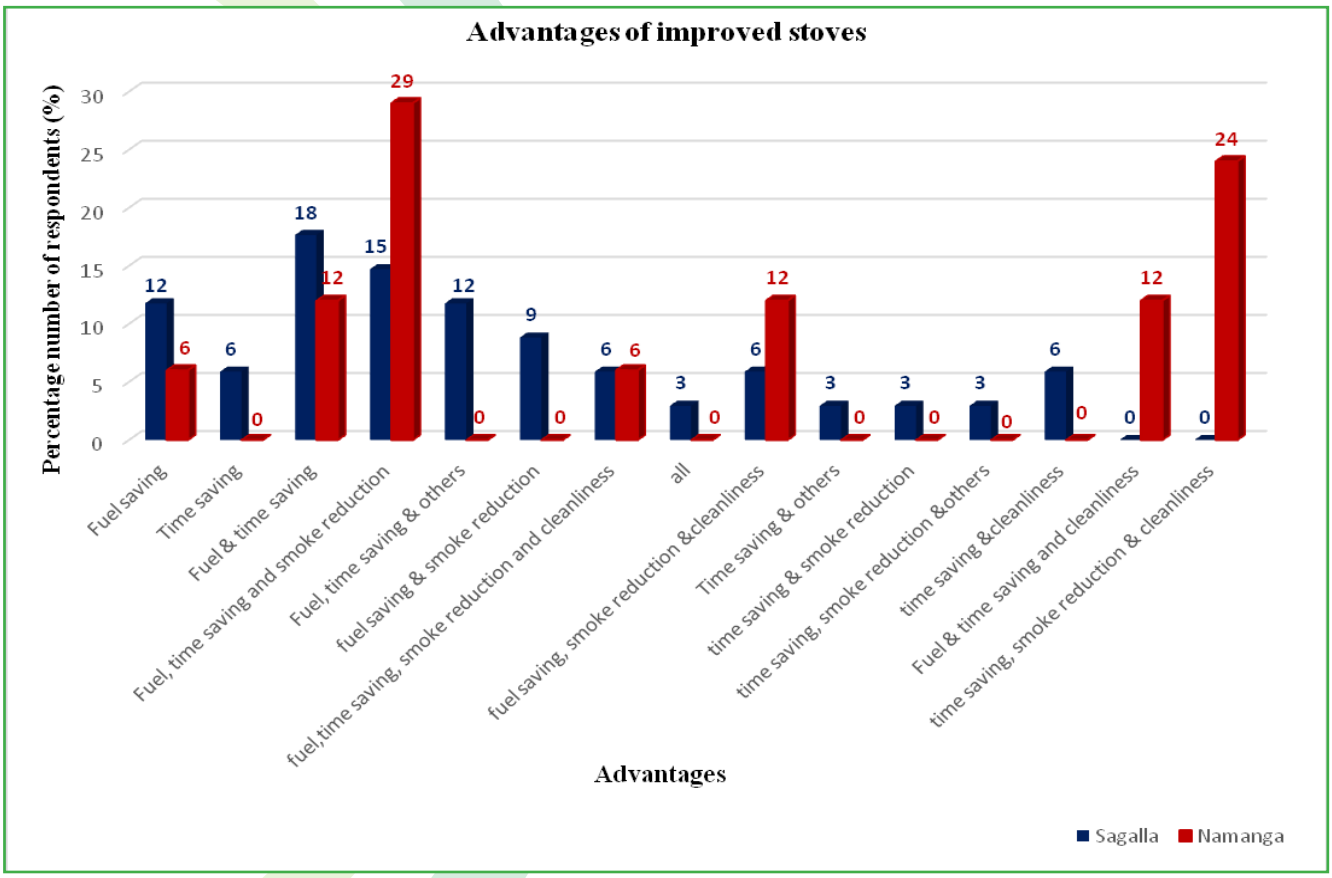


Figure 13: Distribution of households by the advantages of the improved stoves

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

On the question on advantages of the improved stove, the majority of respondents gave saving time, fuel and reduction of smoke as some of the advantages of using the improved stove. The results also revealed that high cost and frequent maintenance were some of the major disadvantages experienced below.

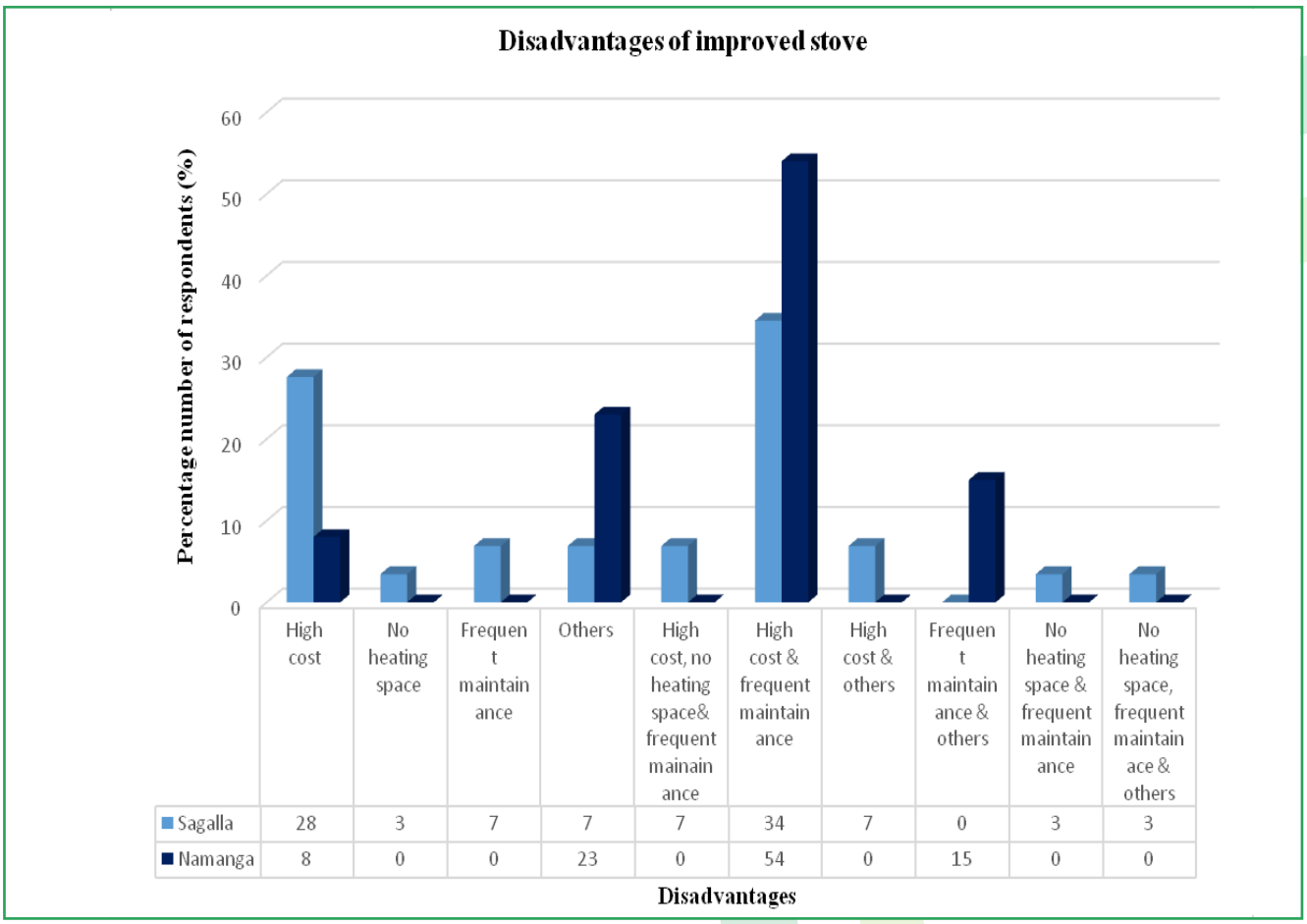


Figure 14: Distribution of households by the disadvantages of the improved stoves

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Table 7: Distribution of households by the time spent (in hours) collecting firewood

Time spent collecting firewood (Hours)	N (Sagalla)	%	N (Namanga)	%
Less than 1	5	10	1	2
1-5	38	73	49	96
6-10	2	4	1	2
NA	7	13	0	0
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

On the question on how much time was spent collecting firewood, it emerged that 72% of the households in Sagalla took between 1 to 5 hours, 96% of the households in Namanga used the same amount of time.

The time taken meant that the firewood was relatively difficult to access. Further probing revealed that the households found it difficult to collect firewood due to injuries from wild animals and thorny vegetation. Other challenges affecting acquisition of firewood as a fuel option was the depletion of forest cover rendering it unavailable thus costly. The households also complained that it was very time consuming and tedious to collect firewood.

Figure 15 below, shows the distribution of households by the general physical condition of the cook stove

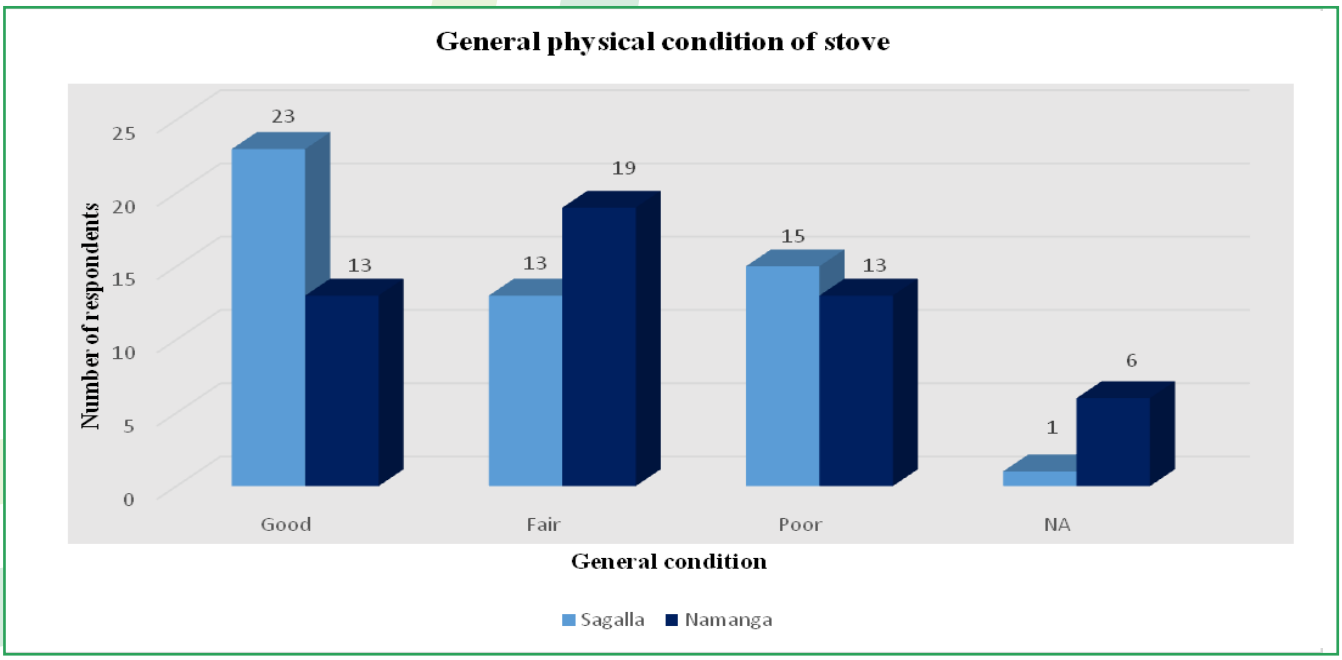


Figure 15: Distribution of households by the general physical condition of the cook stoves
Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The general condition of most of the cook stoves in Sagalla Location was good, while 13 and 15 households revealed that the stoves were in fair and poor conditions. These results revealed that most of the households in this location did a good job of maintaining their cook stoves. In contrast, 13 households in Namanga location revealed that their stoves were in poor condition, followed by 32 households who revealed that the stoves were in good and fair condition. 7 out of all the 103 households surveyed were no longer using their cook stoves for various reasons. 6 households in Namanga and 1 in Sagalla location did not respond.

Figure 16 below, shows the distribution of households by future plans for kitchen improvement

Do you plan to improve your kitchen in future?

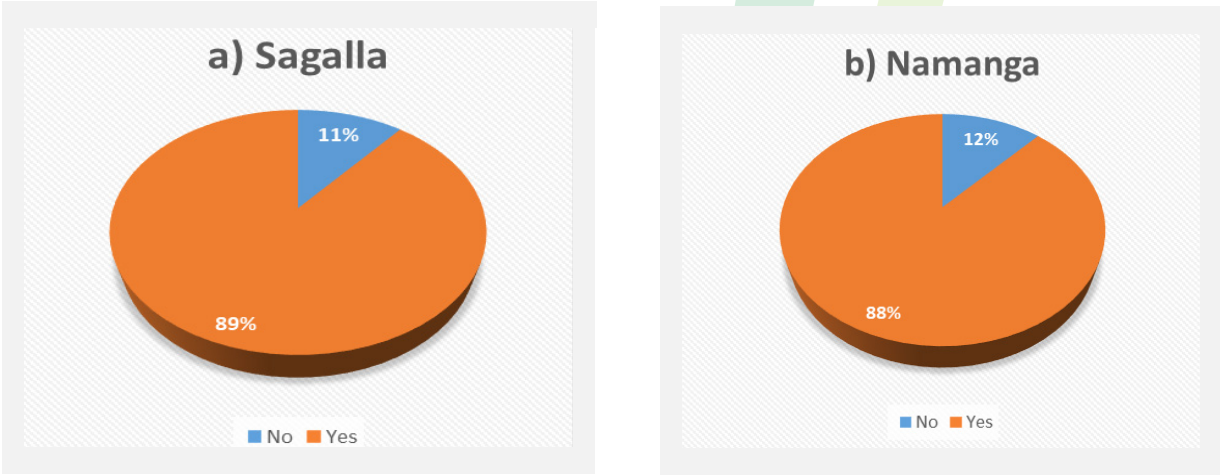


Figure 16: Distribution of households by future plans for kitchen improvement

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

It emerged from the study that 89% of the households in Sagalla have future plans to improve the kitchen area while another 88% of the households in Namanga share the same future plans. Most of the expected improvements, mentioned in both locations, involved purchasing an improved charcoal and/or firewood stove. Additionally, improvements such as building a

more permanent kitchen structure and purchase of other types of stoves for instance, gas stove emerged. This calls for an intervention from the Ministry of Energy, State Departments for Public Health and Housing to come up with a model kitchen that incorporates proper ventilation.

Table 8 below shows the distribution of households by the devices used for lighting

Table 8: Distribution of households by the devices used for lighting

Lighting Devices	N (Sagalla)	%	N (Namanga)	%
Hurricane Lamp	7	13	0	0
Tin Lamp	3	6	16	31
Candle	0	0	0	0
Solar lamp	28	54	8	16
Flash light & tin lamp	0	0	8	16
Other	1	2	0	0
Hurricane & tin Lamps	2	4	0	0
Tin & solar lamp	0	0	5	10
Tin & solar lamps and flash light	0	0	9	17
All	11	21	5	10
Total	**52**	**100**	**51**	**100**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

With regard to the lighting devices used in the households in Sagalla Location, solar lamps emerged the highest 54%. This means that most households were helping keep the environment clean by using solar lamps. Another 13% of the households use hurricane lamps and 6% used tin lamps. The study conducted in Namanga Location revealed a higher percentage 31% of the households use tin lamps for lighting, while 16% used only solar lamps. This means that most households are helping to keep the environment clean and are commended for adopting the use of clean energy. Private sector is also commended for promoting the use of clean energy technologies.

3.6. Real-Time Indoor Air Emissions and Kitchen Performance Test

In this study, Thirty households with fuel-stove combinations covering a variety of fuels including wood, kerosene and charcoal, and different stove types were investigated for indoor air quality (such as; carbon monoxide (CO), particulate matter ($PM_{2.5}$) and carbon dioxide (CO_2) emissions). Out of the thirty eligible households sampled, Twelve were in Namanga location while Eighteen were in Sagalla location. Each household had an average of 5 and 8 persons in Sagalla and Namanga respectively.

3.6.1. Real-Time Indoor Air Emissions

This study set out to investigate the levels of CO, PM2.5 and CO2 emissions from cooking and heating stoves, as well as comparing them to the WHO and EU Guidelines for indoor air quality.

Figure 17 below shows the distribution of households fuel source by mean concentration of CO (ppm) over 24 hours average time in Namanga location.

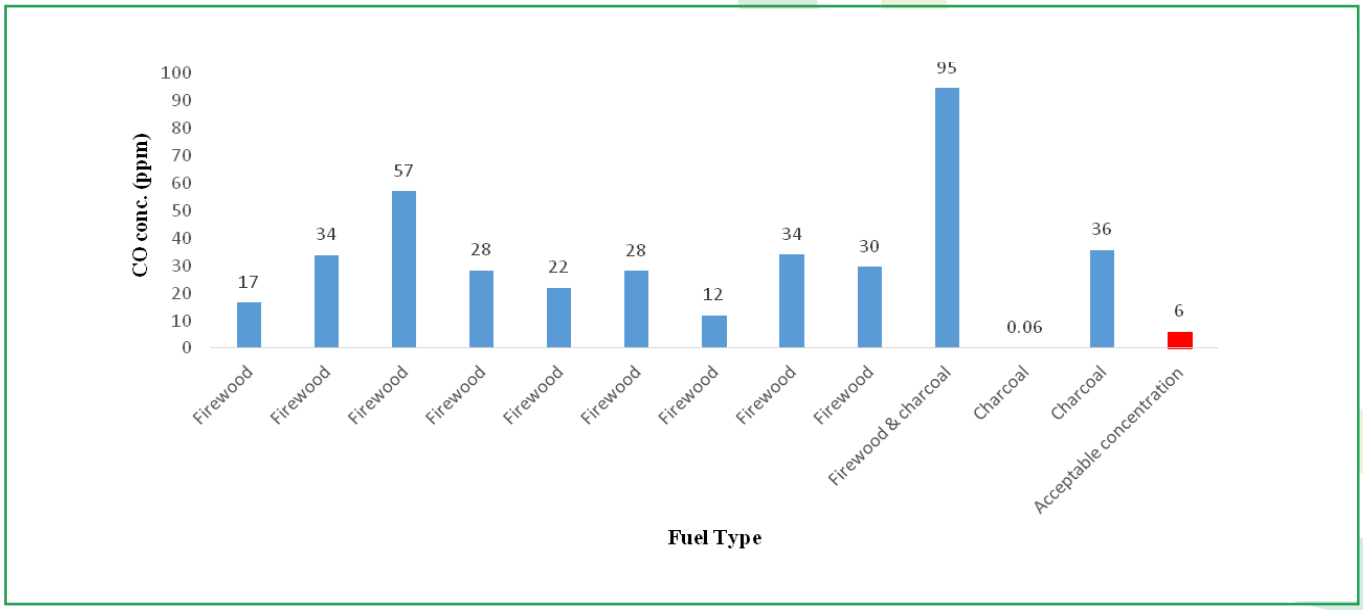


Figure 17: Distribution of households fuel source by mean concentration of CO (ppm) over 24 hours average time in Namanga location

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga Locations

From the figure above, the main sources of CO were firewood and charcoal, and this could have been as a result of poor ventilation in the household. All the 9 households that measured CO ranged from 12-57 ppm this is above the acceptable concentration of 6 ppm.

Figure 18 below shows the distribution of household fuel source by mean concentration of CO (ppm) over 24 hours average time in Sagalla location

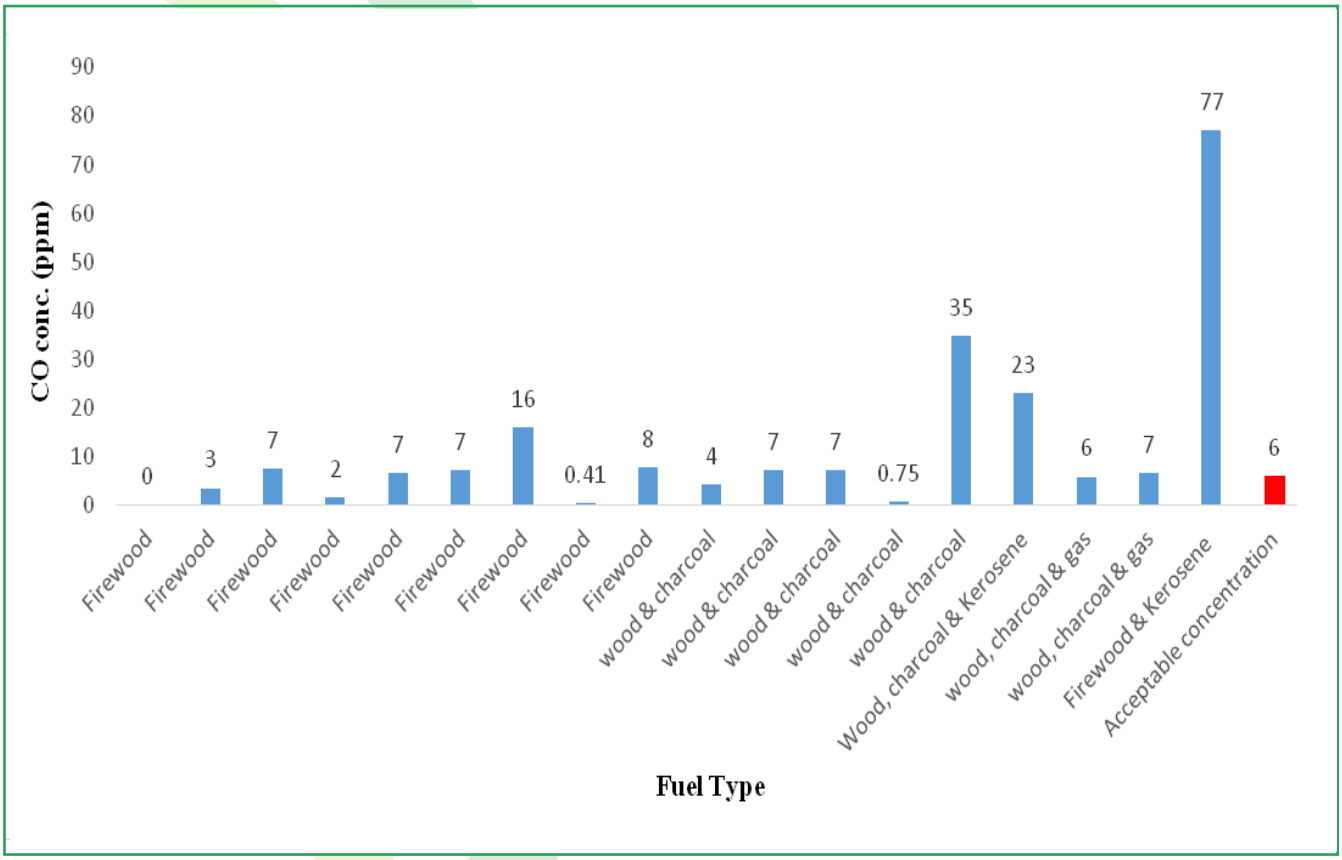


Figure 18: Distribution of household fuel source by mean concentration of CO (ppm) over 24 hours average time in Sagalla location

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

From the results, it can be observed that the average concentration of CO obtained over a period of 24 hours revealed a higher concentration of carbon monoxide (95ppm) from households that used both firewood and charcoal stoves in Namanga (Figure 17), while a similar study revealed a higher concentration of CO (77ppm) for households that use both firewood and kerosene stoves in Sagalla (Figure 18). CO is produced by incomplete burning of carbon containing fuels and is highly toxic. These concentrations reveal that the fuel(s) used in these households produce higher concentrations of CO than the acceptable limit (< 6ppm) according to WHO guidelines for CO exposure are presented in Table 9 below.

Table 9: Maximum permissible CO levels

Exposure time	Concentration
15 minutes	90 ppm
30 minutes	50 ppm
1 hour	25 ppm
8 hours	10 ppm
24 hours	< 6 ppm

Source: WHO Guidelines on CO exposure

It was observed that 61% and 92% of evaluated households in Sagalla and Namanga locations had CO concentration above the acceptable 6ppm respectively. The high concentration of CO in Namanga can be attributed to low ventilated houses prevalent in this area (Manyatta). The level of CO is so high it implies negligence on the part of the concerned authorities. This calls for an urgent intervention by Ministries of Health and Energy and State Department of Public Health.

Low ventilation Maasai house (Manyatta)

Figure 19 below shows the distribution of household fuel source by mean concentration of CO_2 (ppm) over 24 hours average time in Sagalla location.

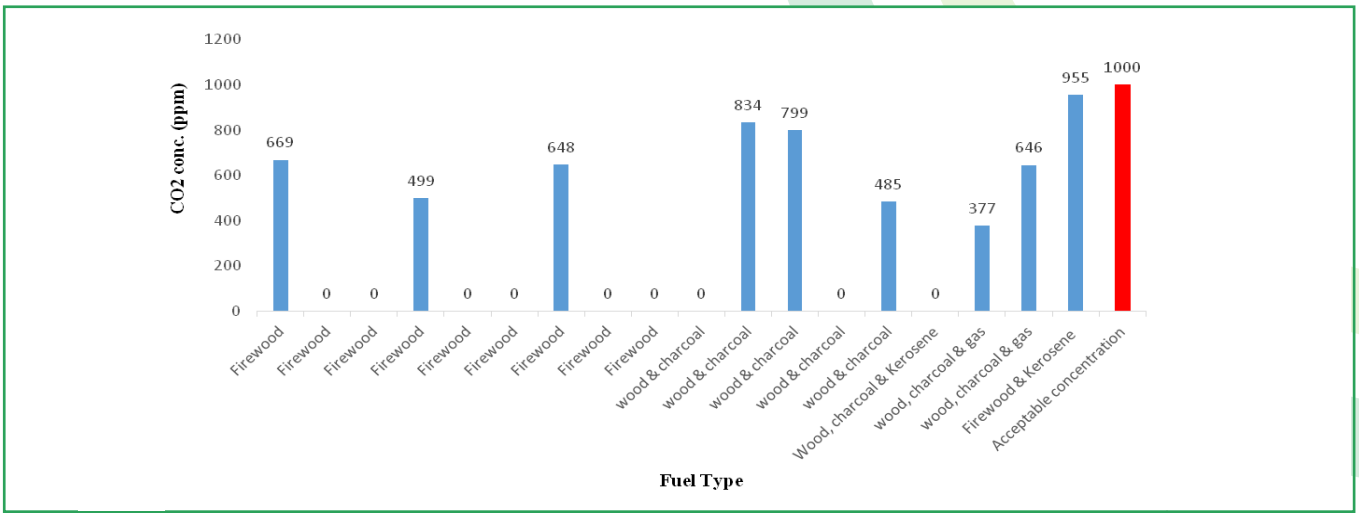


Figure 19: Distribution of household fuel source by mean concentration of CO_2 (ppm) over 24 hours average time in Sagalla location.

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Figure 20 belows shows the distribution of households fuel source by mean concentration of CO2 (ppm) over 24 hours average time in Namanga location.

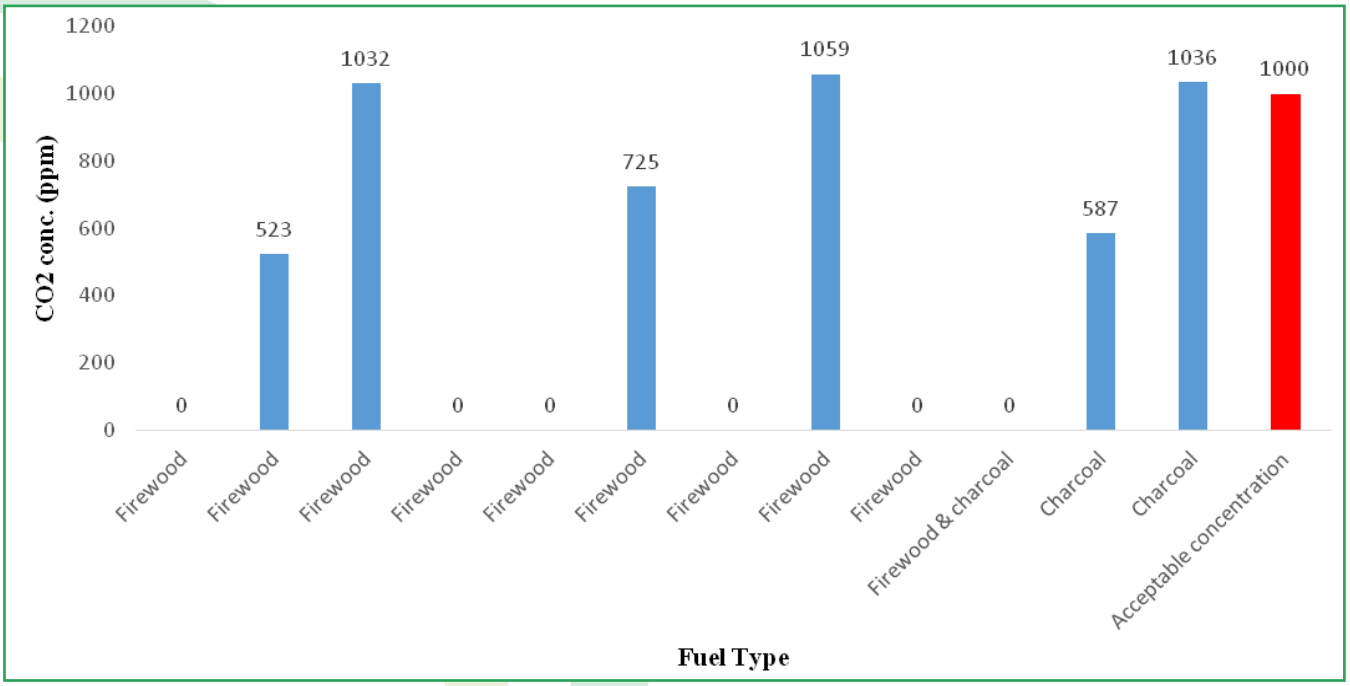


Figure 20: Distribution of household's fuel source by mean concentration of CO_2 (ppm) over 24 hours average time in Namanga location

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga Locations

The WHO guidelines for CO_2 is less than 1000 ppm, while the guideline for $PM_{2.5}$ stipulates that it should not exceed 25 µg/m^3 24- hour mean.

The results revealed a relatively high amount of CO_2 produced after combustion of the fuels. A mean CO_2 concentration of 1113 ppm was the highest amount recorded in Namanga while 955ppm was recorded in Sagalla (Figure 19 and Figure 20). These concentrations are relatively safe since the maximum indoors CO_2 level considered acceptable is below1000ppm. Concentrations typical of occupied indoor spaces with good air exchange are in the range of 400-1000 ppm. The range of 1000-2000 ppm results in drowsiness and poor air quality. It emerged from the study that values equal to or less than300ppm were recorded as 0ppm. The baseline CO_2 concentration was taken to be 300ppm for this study. It was observed that all the houses evaluated in Sagalla location were within the acceptable level of CO_2 concentration, while 75% of the evaluated houses in Namanga were within the acceptable level of CO_2, which can be attributed to better ventilation in Sagalla as compared to Manyattas in Namanga.

Figure 21 shows the distribution of household fuel source by mean concentrations of PM 2.5 (µg/m3) over 24 hours average time in Sagalla location

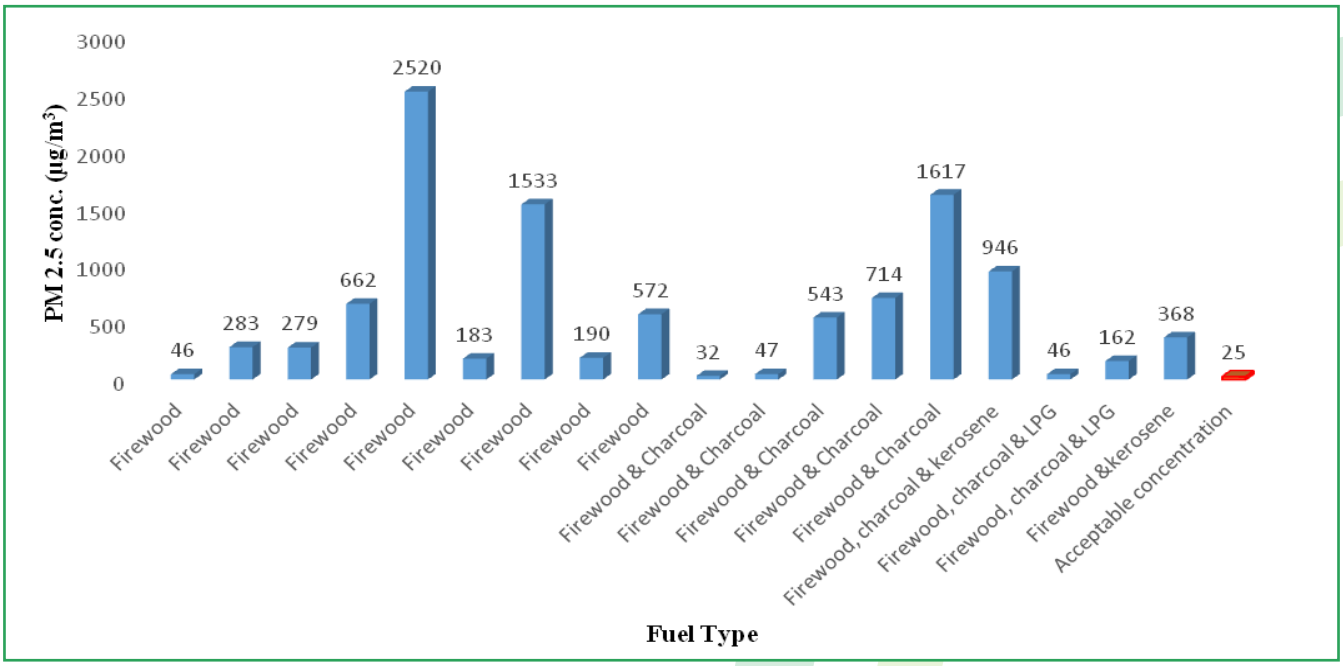


Figure 21: Distribution of household fuel source by mean concentrations of PM 2.5 (µg/m3) over 24 hours (average time) in Sagalla location

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Figure 22 shows the distribution of household fuel source by mean concentrations of PM 2.5 (µg/m3) over 24 hours (average time) in Namanga location

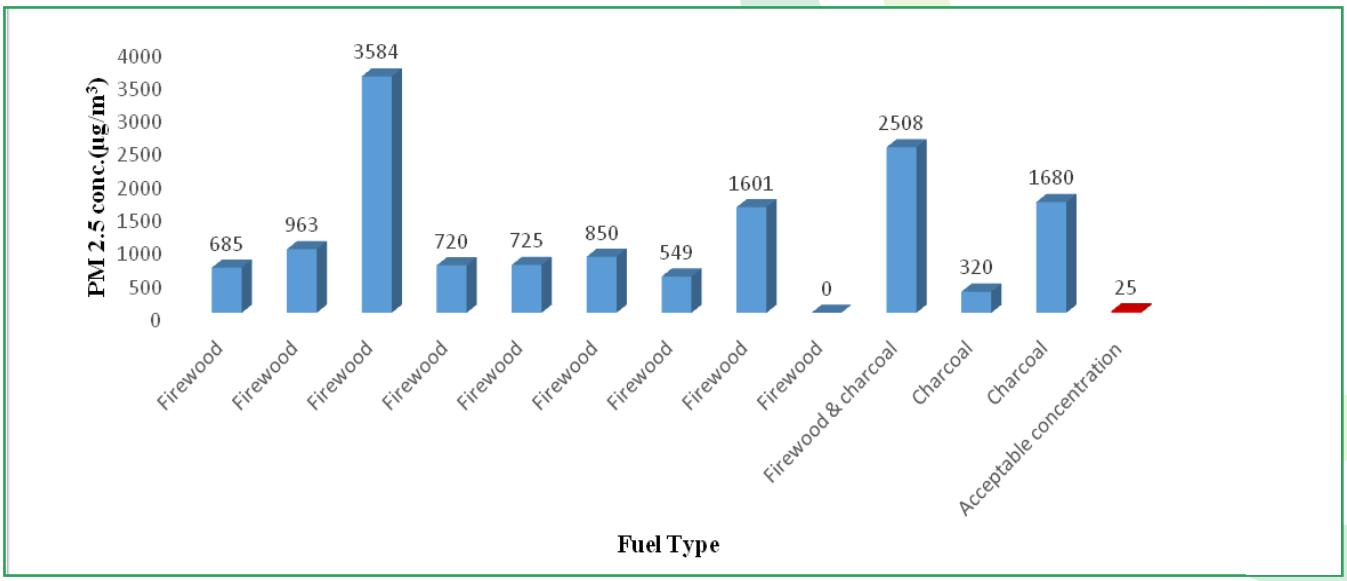


Figure 22: Distribution of household fuel source by mean concentrations of PM 2.5 (µg/m3) over 24 hours (average time) in Namanga location

Source: Ministry of Energy Survey Data 2019, Sagalla & Namanga locations

$PM_{2.5}$ is the sum of solid and liquid particles suspended in air many of which are hazardous. Figures 21 and 22 reveal a mean of at least 100 µg/m^3 for most of the cook stove(s) employed in the sampled households. This value (100 µg/m^3) is five folds more than the stipulated maximum permissible 20 µg/m^3. Therefore, we can conclude that the household members are exposed to very high concentrations of $PM_{2.5}$ posing a big health risk. This results collaborates with earlier findings on health outcomes;- coughing, eye and ear discharge.

It was observed that most of the houses evaluated in both locations have poor ventilations, and use of inefficient cook-stoves. This calls for urgent interventions such as use of improved cook-stoves, improved ventilation by installation of chimneys and awareness creation of the dangers of the emissions from stoves and fuels.

3.7. Kitchen Performance Test

In this section the usage of stove and the fuel consumption are discussed

Measuring firewood to be used over a 24hours period

The distribution of Households by the type of primary stove(s) is shown in table 10. The majority of HH in Namanga (9/12) use 3-stone fire and Maendeleo stove 3/12 as their primary stove.The primary stove used by households in Sagalla are RMS which had the highest penetration rate at 7/18, followed by KCJ at 3/18.and KCJ and 3-stone were chosen as the primary stoves In two households.

Table 10 below shows the distribution of households by the type of primary stove used

Table 10: Distribution of Households by the type of primary stove(s)

Primary stove type	Sagalla	Namanga
3-stone	6	9
KCJ, 3-stone	2	0
KCJ	3	0
RMS	7	0
Maendeleo portable	0	3
Total	**18**	**12**

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The average moisture content of firewood used was 13.19% for Sagalla and 13.55% for Namanga.

Table 11 below gives the distribution of household by the number of people cooked for in 24 hrs and the amount of fuel used to cook in 24 hours. Nearly the same number of people and amounts of fuels were used in the 24 hours in the locations.

Table 11: Distribution of household by the number of people cooked for in 24 hrs and amount of fuel used to cook in 24 hours.

Location	Sagalla	Namanga
No of people cooked for	100	104
Amount of firwood used in 24 hours (Kgs)	79	65
Amount of charcoal used (Kgs)	9	9.5

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

Table 12 below shows the distribution of households by primary stove and average firewood consumption per persons cooked for

Table 12: Distribution of households by primary stove and average firewood consumption per persons cooked for,

Primary Stove	Average firewood consumption Per Capita (Kg/Person)	
	Sagalla	Namanga –
Three-Stone	0.76	1.05
Maedeleo Portable	1.2	None
RMS	None	1.01

Source: Ministry of Energy Baseline Survey Data 2019, Sagalla & Namanga locations

The results of KPT showed that in Namanga, the average fuel consumed in kilograms per day was calculated to be 8.2kg for wood while in Sagalla it was 4.38kg for wood, and 0.59kg for charcoal.

The fuel types used in these households were labelled as follows: firewood (A), charcoal (B), kerosene (C), and LPG gas (D).

CHAPTER FOUR

CONCLUSION AND RECOMMENDATIONS

4.1. CONCLUSIONS

i. Respondents' General Information

- The survey was designed and administered only to households using firewood, charcoal, kerosene and/or agricultural waste as fuel. A total of 52 and 51 households participated in the survey in Sagalla and Namanga respectively
- The survey results indicated that on average household members from both locations were six, which is not comparable to the national figures of the 2019 census results.

ii. Households Health

- It emerged that in the study area, coughing and eye discharge ailments experienced by women and children were attributed to high levels of indoor air pollution and smoke.

iii. Energy: Cook-stoves and Fuel use

- Most of the respondents were aware of the traditional three stones-stoves, which has been in use since time immemorial. The Maendeleo stove was relatively known, followed by the RMS-1 pot and RMS-2 pot. It was observed that the most known stove 3-stones stoves had the highest use percentage which was affordable to set up.
- Majority of the households from both locations used firewood as the main source of fuel for cooking and heating.

4.2. RECOMMENDATIONS

i. The Ministry of Energy, State Departments for Public Health and Housing are called upon to educate communities on how to improve ventilation in houses, build model kitchen and encourage use dry firewood.

ii. Inter-Ministerial Agencies to raise awareness and educate communities on the adverse effects of pollutants (CO, CO_2 and smoke) in households.

iii. The Ministry of Energy, Inter-Ministerial Agencies and Partners to do further research to find out the reason for low uptake of improved stoves despite the many interventions in place.

iv. The Ministries of Agriculture, Environment and other related Agencies to come up with regulations on firewood management.

APPENDICES

5.1. PARTNERS

5.1.1 University of Nairobi

UNIVERSITY OF NAIROBI

5..1.2 Ministry of Energy

MINISTRY OF ENERGY

5.2. GENERAL QUESTIONNAIRE

MINISTRY OF ENERGY
HOUSEHOLD QUESTIONNAIRE ON ENERGY, HEALTH AND BEHAVIOUR STUDY

Introduction

My name is _____sent by ministry of energy-Nairobi. We are carrying out a study in this area on types of fuels used, cooking devices (majikos) and lighting devices, type of concerns (environmental and health) arising from continued use of these fuels and devices. You have been selected randomly to participate in the study. All the information given will be treated with confidentiality and be used for the purposes of the study only. Do you wish to participate in the study?

Yes

No

Thank you very much!

Note to interviewer:

This questionnaire MUST be administered ONLY to households meeting the following criteria.

- Have at least one child below 5 years of age.
- Must be using firewood, charcoal, kerosene, or agricultural waste
- The respondent must be the person who cooks the meals for the family

Respondent must be the person who cooks the meals for the family

Enrolment information

	Question	Data
1	Serial no	
2	Date	
3	Name of respondent	
6	Interviewers name	
7	House number	
8	Location	

	Question	Data
9	Sub location	
10	Village	
11	Beginning time	
12	End time	

PART 1: SOCIOLOGY-DEMOGRAPHIC INFORMATION

The respondent for this part should be the woman whose details were entered in the enrolment table above

	Question	Data
1	What is your age (in years)?	
2	How many people regularly live the household? (Specify numbers) (Define household to include all the people who take meals regularly from the same pot) 1 = under 5 yrs: 2= over 5 yrs	

PART 2: HOUSEHOLD HEALTH

This part seeks information regarding the health of the last child aged under five years and the mother. This should be the woman who answered questions in part 1

Section A: Children health (under five years)

	Question	Data
1	Age of child in months	
2	**Cough:** **A:** During the last month, did the last child aged under fives years suffer from cough? (Yes =1: No = 2)	
3	**Difficulties in breathing** During the last month, did the child suffer from difficulty in breathing? Yes = 1: No = 2	

	Question	Data
4	**Eyes problem:** Do the Child's eyes ever *sting or water? Yes =1: No =2	
5	**Ears** During the last month, did the child discharge pus from any of the ears? Yes =1: No =2	
6	**Headache:** Does the child ever complain of headache? Yes =1: No =2	
7	**Burns:** Has the child ever been burnt with a hot object or liquid in the house? Yes = 1: No = 2	
8	**Exposure to smoke:** When you are cooking, where is the child usually? Inside the kitchen = 1: outside the kitchen = 2	
	Do you think that the smoke from your stove affects your child in any way? Yes = 1: no = 2	

Section 2: Women health

This will be the same woman who has answered the questions about the child in section 1 above

	Question	Data
1	**Cough:** Do you usually cough first thing in the coldest/wettest season? Yes =1: No = 2	
2	**Eyes** Do you experience any of the following eye problems? For all items, code as follows: never/occasionally =1: sometimes =2: much of the time = 3: almost all of the time = 4	

PART 3: ENERGY (STOVE AND FUEL USE INFORMATION)

The respondent here is the same mother who was interviewed in part 1 and 2. However, questions 26-34 should be asked to mothers who are not using improved stoves. Questions 35-55 are for those mothers using improved stoves. Questions 56- 60 are for mothers using any type of stove

	Question	Data
1	Which cook stoves are you aware of? 1= 3-stone: 2= RMS-1 pot: 3= RMS-2 pot: 3= Maendeleo (accept multiple responses) 4= Other (specify)	
2	Which cook stoves do you MOST often use? 1= 3-stone: 2= RMS-1 pot: 3=RMS-2 pot: 4= Maendeleo (don't allow multiple response)	
3	For what purposes do you use it? 1= cooking: 2=lighting: 3= heating: 4=all the above three (multiple responses accepted)	
4	What fuels do you mainly use to cook? 1= firewood: 2=charcoal: 3= agriculture waste (specify ----------): 4=paraffin: 5= saw dust: 6= gas: 7=electricity: 8= others (specify----------)	
5	If firewood, what is the source? 1= own farm: 2= public forest/bush: 3= borrow: 4= buy: 5= others (specify.....)	
6	Do you use any other fuel saving devices? 1= yes: 2= no	
7	If yes, which type? 1= fire-less cooker: 2= thermos flask: 3= covering food while cooking: 4= others specify.....	
	Questions 8-16 should only be answered by those not using improved stoves	
8	Have you ever heard of an improved cook stove? 1=yes: 2= no	
9	If yes, why haven't you acquired one? 1=expensive: 2= can't find one to buy: 3= does not know how to install one: 4= there is enough firewood: 5= does not know how to install one, 6= others specify.....	
10	Would you be willing to purchase an improved stove? 1= yes: 2= no	
11	For what purpose(s) do you use the stove? 1= cooking, 2= heating: 3= lighting: 4= roasting: 5= all	

	Question	Data
12	If you bought (or was given) the improved stove, would you continue to use the traditional stove? 1= yes: 2=no	
13	If yes, give reasons	
	Questions 14-16 should only be answered by those using improved stoves.	
14	Are there foods you cannot cook with the improved stove? 1= yes: 2= no	
15	What are the advantages of using an improved stove?1= fuel saving: 2= time saving: 3= reduced smoke: 4= saves times: 5= cleanliness: 6= others specify	
16	What are the disadvantages of using an improved stove? 1= high cost: 2=no space for heating: 3=frequent maintenance: 4=others specify	
	Questions 17-20 to be answered by all type stove users	
17	How much time is spent in collecting firewood (in hrs)?	
18	What challenges do you experience while collecting firewood? (list them down as they are mentioned by respondent)	
19	What is the general physical condition of the stove/firewood (observe)? 1= good: 2= fair: 3= poor	
20	Do you have plans to improve your kitchen in future? 1= yes: 2 = no If yes, please describe your plans for improvement	
	Lighting Devices	
21	What devices do you use for lighting? 1= Hurricane lamp: 2= Tin lamp: 3= Candle 4= Solar lamps 5= Flash light 6= other specify _____	

5.3. MOE 2019 – KITCHEN PERFORMANCE TEST - HOUSEHOLD QUESTIONNAIRE

1. Project: MOE Sagalla / Namanga Emissions Study - *Household Stoves KPTs*	2.Project Location (write): _____	Primary cooking Stove Type ----------
4.Date of Purchase:	5.Surveyor:	
6.HouseholdID:	7.Name(MainCook):	8.Date of Survey (day/month/ year):
9.Province:	10.County:	11.Town/Village:
12.Household Address (GPS coordinates):		
13.Participant Phone number:		14.How many people eat in this Household normally per day?
15.What is the number of children of age 14 or less?		
16.What is the number of females of age 15 and above?		
17.What is the number of men age between15-59 years?		
18.What is the number of men above 59 years?		
19.a) Do you cook food for sale? i)YES; ii)NO (*circle the answer given)* 19 b) If YES, for how many do you normally cook food to sell per day?		
20.How much fuel do you typically purchase / collect in a day?		

Types of fuel	Quantity / volume in local units (e.g. Kgs, liters, headload, etc)	Cost of the fuel in (??)
a) Firewood		
b) Charcoal		
c) Kerosene		
d) LPG (gas)		

21. StoveType	a)Number Of Stoves	b) No of days stove used per week	c) Condition of stove*(tick as appropriate)*			
			i)very good	ii)good	iii) bad	iii) verybad
A. Firewood						
B. Charcoal						
C. Kerosene						
D. LPG(gas)						

22.What type of cooking does your household perform?*(circle the answer given)*	1.Domestic 2.Commercial 3.Both Domestic & Commercial 4.Institutional *(specify):*

Visit#1	23.Date (day/month/year):	24.Time (hh:mm):
25.New CharcoalTotal (kg):		26.New Wood Total (kg):
27.New LPG Total (kg):		28.New Kerosene Total (kg):

29. Wood Moisture Sample 1:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
30. Wood Moisture Sample 2	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
31. Wood Moisture Sample 3:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:

Visit#2(~24 hours later)	32.Date(day/month/year):	33.Time(hh:mm):
34.Unused Charcoal Total(kg):	35.Unused Wood Total(kg):	
36.Unused LPG Total(kg):	37.Unused Kerosene Total (kg):	
38.New Charcoal Total(kg):	39.New Wood Total (kg):	
40.New LPG Total(kg):	41.NewKeroseneTotal (kg):	

42. Wood Moisture Sample 1:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
43. Wood Moisture Sample 2:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
44. Wood Moisture Sample 3:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:

45.Breakfast	(a)No. of people cooked for:_____(b)Childrenage-d14yearsorless? -------- (c)Females aged 15 and above? -------- (d)Men aged between15-59 years? ---------- (e)Men above 59 years? ----------	(f)Food(s):(write the appropriate codes)
	Type &No of stove (s) used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s) used:
46. Lunch	(a)No.of people cooked for:---------- (b)Children aged14yearsorless? ---------- (c)Females aged15 and above? -------- (d)Men aged between15-59years? ---------- (e)Men above 59years?----------	(f) Food(s): (write the appropriate codes)
	Type&No of stove(s) used: (g)Type of stove:---------- (h) No of stoves ----------	(i)Type of fuel(s) used:

47.Dinner	(a)No.o fpeople cooked for:_____ (b)Childrenaged14years or less? -------- (c)Females aged15 and above? -------- (d)Men aged between 15-59 years? ---------- (e)Men above 59years? ----------	(f)Food(s): (write the appropriate codes)
	Type & No of stove(s) used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s) used:

48. Tea/coffee/ other	(a)No.of people cooked for:_____ (b) Children aged 14yearsorless? --------	(f)Food(s):(writethe appropriate-codes)
	© Females aged 15 and above? -------- (d) Menaged btween15-59years? --------- € Men above 59years? --	
	Type&No of stove(s) used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
49.Other fuel usage/Notes:		

Visit#3(~24 hours later)	50. Date (day/month/year):		51.Time(hh:mm):
52.Unused Charcoal Total(kg):		53.Unused Wood Total (kg):	
54.Unused LPG Total(kg):		55.Unused Kerosene Total(kg):	
56.NewCharcoalTotal(kg):		57.New Wood Total(kg):	
58.NewLPGTotal(kg):		59.New Kerosene Total(kg):	
60. Wood MoistureSample1:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
61. Wood Moisture Sample 2:	(a)Reading #1:	(b)Reading #2:	(c)Reading #3:
62. Wood Moisture Sample 3:	(a)Reading #1:	(b)Reading#2:	(c)Reading #3:

63. Breakfast	(a)No.of people cooked for:_____ (b)Childrenaged14yearsorless? -------- (c)Female-saged15 and above? -------- (d)Menagedbetween15-59years? ---------- (e)Menabove59years? ----------		(f)Food(s): (write the appropriate codes)
	Type&No ofstove(s)used: (g) Type of sto ve:---------- (h)No of stoves ----------	(i)Type of fuel(s) used:	

64. Lunch		(a)No.ofpeoplecookedfor:_____ (b)Childrenaged14yearsorless? -------- (c)Femalesaged15 and above? -------- (d)Menagedbetween15-59years? ---------- (e)Menabove59years? ----------	(f)Food(s):(write the appropriate codes)
	Type&No of stove(s) used: (g)Type of sto ve:---------- (h)No of stoves ---------- ----------	(i)Type of fuel(s)used:	

65.Dinner	(a)No.ofpeoplecookedfor:_____	(f)Food(s):(writethe appropriatecodes)
	(b)Childrenaged14yearsorless? -------- (c)Femalesaged15 and above? -------- (d)Menagedbetween15-59years?---------- (e) Menabove59years? ----------	
	Type&No ofstove(s)used: (g) Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
66. **Tea/coffee/other**	(a)No.ofpeoplecookedfor:_____ (b)Childrenaged14yearsorless? -------- (c) Femalesaged15 and above? -------- (d)Menagedbetween15-59years? ---------- (e) Menabove59years? ----------	(f)Food(s):(writethe appropriatecodes)
	Type&No ofstove(s)used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
67.Other fuel usage/Notes:		
Visit#4 (~24 hours later)	68.Date(day/month/year):	69.Time(hh:mm):
70.UnusedCharcoalTotal(kg):	71.UnusedWoodTotal(kg):	
72.Unused LPG Total(kg):	73.UnusedKeroseneTotal(kg):	
74. Wood Moisture Sample 1:	(a)Reading #1:	(b)Reading #2: (c)Reading #3:
75. Wood Moisture Sample 2:	(a)Reading #1:	(b)Reading #2: (c)Reading #3:
76. Wood Moisture Sample 3:	(a)Reading #1:	(b)Reading #2: (c)Reading#3:

77.Breakfast	(a)No.of people cooked for:_____ (b)Childrenaged14yearsorless? -------- (c) Femalesaged15 and above? -------- (d)Menagedbetween15-59years? ---------- (e)Men above 59years? ----------	(f)Food(s):(writethe appropriatecodes)
	Type&No ofstove(s)used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Typeoffuel(s)used:

78. Lunch	(a)No.ofpeoplecookedfor:_____	(f)Food(s):(write the appropriate codes)
	(b)Childrenaged14yearsorless? -------- (c)Femalesaged15 and above? -------- (d)Menagedbetween15-59years?---------- (e)Menabove59years? ----------	
	Type&No of stove(s) used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
79.Dinner	(a)No.of people cooked for:_____ (b)Childrenaged14yearsorless? -------- (c) Femalesaged15 and above? -------- (d)Men aged between15-59years? ---------- (e)Men above 59years? ----------	(f)Food(s):(writethe appropriatecodes)
	Type&No ofstove(s)used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
80. Tea/coffee/other	(a)No.of people cooked for:_____ (b)Children aged14years or less? -------- (c)Females aged15 and above? -------- (d)Men aged between15-59years?---------- (e)Men above 59years? ----------	(f)Food(s):(write the appropriate codes)
	Type&No of stove(s) used: (g)Type of stove:---------- (h)No of stoves ----------	(i)Type of fuel(s)used:
81. Other fuel usage/Notes:		

Other Information on Visit#4			
82.	What kinds of pots are used for cooking(e.g.round or flat bottom, metal or ceramic, etc.)?		
83.	Are pot-lids usually used for cooking?		1.Yes 2.No
84.	Does the family perform Maintenance on the improved stove?	Typeofmaintenance: (a)Cleaning stove of ashes	Frequency(circleappropriateresponse) 1.Never2.Daily 3.Weekly 4.Monthly
		(b)Repairing cracks	1.Never2.Daily 3.Weekly 4.Monthly
		(c)Other task*(specify):*	1.Never2.Daily 3.Weekly 4.Monthly
85.	What does the primary cook like about the stove(list replies)?		
86.	What does the primary cook dislike about the stove(list replies)?		
87.	Before purchasing the improved stove, did the household ever use wood to cook?		1. Yes 2. No
88.	Briefly describe the condition/appearance of the stoves.		
89.Notes/Observations: **Take photos oft he stove(s) [from the top and front],kitchen,and home with HHID.			

5.4 REFERENCES

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