FACTORS INFLUENCING ADOPTION OF IMPROVED COOKSTOVES AMONG HOUSEHOLDS OF THUTI LOCATION, OTHAYA, NYERI COUNTY, KENYA

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DECLARATION

This research Thesis is my original work and has not been presented for a degree in any other university.

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This Thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

I sincerely dedicate this dissertation to my family especially my wife Janet, sons Howard, Abraham and daughter Louise for standing by me during this expeditious academic journey.

To my Father, William and Mother, Prisca-Thank you for nurturing me to succeed in academic and life as a prolific being and leader. May you live long to witness another milestone in academia.

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May God bless you abundantly and to infinity.

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LIST OF ABBREVIATIONS

CNISP: Chinese National Improved Stove Program

DEEP: Developing Energy Enterprise Project

EPA. Environmental Protection Agency

FAO: Food Agricultural Organization

GACC: Global Alliance for Clean Cookstoves

GEA: Global Energy Assessment

GIZ: Gesellschaftfur International Zusammenarbeit

GTZ: German Agency for Technical Cooperation

GVEP: Global Village Energy Partnership

HAP: House Air Pollution

ICSs: Improved Cookstoves

IEA: International Energy Agency

ISAK: Improved Stoves Association of Kenya

KCJ: Kenya Ceramic Jiko

KENGO: Kenya Energy and Environment Organization

KNCA: Kenya National Cookstove Alliance

LPG:	Liquefied Petroleum Gas
MoE:	Ministry of Energy
MoWE:	Ministry of Water and Energy
NEMA:	National Environmental Management Authority
SACCO:	Savings and Credit Cooperative Society
SDGs:	Sustainable Development Goals
SDGs:	Sustainable Development Goals
TaTEDO:	Tanzania Traditional Energy Development and Environment Organization
UNDP:	United Nations Development Program
UNEP:	United Nations Environmental Program
UNICEF:	United Nations Children's Fund
USAID:	United States Agency for International Development
WHO:	World Health Organization

ABSTRACT

Majority of the rural households in developing nations use traditional cooking devices with high-energy inefficiency and biomass use. The result is a high pressure on forests that serve as sources of firewood. Improved cookstoves have been promoted as a potential solution to slowing the loss of biomass. The major aim of the study was based on the assessment of factors influencing adoption of improved cookstoves among households in Thuti location, Othaya. To achieve this, the study assessed the cooking devices and energy use among study households, determined factors associated with the adoption of improved cookstoves, and assessed the benefits of adopting and using improved cookstoves among households in Thuti location. A sum of 101 households were randomly selected from the 1006 households in Thuti village and questionnaires administered. More than half of the households (54%) reported using improved three stones as the cooking devices, and 23% used the traditional three stones method, while 24% used ceramic jiko, concrete insulated stove, multipurpose stove, jiko koa, LPG gas, biogas, pot jiko and scode firewood stoves. Forty- five percent of the household reported that they used the cooking devices because of their speed in cooking and being economical. More than two-third (68%) of the households were aware of the cookstoves. The main source of this information was neighbours, seminars and meetings. The cooking devices were priced between Kenya shillings 100 and 1000, with the cookstoves obtained from local Jua Kali contributing 43% of total cookstoves owned by households. Two-thirds of the study households indicated cost effectiveness and availability of fuels as the major factors influencing adoption and uses of the improved cookstoves, with majority of the respondents favouring them as economical

to use. In conclusion, initiatives aimed at adoption of improved cookstoves should up scaled by effective dissemination of information on the characteristics of cooking devices. To increase adoption of cookstoves, I recommend increased awareness of their benefits and affordable pricing of the devices and energy/fuels including options such as financing or subsidies by major stakeholders and the government.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Among developing nations, close to 1.6 million household have no connection to power while 3 million household depend on the traditional wood fuels for food preparation, heating and other basic households requirements (IEA, 2002, Smith *et al.*, 2004) postulates that globally the dependence of people on dung, wood and other biomass fuels for cooking on open fires is about 2.4billion, which accounts for the poor fuel burning and less efficiency consequently emitting excessive pollution emissions. Improved wood cooking devises were found to be a better alternative to address this problem. Biomass cookstoves are devices in which wood and farm residues are utilized as a source of fuel. The three traditional stones are occasionally improved in various ways to improve efficiency and reduce level of indoor air pollution and its effect on health of the household members. According to World Health Organization globally up to 15,000,000 persons pass on annually due to polluted air related to cookstoves (WHO, 2002). Currently, there are close to one hundred and sixty cookstoves programs being implemented globally narrowing down to capacity of the stove, stove type disseminated, the way of design and awareness (Gilford and Mary, 2010).

The adoption of new technologies performance should be analyzed to gauge their viability and suitability to the user (Ruiz-Mercado *et al.*, 2008), it is necessary to examine the factors influencing the adoption, other sources of domestic energy effects, types of improve cookstoves, relative advantages or benefits of each device.

New technologies are beginning to attract governments, non-governmental organizations and other agencies due to varied significance they carry over traditional stoves. On the other hand, improved stoves is understood to require large increase in combustion efficiency as well as increased fuel efficacy over traditional stoves (Venkataraman *et al.*, 2010).

Efforts geared to the improvement of this devices have occurred since 1940s. Improved cookstove development started in India in early 1950s. The stoves were designed with a chimney to remove smoke from the kitchen. In the 1970s the oil crisis brought energy issues back to the top of agenda and improved cooking stove programmes were considered as a solution to the fuel wood crisis, deforestation around the world (FAO, 1996). During this period, research focused on the technical aspects like thermodynamic and heat transfer of cookstoves and various bodies promoted biomass stoves all over the world particularly in Asia, Latin America and Africa. However, the impacts of these programmes have been often short-lived (Cowan and Spreng, 1976).

In China, the Chinese National Improved Stove program (CNISP) started in between 1980 with the leadership of the Ministry of infrastructure. By 1994, CNISP had disseminated 144 million improved biomass stoves in their project areas translating to about 62% of all rural households (World Bank, 2005). This success was however not observed with similar initiatives in India and Africa.

In Kenya, improved cookstoves have been promoted since 1980s following a conference hosted by the United Nations, other stakeholders including; USAID, practical action formerly GT2 in outlining renewable sources of energy (Pattanayak *et al.,* 2012).

According to World Energy Council (2005) improved cookstoves unlike the traditional biomass cookstoves can ensure efficiency in use of traditional fuels, a variety of improved cookstoves are being promoted in Kenya, some being locally manufactured while others are imported models.

1.2. Statement of research problem

The improved biomass cooks stove have been identified as a promising option to reduce the negative impact of cooking with the traditional open fires (Arnold *et al.*, 2003). The adoption process of these new devises has however been cumbersome with little effort directed towards addressing the problem or understanding the factors influencing adoption. Othaya being a modern town and well supplied with electricity yet the household are not using it for cooking therefore, it is important to investigate types of cooking devices used, perceived benefits that accrue while using them and factors influencing their adoption.

Majority of the households still use open fires and traditional stoves in household cooking and views on adopting cookstoves seem to vary at the user level and project levels. In particular, this study seeks to assess the factors affecting usage and adoption of these stoves among households in Thuti Location, Othaya.

1.3. Research questions

The study was guided by the questions below:

i) What are the Cooking devices and energy used among the household in Thuti Location?

ii) Which are the factors affecting adoption of improved cookstoves among household in Thuti Location?

iii) What are the benefits of adopting improved cook -stoves among household in Thuti Location?

1.4. Overall Objective

The overall research objective was to assess factors influencing adoption of improved cook- stoves among households in Thuti Location, Othaya Sub-County.

1.5. Specific Objectives

The study was guided by the following specific objectives: -

i) To assess the type of cooking devices and energy used among the household in Thuti Location.

ii) To evaluate factors affecting adoption of improved cook- stoves among households in Thuti Location.

iii) To assess the benefits of adopting improved cook- stoves among households in Thuti Location.

1.6. Justification of the study

Despite the effort W-power has made in disseminating information, distribution and marketing of various improved cookstoves among the rural households in Thuti location, majority have not embraced the adoption. And since global interventions have given varying, scanty results, the cumulative study to be conducted in Thuti location, Othaya on influencing factors on adoption of improved cookstoves, provided valuable information on promoting clean energy technology use and setting achievable strategies

to enhance adoption rate of such cookstoves. The study ought to assist policy makers both at county and national levels in designing policies that enhanced household welfare while sustaining the environment as stipulated in the sustainable development goals and vision 2030 (World Bank, 2003) a time which is also in tandem with the Sustainable Development Goals (SDGs) as postulated by the United Nations. Therefore, this research will contribute to fill the gap on factors influencing adoption of improved cookstoves. Other researchers may also use the finding of this study in relation to factors influencing adoption of improved cooking devices in rural areas in Kenya and may contribute to contemporary empirical literature on factors that determine household's choice of adoption of improved cookstoves in most developing countries.

The outcome of this research will be of significant to stakeholders working within clean energy domains, policy makers both at the County and National levels of Governments and future researchers on improved cooking devices, adoption and usage.

1.7. Scope of the study

Primarily, the research was confined to Thuti Villages, Othaya Sub-County, Nyeri County, Kenya. Conceptually, this study was limited to identifying factors influencing the adoption of improved cookstoves for sustainable domestic energy use in households in rural Thuti villages with a total 1006 households areas in square kilometers, and 7.5 square kilometers width and density population of 487. Theoretically the research was based on Theory of Technology. Planned behavior, energy ladder and stacking, theory of change, diffusion of innovation theories in identifying factors influencing household's decision to adopt or not the improved cookstoves.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents the literature review, the development of improved cookstoves around the world, Africa and in Kenya, the various cooking devices used by households in cooking, factors influencing adoption of improved cookstoves and benefits associated with the adoption of improved cookstoves, empirical literature on influencing factors on adoption of improved cookstoves. This chapter discusses theoretical and conceptual framework of the study.

2.2. Development of improved cookstoves

In America, the chronology of the cookstoves concentrated on the period from 1865 to 1920 due to the factors that influenced their manufacture, purchase and use 1893 (Cowan and Spreng, 1976). This period is one of the beginning of rapid change in cast iron stone before the decade of the most dramatic occurrences in pattern of household chores. Therefore, the general perception during 1865-1920 was towards advancement in household technology especially the white and outlined views on the cookstoves. Stoves manufacturers for example, Kelley was among stakeholders who had their stoves exhibited at the worlds Columbia Exposition in Chicago in 1893 (Cowan and Spreng, 1976).

Those who purchased and used the stoves had few reasons to be happy about the new technology awareness during the 19thC. Home life for the family in general would alter little with the acquisition of a stove, however, revolutionary and only the middle class

would be quick to take advantage of newer products. The cast iron range, which burned wood or coal had evolved from the 18th Century Dutch stove of cast iron plates. The new range expanded with the addition of grate, an ash chest and a coasting oven on one side. Another inventor Philo Penfield Stewart patented the cast iron Oberlin stone- a most successful venture in 1834. Although the inventors had probably not been quite slowly as that, its certain that stove improvements multiplied rapidly.

In 1947 the first improved cookstove was reported in India called Megan Chulha. According to FAO, (1993) by the beginning of 1950s, the first phase of improved cookstoves development started with technological attempts to improve the design of biomass fired stoves. However, the scientific research and development of improved cooking stove began to proliferate in the 1970s and at the beginning of 1980s. According to Kammen, (1995), the first improved cooking stove were designed by aid groups such as the United Nations Children's Fund (UNICEF) and the Humanitarian Organization Fighting Global Poverty (CARE) in Kenya. And because of inefficient testing, those who design the initial batch of these stoves in Europe, recorded weak results. For example, the stove openings were not similar in size of the parts to be used by households. Significantly, problems plagued some of the initial prototypes, and consequently, the in-depth analysis into their performance revealed that the largest loss of heat from fire was about 50 to 70 percent occurs from radiation and conduction through the metal walls.

Since the late 1970s, attention has been shifted on the design and dissemination of simple, low-cost improved cookstoves. Compared to the open fires, such stoves can save up to 40% of wood fuel and 25-35% of the fuel compared to traditional cookstoves, thereby ushering better designs in the mid-1980s. At that time, a number of academics

started to publish serious analyses of optimal stove combustion temperatures and the insulating properties of the ceramic liner materials. According to FAO (1996) the improved cookstoves can be classified into various categories namely; Functional; an improved cookstove which primarily performs one function such as cooking or any other single special function such as fish smoking, baking, roasting, milk simmering. Portability; on this basis, improved cookstoves can be classified as fixed or portable-they are portable in nature and can be moved from indoors or outdoors. Fuel type; the performance of different improved cookstoves having the same functions and constructed with the same materials, will ultimately depend on the type of the fuel used and construction material. Improved cookstoves are mainly made of single materials; metal, clay, fired clay or ceramics and bricks or are hybrids in which more than one material is used for different important components. This classification based on the material helps in selecting an appropriate design on the basis of locally available raw materials skills for fabrication and necessary product facilities.

2.2.1. Chinese National Improved Stove Project

It has been accepted by many scholars that the Chinese National Improved Stove Project (CNISP) was the most successful example of cookstoves distribution at a large scale. During this period, progress in India and Africa were not nearly as successful. The Chinese National Improved Stove Programme (CNISP) for example, introduced 129 million cookstoves to rural areas during 1982-1992 campaign.

By 1992, 60% of rural households adopted improved stoves (Climate Institute, 2009) the success in china has been attributed to stove designs suited to user's needs, targeted natural promotions scheme effective local implementation and constants monitoring and evaluation entrenched program from bottom up starting from pilot programs at

local level instead of testing to implement from the top. Teodoro (2008) also concurs with other scholars on the success of Chinese program as marketing of rural energy companies in china managed to ship in various items with varied functionalities for example space-heating which was deficient in Africa, improved biomass stove program also benefited from logistics and distribution channels initiated by biogas, micro-hydro programmes in 1970s. There was also less impact from governments participation which occasioned to the ownership and higher rate of adoption of new technology use in China.

2.2.2. Improved Cookstoves development use and adoption in Nepal

Nepal is suitable country for researching of improved cookstoves adoption because of the widespread in cooking technologies that uses fuel wood as the main origin because of the availability of forest and furthermore, Nepal has limited natural gas, electricity, and coal. Further, research has been conducted in Nepal on improved cookstoves from1980s, (Manibog, 1984) and this is yielding positive results of relevant cooking devices and access to implementation programmes, heavy forest cover whereby close to 80% of the people are living in the rural areas, and in the scattered homes. Nearly a quarter of the country's, 27million citizens living below the poverty level. Therefore, majority of the families use fuel wood in the traditional cooking stove- popularly known as Chulo, which has been used over generations and generations (Nepal, *et al.*, 2011). While the type of Chulo varies across the level, depending on local habits, diets and climate, most Chulos are essentially holes in the kitchen's (hard clay) floor. A simple brick and clay structure surrounds the hole completing the chulo. An opening allows wood to be inserted horizontally and burned, its flames rising up through the openings on which the cooking vessel metal is prepared.

In the middle and lower regions of Nepal, the meal generally consists of three items, rice, lentils (dhaal) and a vegetable curry, usually potatoes. Whereas in the hilly and mountainous regions, or where corion is common or where work consist of labour in the fields and manual lifting of materials, the main meal consists of porridge (dheedo) whose preparation requires the stove to withstand heavier and rougher use, and big flames. The colder regions also use stoves to heat their homes as well as for brewing alcohol, cooked in large vessels for longer period. These attributes contribute to either positively or negatively on the adoption of improved cookstoves amongst people of Nepal. For example, in a number of households, cooking is an activity with spiritual, social, and religious associations as the country is dominantly Hindu culture. Households respect the norms which are passed down generations to generations thus affecting adoption of improved cookstoves (Nepal, *et al.,* 2011).

But the younger generations have different ideas about the famous traditional Chulo (cookstove), on the other hand, the young generation love being near the open fires as a family unit although they are less tolerant to smoke. There is therefore an increasing need for new stoves which are smoke free. This means a lot has to be done on improving the ***chulo*** towards smokeless status-which allows the young generation to seat around the fire longer.

2.2.3. Improved cookstoves development in Africa

In Ethiopia's energy supply is heavily dependent on biomass, which accounts for above 95% and in terms of consumption, household accounts for about 91.3% of the total energy consumption, of which biomass fuel accounts for 98.5% and also within the household sector the rural and urban household energy consumption accounts for 92 and 8% respectively (Asres, 2002). This heavy dependency on biomass fuel, coupled

with open three-stone fire cooking, is one of the significant causes of forest depletion and degradation, resulting to loss of agricultural productivity and creates indoor air pollution (Gcbreegziabher *et al.*, 2010; MoWE, 2012). According to Cesar and Ekbom (2013), between 2010 and 2030 yearly biomass consumption will rise by 65% with large effects on forest degradation. Thus, for emerging economies for example Ethiopia, fuel provision relies on wood fuel such as firewood, charcoal and agricultural residues, technological progress in energy efficiency are critical (GACC, 2011).

Under the implementation of World Food Progamme-Ethiopia, there is also a new initiative, which is called Ethiopia Improved Cookstoves Initiative (CPA 1) to disseminate Mirt stove for injera baking that will lasts for 21 years (WFP-Ethiopia, 2013). Further research by EPA (2004), indicated that improved charcoal stove and biomass closed Enjera stove can save up to 25% and 47% over open fire devices respectively.

In Tanzania cookstove programmes was jumpstarted in 1980s by the development of improved charcoal stoves in Morogoro, which was brain child by the Tanzanian government and with key associates and introduction of Kenyan Ceramic Jiko (KCJ) version. Thereafter, rapid advancement has been made through organizations such as Tanzania Traditional Energy Development and Environment Organization to improve and distribute the new cooking devices to the people of Tanzania.

Global alliance carried out research and CNEP recorded that close to 400,000 families had these stoves using charcoal as the main source of fuel, while new cookstoves were accessible within major town centers in Tanzania. Although information on new

cookstoves is minimal in rural areas at approximately 5% due to economic and distribution barriers (GVEP, 2012).

The promotion of improved cookstoves has been ongoing in Kenya since 1980 and an initiative by the ministry of energy especial on the use of new as well as renewable energy sources conference, Nairobi. The early stove designers like GIZ and practical action, have improved and captured customer and user acceptability and intensive local artisan training yielded into stove production center establishment in the country. Bellerives foundation, USAID and UNICEF. EnDev Kenya also in 2005, was aiming at developing as well as sustaining a market for modern cooking stoves through the consistent production and marketing approaches, the dynamic market was initiated for the improved cooking devices. The other goals of the project comprised of public education to boost awareness, training of individuals and groups on stove production, technical as well as marketing education as well as highlighting on the new and emerging issues in the sector. Improved stoves association of Kenya (ISAK) was established by EnDev Kenya to promote sustainability in development by bring together all stove builders in the country.

The stove that was adopted was designed in form of a Thai Bucket stove was the KCJ (Kenya Ceramic Jiko) formed the pioneer development of stoves in Kenya and is one of the most successful projects on improved cookstoves. The components of the KCJ encompass the metal cladding, wide base, and the ceramic liner which is over 25% perforated, three pot rests and legs, as well as two handles and weighs 6kg (KENGO, 1991).

For example, in Kenya, we have different communities grouped in culturally- oriented tribes that are still subdued into their traditional/cultural norms in cooking. The new comers in the sector comes with sophisticated technologies either imported or designed but they fail to reflect the Kenyan traditional cooking, for instance, in preparing porridge that requires constant stirring, the stoves may not be so effective, the very reason the EnDev. Kenya favors Jiko Kisasa and the Rocket stoves cooking technologies (GVEP, 2009).

Most Kenyan traditions also recognize the roasting of maize as a way of discussion and is only possible by use of open fires. Teodoro (2008), postulates that the Kenya's national program on clean energy under the umbrella watch of Ministry of Agriculture is one of the successful stoves in Africa. And according to Winrock International (2011) Kenya has a good success story in Africa compared to other nation- thereby having at country level 30% - 40% of households have an improved cookstove of same type and 50-60% in urban areas.

2.3. Cooking devices

Households around the world finds it easier to stick to the traditional way of cooking because of the little expenses associated with the use of traditional cooking stoves like the open fire, fuel gathering, hence, changing to a new technology is an uphill task. Ordinarily, smoke and activities associated with cooking is considered part of womanhood as they are the ones charged with the responsibility of cooking around the world. The use of technologies methodologies that conserve fuel like wood are usually aimed at reducing the wood fuel demand from forest and other sources. It is also aimed at improving livelihood and enhancing productivity (GTZ, 2007). The Jiko Kisasa and

Rocket stove according to EnDev. Kenya is the most efficient and energy conserving wooden stoves available and they are encouraging Kenyans to adopt and use to minimize energy wastes in cooking.

2.3.1. Jiko Kisasa (Maendeleo Jiko)

Jiko Kisasa is a stove that was adopted in Kenya in the 80s after intensive research by many institutions under the leadership of Ministry of Energy, GIZ and Maendeleo Ya Wanawake Organization (WYMO). The Jiko Kisasa uses both charcoal and firewood, and have different sizes and types, in contrasting it to the open fire traditional method, it has the ability to minimize 30% of emission and energy loss (GIZ, 2013). In order to achieve the combustion quality chambers, the lining of the chambers is made from the right material with proper tools and techniques according to EnDev. Kenya education and training. The stove can be fixed in the kitchen or can be portable by being enclosed in metal below. According to TaTEDO (2000), in Tanzania a household using three stones stove consumes around 2880 kg/year of firewood. According to this study, through the use of improved firewood stove consumption is reduced to 1728kg/year/household, annual saving is around 1152kg/household (equivalent to more than 20 tresses per year).

2.3.2 The rocket stoves

Individual stove builders are the architectures in developing the Rocket stoves, which uses on pot size at time just like the Jiko Kisasa. However, in terms of energy saving, conservatism of fuel, and efficiency, they are the best stoves available. They have the ability to conserve over 60% of wood and have an efficiency rate that exceeds the Jiko Kisasa by 20% (Kamfor, 2002). The rocket stove addresses institutional needs, for

example of school canteen. EnDev. Kenya launched the rocket stove technology in 2007 as new players come in today's Kenyan market, for example, instead of using firewood, the rocket stove uses plant oil, ethanol, and LPG.

2.3.3. Biogas stoves

The conditions and requirement attached to biomass production encompass adequate water supply, number of livestock's, favorable for farming practices, climate, labor needed for the management of digesters and it's the best fuel for the household based in a rural setting. Although the initial cost of installation is high when managed well, the household is able to save daily fuel usages, wood purchases, it produces fertilizer slurry. This is applicable for Thuti location as it exhibits similar climatic characteristics, although it still unexplored in details by locals.

2.3.4. Solar cookers

The use of the solar cooker saves 25 to 40% of the expenditure on charcoal or firewood in the following countries Ethiopian, Kenya and Bolivia. The solar cookers as evaluated by the Szulczewski, (2006), have a longer lifespan compared to other sources of fuel combustion such as cookstoves 4-7years as it was the case in Bolivia where 90% of the solar cookers distributed lasted for the above duration. The low quality solar cookers distributed in African market under performed based on the expectations. The solar cookers are effective but needs a backup method as they can only provide about 40% of the entire household cooking needs, because it depends on sunshine which may not be reliable enough depending on the weather conditions in the region. The poor coordination and planning strategy is the major barrier in producing and marketing the cost high quality solar cookers to serve the African and Asian markets.

2.3.5. Alcohols

Ethanol use as a fuel source for other improved cookstoves, is majorly evidenced in the urban centers where its supply could be certain enough, and its use leaves minimal evidence unlike other fuel sources. The challenges faced is the issue of prioritizing its use from the illegal and legal alcoholic markets that offer competition to the fuel use needs, making it unreliable fuel source despite its wide production materials and stocks (Pattanayak *et al.,* 2012).

2.3.6. Patsari stove

The partnership involving the CIECo (Center for Ecosystems research of the National University of Mexico) and the Mexican NGO- GIRA AC, collaborated to develop the Patsari stove. GIRA, over the years, disseminated over 10,000 stores in the pure pecha region of Michoacán, Mexico. Cooking normally takes palace in an open fire with three stoves supporting the cooking surface or a borehole designed stove in the kitchen without a chimney.

The Patsari stove was designed to minimize indoor pollution exposure, use affordable technology to meet the common people's basic needs of cooking, and the reduce the greenhouse effect gases, as well as control biomass fuel consumption in the country, thus it was produced using a participatory approach in order to meet those goals (Masera *et al.,* 2007). The use of this stove is considered as valuable asset as it has greater opportunities to facilitate the saving of expenses that would otherwise be very high, thus offering extra funds to promote other changes in the household (Armendariz *et al.,* 2005).

2.3.7. The traditional three stone stoves

This is the traditional cooking device, which has been passed on from generations to generations and more or less similar to the patsari stove of Mexico. Since it simply involves looking for stones of equal size and height for the pot to balance over a fire, the three-stone fire is the most economical stoves ever produced in the world. According to Umair Irfan (2013), majority of the emerging stove designs inculcate the chamber of combustion like the one in the rocket stoves, to increase the stove temperature in order to attain the and allow complete combustion of fuel as well as minimize emission by confining fuel combustion to an insulated and enclosed area. Constricting the shield to safeguard the fire, sinking the zone of combustion forms the various innovations that can be adjusted on the typical traditional three stone methods to improve its efficiency and effectiveness in cooking.

2.3.8. Lorena adobe stove

Lorena adobe stoves preceded the Patsari stoves. These stoves were designed for simple production using the local materials in the Central America. The mud and sand word root in the Lorena, imply the combination of the two materials generated the stove, rammed earth, a chimney on it (Praveen *et al.,* 2012). The rammed earth deployed in developing the Lorena stove absorbs heat instead of resisting and preventing heat loss. The heat absorbed into the structure radiates providing more heating effect as compared to open fire cooking style, this is difficulty to use in the hot weather. Additionally, the stove could be used in drying cloths because when the fire goes off, the mass cools off thus drying the cloths.

2.4. Factors influencing the adoption of improved cookstoves

Even though the envisioned many benefits of adopting various improved cookstoves, efforts of stakeholders at national, regional and global programmes, the rate of Improved cookstoves adoption has fallen behind the expected outcome due to different factors (Lewis and Pattanayak, 2012) in order to identify factors affecting the adoption of Improved cookstoves, several studies were done on the topic.

Lewis and Pattanayak (2012) conducted a review of 11 empirical studies with regard to factors affecting improved cookstoves adoption. A study conducted by Okello (2005) in collaboration with the Ministry of Energy in Homa Bay County, Kenya on adoption of improved cookstoves by households, found out that socio-cultural factors played pivotal role in new technologies adoption. However, significant negative associations were found between the adoption of improves cookstoves and household heads age and socially marginalized status. According to Vankataraman *et al.,* (2010) the process of adopting and using of IBSs in rural Mexico by taking community's acceptance, household characteristics, and season of adoption as explanatory variables. Thereafter, the study found that community acceptance of the stove, problematic experience with the traditional stoves and the compatibility of the stove with the type of fuel- wood used are statistically significant and positive factors of adoption of Improved cookstoves on the other hand, rainy season, household higher valuing of open fire over the improved ones, proximity and free forest access to collect wood were found negative factors of improved biomass stoves adoption.

In Kenya, Wasula (2000) conducted a research on improved cookstove adoption and postulated that indeed several factors ranging from financing and promotions of improved cookstoves, information dissemination to the locals, socio-cultural aspects of the rural communities, types of cookstoves, amongst other factors play a valuable role in adopting and using the Improved cookstoves.

Levine *et al*., (2013) conducted research in Uganda and identified variables that impede improved cookstoves adoption by considering variables of information, liquidity, and present biomass and terms of payment. From the study, it was found that customer's liquidity constraint, imperfect information, unfamiliar with the new fuel stove savings, performance and skepticism about the durability are important barriers of improved cookstoves adoption.

Axen (2012) analyzed the influencing aspects that control the spread and potential use of cooking stoves that are fuel efficient in Northern Tanzania with the focuses of potential user's perception, financial capital, social capital, and household heads gender. From the study, positive perception on the improved cookstoves, its price, access to credit, awareness, knowledge about the benefits of improved cookstoves were found to enabling factors for the adoption and spread of improved cookstoves. Also, membership to social associations and be networked were positive indicators of adoption of improved cookstoves. On the other hand, the lack of these concerns and the free access to fuel- would were found to be factors that hinders the adoption of Improved cookstoves in Tanzania.

In Kenya, Okello (2005) conducted a study on the factors responsible for adoption of improved cookstoves in Homabay County and the findings indicated that the access to inputs, credit, and membership variables influenced the degree of improved cookstoves adoption. The absence reliable supply of improved cookstoves and poor marketing systems in the local markets formed the major constraints in studying the improved cookstoves. The gender and poverty issues related issues illuminates a strong linkage on the improved cookstoves adoption process and use. According to Khamati (2000), study on the rural stove program in Kenya, introduction of improved cookstoves in the rural settings of this country is very challenging based on the strong bondage the locals in the rural areas have with the three stones traditional stove and the large amount of expenses and costs needed to facilitate the process which may not pay off.

The study further indicated that the women and children in the rural setting played the function of firewood gathering and they households are generally poor, therefore, there is little if any motivation to adopt the improved cookstove unlike the urban households. Because more of the literature reviewed has focused on important factor influencing adoption of improved cookstoves for example, physical factors (technology used in the cooking device) environmental factors (health, global warming) social – cultural aspects of the people like cooking styles roasting of maize, cooking Githeri and fish for business ventures who are in the production and distribution of improved cookstoves, and with this research, the outcome will try to shade more light on the variables that influence adoption and usage of improved cookstoves amongst the households of Thuti location, Othaya, Nyeri County.

2.5. Socio- economic factor influencing the adoption of improved cookstoves

In Paraguay, for instance, cooking activities and practices are custom based, during large gatherings and holidays plenty of corn baking is done which takes length time as well as need an oven for the cooking. Households that keep livestock need sufficient time to prepare animal feeds as well as their meals which all constitute the amount of cooking that have to need to be done daily. The Paraguayan meal, Yucca, consumed in every meal takes a lot of time and heat to cook.

More than half of the households in Guatemala, indicated that improved cookstoves were used alongside the open fire method to cater for the tradition rituals, customs, and cultural oriented cooking habits as contended by Ruiz-Mercado *et al*., (2013) study. In Guatemala, stoves act as heat and lighting sources in family gatherings–where families could talk and pass on traditional stories to the young after along days' work.

In Kenya there is continued persistent in traditional cooking custom problems despite minimized incidents following the introduction and adoption of the improved cookstoves with well to do households while the poor failed to afford and adopt the new improved cooking methods (Silk *et al.,* 2012) more so, the cultural norms in cooking habits types of food cooked plays an important factor in adoption. For example, among the people of central Kenya, their staple food is Githeri (Maize mixed with beans) is always cooked over open fires since it takes long to cook. Apart from cooking, the old women and men believe that around open fires, roasting of maize can take place and stories can be told and retold to the young ones. In central Kenya, the temperatures are also low- making it cold and the houses requires warming. Among the western people of Kenya, their delicacy is fish- which requires open fires served with traditional vegetables.

2.5.1 Income level of family

The systematic review by Puzzolo *et al.,* (2013) found consistency among research result that higher socio-economic status of a family is positive and significant factor in determining a household improved cookstoves adoption decision. Lewis and Pattanayak (2012) found that income is positively and significant factors that determined the adoption of improved cookstoves across studies reviewed for example as disposable income increases, there is higher rate of households switching to cleaner and higher efficient cooking fuel techniques (Barnes *et al.,* 2011). Person *et al.,* (2012) experience is the leading factor influencing the household decision to purchase and use improved cookstoves.

2.5.2 Gender

There is a distinct dimension in the household energy sector in much of the developing world (Malhotra *et al.*, 2004). He adds that gender consideration is vital social aspects to consider in stove programme design. The aesthetical appeal and the ability of the new cooking technology to retain its traditional cooking features would attract a higher market demand as he further argued in the study. The role of women in household cooking decisions is evidenced when the study by Rao and Reddy (2007) asserted that women headed households prefer modern fuel cooking methods as compared to men headed households. Miller and Mobarak (2013) women bearing cooking cost that are disproportionate prefer improved cookstoves in rural Bangladesh but they have no power to make such decisions and calls.

2.5.3. Family size

According to Puzzolo *et al.*, (2013), postulated that households with larger family size consume larger fuel wood as compared to household's smaller family size thus resulting in influencing larger family size household to economize fuel usage and has a positive probability of adoption of improved cookstoves. According to Carr (2005) postulated the size of the family as factor that increases the cost and demand for fuel needed to cater for the family consumptions needs.

2.5.4 Education levels

It is argued that educated potential customers are probably aware of the advantages, benefits, and gains accruing from the use of improved cookstoves over the uneducated or less educated customers (Inayatullah, 2011). They postulated that consumer's education based on the various financial instruments that can be deployed to acquire the improved cookstoves so as to minimize the perception that they are actually expensive. The education level of the household wife plays an instrumental role in increasing the possibility of switching from traditional cooking approaches to modern more efficient methods as Pundo and Fraser (2006) contends.

2.5.5. Price of improved cookstoves

Price variables include the price of improved cookstoves, the price of fuel- wood, the price of kerosene, charcoal etc. Axen (2012) for example argues that the price of improved cookstoves and household's perception on the price have effect on the probability of the household's adoption decision. Kakame (2007) found that the purchasing price of cookstoves was an important factor in influencing a household's adoption decision. He further argues that low affordability of the cost improved

cookstoves negatively affects cookstoves adoption likelihood by the poor who are predominantly in the rural areas.

2.5.6 Effects of value chain addition

The diverse business models in play makes the improved cookstove sector very complex as the type of stoves produced by different entrepreneurs differ from one country or business to another. But DEEP Program has dominated technology advancement in improved cookstoves as it accounts for over 43% of the entire Kenyan business in the sector (GEA, 2012). In the DEEP Program improved cookstoves business ventures are classified as follows liner production, assembling, cladding, full, and stocking improved cookstoves.

2.5.6.1 Production of improved cookstove liners

This type of business venture concentrates on ceramic liner production that is deployed completing the improved cookstoves. The types of liners produced encompass charcoal liner stoves like the Kenya Ceramic Jiko liner as well as the firewood burning liner stoves which includes the fixed Jiko Kisasa and the Kuni Mbili (SNV/IT/Power EA, 2011). The ready and standby customers to supply the improved cookstove liners to make the producers very efficient and more productive.

2.5.6.2. Production of improved cookstove cladding

The metal cladding that is used to hold and protect the liners in the development of the improved cookstoves are a times manufactured by independent business who then sell to the stove building business entities. The local artisans with good skills in metal work are deployed to make metallic items alongside the cladding production.

2.5.6.3. Assembling of improved cookstoves

The assemblers make stoves from component parts the liners and cladding produced from other places and only purchased as raw materials, this facilitates their constant flow of their products on the market as there is no limitation of producing the component parts of the stove (FAO, 2012). The products of assemblers are either distributed via dealership or directly sold to end consumers.

2.5.7 Sources of fuel wood

Wood-fuel contributes to over 70% of the country's energy demands inform of biomass energy and the majority of 90% of the Kenyan population and household use wood or charcoal as fuel for their cooking and heating the homes (MoE, 2003). Small scale firms and industries rely on wood as the source of fuel mostly produced in the local farmlands and is harvested and used in producing biomass energy that these industries use in running and operations (NEMA, 2004). A study by Pine *et al.*, (2011) found that access to forest is statistically significant with the improved cookstoves' adoption decisions since people tend to go for free wood fuels instead of the ones that could be purchased. And therefore, this finding forms a good background for my research in Thuti village which is close to Karima forest.

2.5.8. Separate kitchen

Based on the existing literature, having separate kitchen is expected to have influence on the improved cookstoves adoption decision among the households in the country as many studies illuminates. Puzzolo *et al.*, (2013) found consistency among research results that having separate kitchen is positive and statistically significant factors in determining a household Improved cookstoves adoption decision. For example, studies

conducted in Homa-bay County by Thenya (2015) revealed that families cooking indoors- more surprisingly in the bedrooms to drive away mosquitoes at night. This means, for such a family to adopt improved cookstoves is negative because they require the smoking "Smokey" affair to protect themselves from mosquitoes and other insects.

2.5.9 Human health factors

The use of inefficient cookstoves has deep sited threats to environmental and human health with children and women being the most vulnerable groups that are affected most with air pollution, respiratory illness, like asthma. The adoption of improved cookstoves promises cleanliness, high standards of hygiene in the cooking environment such as walls, ceiling, and people thus boosting the living stands of people as well as safeguarding the environment (Smith, 2012). According to the UNEP (United Nations Environmental Program, 2011) regulating carbon emission in the world could respond to reducing annual death rate by 2.4 million people (GTZ, 2011).

2.5.9.1 Collecting fuel and cooking time

The households in any country deploying inefficient cookstoves increases the time and effort committed in collecting wood and it have adverse influence on the forests and the environment as a whole, this is because excessive dependence on wood fuel results in degradation of forests in the world (FAO, 2010). Increase in distance causes the household to shift to quality fuel to reduce the time duration needed to collect fuel for their cooking (Brouwer *et al.*, 1997). Additionally, time spent by women in the rural setting cooking is more than time urban area women uses in cooking because of the differences in the type of fuel and models used in cooking (Jiang and Bell, 2008). In the rural areas women are involved in diverse activities revolving around wood fuel,

for instance, harvesting, splitting, storing, clearing the cooking areas, and fire starting the hustle that urban area women are saved from.

2.5.9.2 Other institutional factors

Makonese *et al.*, (2006) maintain that the existing institutional set ups are the key factors that influences the implementation, promotion, and dissemination of improved cookstoves in a given country. For example, training, technology and information exchange, technology standards, and decentralizing energy systems by key stakeholders e.g. government agencies, NGOs do influence the production, dissemination, and adoption of improved cookstoves. Agarwal (1983) found that extension services such as awareness creation and financial access to the users and producers are positive institutional factors that influence the adoption decisions of improved cookstoves.

2.6 Benefits associated with adoption of Improved Cookstoves

Improved cookstove program and project implementers and coordinators including National Programmes, regional and global initiatives, donors, non-governmental organization and other stakeholders throughout the developing world strongly claim the significant of role of improved cookstoves. In improving household's health conditions, improving the livelihood of the poor, reduce the level of deforestation and mitigating global climate change (WHO, 2011). Global Alliance for clean cookstoves (GACC, 2011) argues that in addition to its contribution to health, economic gender, environmental imperatives, the adoption of improved cookstoves plays pivotal roles in meeting some of the United Nations Sustainable Development Goals (SDGs),

specifically on child mortality, material health, gender equality, poverty eradication, and environmental sustainability.

Garcia Frapolli *et al.,* (2010) postulates for the positive role that improved cookstoves play such as reducing cooking related health problems, saving fuel wood and time to collect fuel wood, reducing the rate of deforestation and mitigating global climate change. These sentiments on benefits of adoption of improved cookstoves have and been supported by a number of empirical case studies and experiments conducted in developing countries for example in Asia, Latin America and Africa thereby asserting the positive impacts of adoption and usage of improved cookstoves.

Asia; for example, Dewan *et al.,* (2013) found out in China that the adoption of improved cookstoves can reduce fuel wood for cooking, time to collect fuel-wood and the newly felled trees by 40:1%, 38.2% and 23.7% respectively. Edwards *et al.,* (2004) also found that in China improved cookstoves have both short term and long-term impacts whereby in the short run improved cookstoves reduces the emission of health risky pollutants and in the long run, there stones play significant role in reducing greenhouse gases emission and mitigate global warming.

The south America a study conducted by Garcia Frapolli *et al.,* (2010) in Mexico also revealed that the adoption of improved cookstoves the famous Patsari has a significant contribution for the improvement of living condition mainly because of wood savings (about 53%) and reduction of indoor air pollution related health problems (by about 28%). In Ethiopia, Assefa (2007) experimentally found that Improved cookstoves particularly Mirt stoves can reduce carbon monoxide (CO) concentration and particulate materials by about 88% and 17% respectively. They also concur that

improved cookstoves are able to reduce land degradation in such a way that if the stoves are adopted and used; less dong will be used as fuel so more manure is available for agriculture, thus fertile soil, less wood consumption, thus reducing deforestation so more wood is available. In turn less, dong and crop reside for fuel and less time spent for fuel wood and dung, thus less time spent for cooking. Asres (2002) also found that in Ethiopia, the adoption of improved cookstoves Lakech and Mirt stones, can save about 475: 44kt wood, and about USD 47 million and 122,619 Ha. of forest per annum reduce indoor air pollution and improve health conditions as well as mitigate greenhouse gases emission.

In Africa-Gambia, a study by Jacob (2013) also found that improved wood burning stoves can save fuel wood consumption up to 40% and reduce indoor pollution up to 90%. The Tanzania, also came with evidence that the adoption of Improved cookstoves saved fuel wood consumption by about 70%, reduced women's workload, reduced the time spent to collect food from 4 hours to 2 hours per day, created self-employment, and source of income for the producers, and reduces smoke emission.

2.7. Theoretical framework

2.7.1. The theory of technology adoption

According to Simons (2012), technology adoption is a complex area of study that has been studies over time using several theories. The postulated several models used to investigate adoption behavior of individual technology frameworks that provides a theoretical foundation for examining the factors influencing technology adoption and use. In this study we will focus on the theories of energy ladder model amongst others.

2.7.2. Planned behavior theory

Planned behavior was postulated by Ajzen in 1985 and later improved on in 2006. And consists of several determinants in adoption of something new, mainly: attitude toward technology, normative beliefs, and subjective norm with a central factor being individual's intention to perform a given behavior. The behavior is intention guided and controlled as well as the information, beliefs, and performance influence and impacts on human behavior.

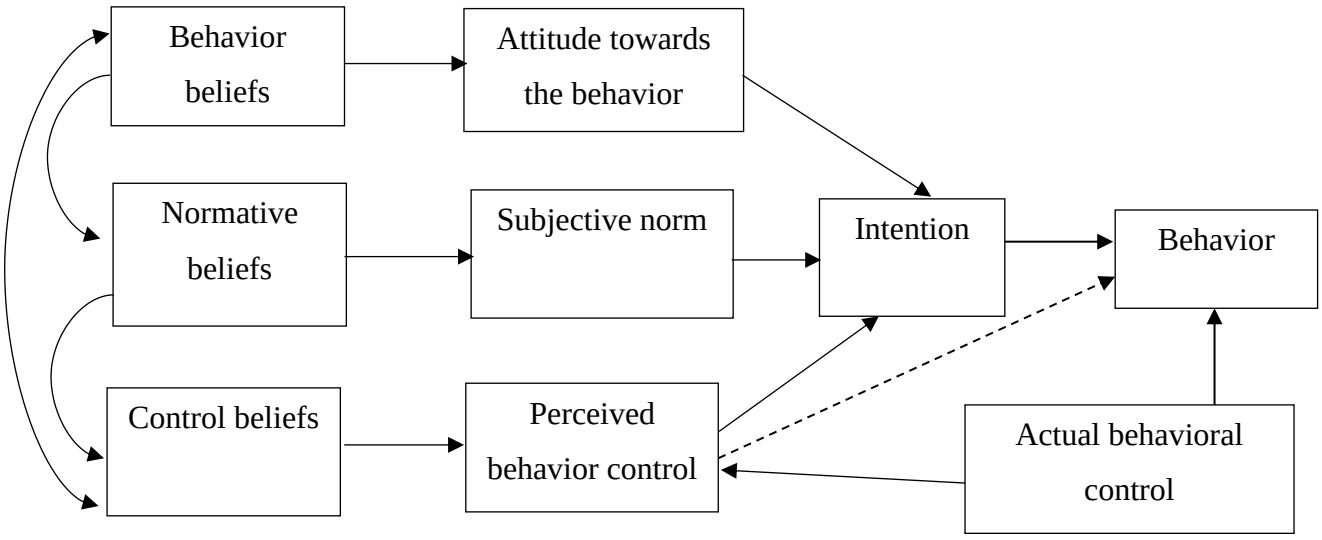

Figure 2.1: The planned Behavior Model

Source: (Ajzen, 1985)

2.7.3. Energy ladder model and energy stack model

An interest in the idea of energy ladder emerged with the perception of fuel wood crisis in the 1970s and 1980s (Taylor, 2010). Energy researchers postulated household ranking based on economic conditions in relation to the type of fuel used and based on the utility maximization behavior of households imply that the economic theory of consumer also applies in the energy sector of the economy (Kowsari, 2011). Increase

in consumer disposable income implies that the household will shift to more superior fuel type for cooking. According to Goldemberg *et al.,* (1985), costs and level of cleanliness dictates the fuel rang. This statement is also echoed by Smith (2004) in his interpretation of the traditional energy ladder which explains the behavior of families as they acquire additional income.

2.7.4 Social behavioral theory

Behavioral Scientist contends that economic factors of the firm or a person does not influence their decisions, as risk, salient information, value proposition, social intervention factors are important in shaping the types of decision. The important aspects that investors put in mind while making investment decisions are the same aspects that households consider in making a decision to choose among the fuel types. The accumulated impacts of decisions that household makes, thus, transforms to the final decision to cross over to a cleaner fuel in the future.

According to Kahneman (2011), people and organizations fail to conform to the economic rational thinking in decision making situations. The human attitudes of like or dislikes, experiences, past practices, reference points, social interactions, perceived risk or benefits, and competing value propositions, shapes decisions besides financial factors. Bounded rationality model by Simon (2006) proposed that the decision-making rationality of humanity is limited by the availability of information to the cognitive limitations and the time constraints for making a decision. The importance of social interactions and behavioral factors in technology diffusion model as highlighted by Rogers (2003) in which he contends that it is a process by which an innovation is communicated through certain channels over time among members of social system.

2.7.5 Recognition and information search

Individuals recognize the need that necessitates the adoption of innovations in technology and decisions to do so, as incorporated in the diffusion network and the decision concepts. They must hear and learn about the technology through their communication or information network. Central questions of technology adoption are when an agent decides to evaluate the technology for possible and what factors initiate this adoption evaluation for example, urge to consider improved cookstoves purchase fun a trusted fired or related, observation of improved cookstoves being used in the neighborhood, marketing contacts by improved cookstoves retailers, information share within the community gathering media messaging about electricity price forecasts, incentive programs and improved cookstoves adoption success and failure and utilities offering improved cookstoves incentives program etc.

Diffusion network (Rogers, 2003) involves communication channels and streams, assessment leadership and social learning. Research recommends that negative individuals perception on new technology has more influence than positive individual's perceptions. Personal influence has more impact than mass media when two are in contrasting; individual influence is more impact to leaders when they are looking for information versus congruity and being influenced by comparative people is more typical than being influenced by disparate people, however being influence divergent people is basic among trend-setters (Gatignon and Robertson, 1985).

In searching for important information for decision making purposes or for assessment of options, the sources encompass the internal information search and outside information search, external sources. The primary reason the consumers search for information is to boost their certainty before reaching a decision to accept the product.

There is a positive correlation between consumer benefit perceived and the costs that are perceived to be incurred Schmidt and Spreng (1996). Further, the desire for the consumer to seek information is motivated by the risks perceived to be involved, the educational level, subjective, objective level, and cognitive need are part of the driving forces behind the need to search for information. Subjective knowledge level plays a significant role describing consumer information search under this model.

2.7.6. Theory of diffusion of innovation

The process of an innovation communication to the members of a given social system via certain channels over time is what constitutes the theory of innovation diffusion as Rogers (2003) highlights. He further reveals the following elements of innovation diffusion: time, social systems, innovation, and communication channels. The idea, behavior, objects, and methodology of doing things perceived by the audience as new, or pioneering is called innovation. The theory seeks to illustrate and expound on how the society or a given population receives an innovation into their social system. The insights the diffusion of innovation offers in the society encompass the qualities that contribute to the spread of an innovation, the usefulness of the peer's conversation with each other, and understanding the basic needs of the target market segment.

2.7.7. Qualities that makes innovations spreads

Diffusion of innovations adopts a drastically unique strategy as compared other theories regarding change (Smith, 2004). The theory does not focus on converting people to change instead, it sees change as a fundamental rule about evolution or reinvention of products and for what reason do certain innovations spread more rapidly than others?

Also, for what reason do others fall? Diffusions scholars perceive five characteristics that decide the achievement of an advancement.

a) Relative advantage

This measures the extent of an innovation is perceived as superior to anything that exceeds it by a specific gathering of users, measured in wording that issue to those users, as financial advantage, social eminence, convenience or fulfillment. The more prominent the perceived competitive advantage, the faster an innovation's adoption rate resembles that of improved cookstoves in Kenya.

b) Compatibility with existing values and practices

It measures the extent to which the technological innovations in the energy sector is deemed reliable by the by the potential adopters of the innovation based on the values, expenses or costs involved, and the level it can meet the customer needs. The adopters of the new technological innovation will exhibit resistance to accept the innovation if it conflicts with their beliefs, norms, and normal practices.

c) Simplicity and ease of use

It is difficult to understand and accept new technological innovations in the cooking energy sector given the majority of the users are either illiterate or are resistant to learn new things. The adopter of new innovations need to have or develop new skills that will facilitate the acceptance and consumption of the new innovations, for instance the improved cookstoves and IBSs in this case.

d) Observable results

The simpler it is for people to get consequences of an innovation, the more probable they are to embrace it. Visible outcomes bring down vulnerability and furthermore

animate associate choice of new thought, as companions and neighbors of an adopter frequently ask for information about it. As indicated by Rogers (2003), there are five factors that influence adoption of an innovation for given new technology.

The discussion about an innovation is the best technique of facilitating its adoption by many target or potential adopters as compared to the generic strategies of marketing such as advertising, mass media promotion which only focus on informing and creating the awareness of the innovation to the public. The reason being new product or behavior adoption need a thorough assessment and management of checklist and risk vulnerability of the product before accepting to use it. It is generally people entrusted to try and adopt an innovation to predict it level of successful adoption and give judgement as to whether changing an activity brings about embarrassment, humiliation, financial misfortune or wasted time. They are the general population whose lined illustration is the best educator of how to adopt an innovation or new product.

2.7.8. The importance of peer-peer conversations and peer networks

There are exceptions to this rule in terms of early adopters who are economically, financially secure and stable, high personal confidence, well informed about emerging products, and have a lot of information about the market and products, thus they seek risk products with aim of gaining a competitive advantage or reaping higher return before the market is flooded the innovation (Rogers, 2003). The early adopters take up an innovation even with little and unclear information while the rest of the people scramble to find trustworthy information about an innovation before they can consider adopting it, the early adopters are already reaping results from the innovation. The foretasting model illustrated that early adopters inculcate the innovation faster enough

so that the audience seeks information and ideas from them in a face to face communication to help create assurance and spread the innovation.

2.7.9. Understanding the needs of different user segments

Based on different propensity to adopt a particular innovation or new products, the population if classified into the following five groups according to the Diffusion researchers

a) Innovators
b) Early adopters
c) Early majority
d) Late majority and
e) Laggards

The groups have specific personality based on its attitude towards a particular innovation as shown below.

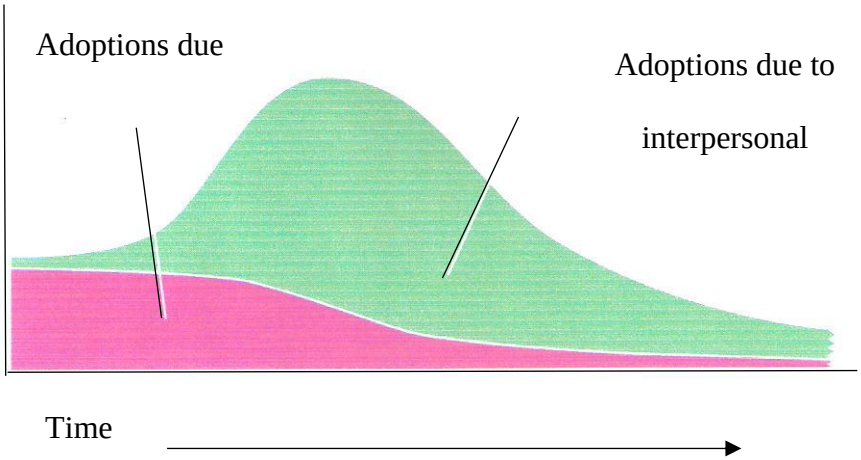

Figure 2.2: The Bass Forecasting Model

Source: Mahajan, Muller and Bass (1990) as reproduced in Rogers, E.M. (2003)

Innovators

The innovation adoption process is initiated with a living number of innovators who are visionary and imaginative who are willing to seek new innovations and try them first before other people can learn about their existence. These people deployed more energy, time, creativity, and effort in building and developing new ideas and they are more risk-takers than any other group.

Early adopters

The next in line to leap in the loop of trying new innovations upon realizing that its profitable and benefits accrue from it are the early adopters. These group of people are fast in linking a clever or creative innovation with their needs either personal or business needs, to facilitate development and growth of either their personal lives or businesses. They are always competing with their peers and trying to gain a competitive advantage over each other for personal growth, prestige, be a leader, in the business market or social settings (Rehfuess *et al.,* 2013). Early adopters are ambitious people as they burn with desire to become trend setters in economic success, business connection, information, as well as social reputation and respect, aspects the aid innovation take off with positive forces, as they become the innovation spreaders in the market.

Early majority

If the product or an innovation escapes the chasm and reaches the majority audience, the early majorities are the group of people who need solid and trustworthy information and evidence about the success factor of an idea, behavior, or product before making a decision. They form the comfortable group seeking moderate progressive innovations,

ideas, and products as well as they are the pragmatists in the community. These people adapt product fast is its endorsed by a reputable figure in the society, market, or industry, they are very sensitive to cost and expenses and are risk averse; they demand for collateral, proof, guarantee for success before venturing into new areas or products.

Late majority

The group that have a phobia for not fitting in, opinions of laggards, fear to influence their decisions, thus, they wait for the mainstream fashion and well-set standards before reaching a decision on the product or a new innovation. They are conservative group that can only be lured into adopting new ideas and products by proving to them that product is socially acceptable and other conservative folks like them have adopted the product, as well as emphasizing the risks of being lift out by the rest of the convective community.

Laggards

Laggards are bounded by tradition and they form a group of people that are extremely conservative and considers all new products, ideas or innovations as being very risky, hence they dare not try it. These people lack sleep over night regurgitating over the thoughts and all possible reasons against trying new things by assessing the risks in their minds over and over again. Although, to some extend they might be right and they are only being innovators who are challenging new business ideas to gauge their viability.

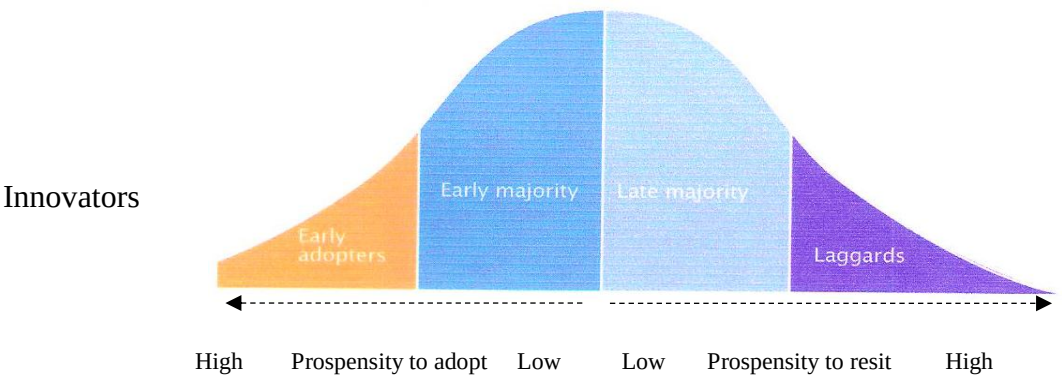

Figure 2.3: Population can be segmented into five units for any new technology as the diffusion scholars believes.

2.8 Theory of change on improved cookstoves market transformation

Theory of change is an explanation of how and why a particular intervention will lead to a certain desired change or impact (Rwiza, 2009).

Improved cookstoves market transformation involves change beyond the confines of individual projects. Atteridge *et al.*, (2013) postulates potentially that, consumers or adopters must beoadly accept new way of preparing food, improved innovations and better energy for a postive change to be experiened. Market transformation implies a transition from one-off financial inputs to a scaled–up and self- sustaining market place made up of producers, distributors retailers merketers, consumers, after sales support and financial services.

The transition from traditional cooking to one based upon new practices (improved cookstoves) technologies and fuels require more than a transfer of hardware (Johnson *et al.,* 2012). Hence there is increasing recognition that efforts to achieve improved cookstoves market. Transformation must address multiple factors (Rehfuess *et al.,* 2013) such as technical specifications, design, quality, acessibility, finance and the enabling environment. They can be classified as follows;

2.8.1. Understanding what users want and how to shift behaviour and mobilise demand for Improved Cookstoves adoption.

In the first place, the technical specifications of the stoves used adopted must actually meet the goals of improved energy eficiency and reduced emissions. A second important is the desiraility of the profuct for their satisfaction and function, culture and social norms, apropriateness and advancement better than the older stoves or traditional three stoves fire (Rehfuess *et al.,* 2013, Shrimali *et al.,* 2011).

This ordinarily requires making design of the device for a particular purpose. (Simon *et al.,* 2012) espcially those living in rural areas like Thuti village, Othaya county. Investing upfront in market research and applying a user- centred approach to the design of the stove can help ensure the development of a final product that users are motivated to purchase and adopt (Lambe and Altridge, 2012). Provision of concrate results to the user for example, reduction in fuel expenses, the household has a bonus to adopt any stove fairly well (Brinkmann *et al.,* 2014). The stove must also be durable. For example, many users are in rural locations where the breakdown of a stove will simply result in it being discarded and abandoned which will harm the Improved cookstoves programmes reputation by various stakeholders. The study also has shown the importance of after sale benefits such as repairs, warranty etc (Brinkmann, *et al.,* 2014).

2.8.2. Finding appripriate business models

This is important to achieving a sustainable market where enterprises earn enough to keep going, users can aford the product and financial backers get an adequate return on their investment. Inadequate assets including financial, human capital is a frequently cited factors affecting adoption of improved cookstoves. Shrimali *et al.,* (2011)

postulates that access to seed capital for market research, product design and basic marketing is essential, lest improved cookstoves enterprises may try to get off the ground on the demand side, even if new technologies fits users requirements, while some of the poor families ocassionaly are unable to manage cost of new innovations for cooking. Therefore, sustainable funding systems for example, allowing households to pay through instalments and loan facilities accessible through small and midium exterprises to market these improved stoves, will help overcome this barrier.

2.8.3. Creating enabling and regulating environment

To ensure a dynamic cookstove market, the enabling and regulating environment must actively support innovation, enable scale-up and facilitate competition. Learning needs to be harnessed to bring better and more affordable technologies to users. Standards are also important at the onset, to ensure that poor quality products do not harm market penetration and development. Studies of improved cookstoves sector in India (Atteridge, *et al.*, 2013) emphasizes the significance of mechanisms that support technological experimentation to find out various avenues, business types, forward investment in market segmentation with the application of user- centre phenomena to the design of the stoves. This will facilitate technology disemination in order to create awareness that do not depend of subsidies. Therefore, these depend on the basis for a systems approach to improved cookstoves market transformation which emphasies the importance of linking multiple stakeholders in order to contend with and successfully overcome multiple interrelated barriers to adoption of improved cookstoves amongst households in rural settings.

2.9. Conceptual framework

This section provides a context for interpreting the study findings by explaining clearly the relationships between independent and dependent variables as figured below; Here, the study forecast on assessment of types cooking devices available, accessibility, information on their characteristics on whether they can meet the rural folks cooking needs. On the other hand, the analysis of socio-Economic variables that do influence adoption and usage of improved cooking devices for example, family size, income, gender was done. More importantly, the assessment of physical and environmental factors comes handy for the study to provide indicators to research problem. Market penetration and dissemination of information on new and improved cooking devices will also give impetuous to the study and allowed the researcher derive more data on adoption for better analysis (Masera *et al.*, 2000).

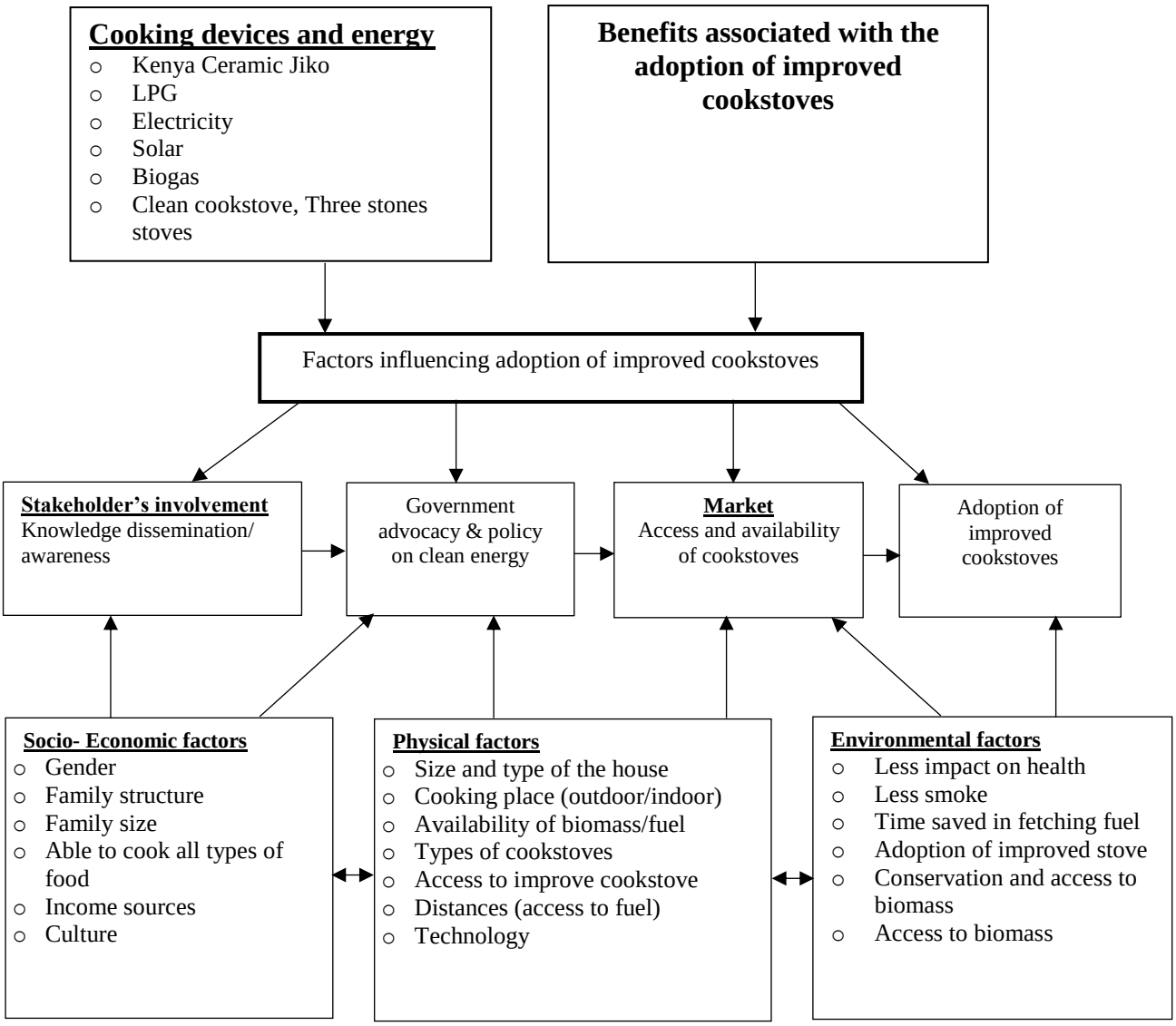

Figure 2.4: Conceptual framework, 2018

Source: Adapted from Simon, (2006)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter deals with the Methods of study. Under this section, the selection study area, description, research design, study population, sampling design and procedures, data collection and instruments, data collection procedures, data processing and analyzing procedures, and model specification are presented.

3.2. Area of study

The study was conducted in Thuti Sub-location in Karima, one of the four locations in Othaya Sub-County, Nyeri. Othaya town is situated in the southern part of the county of Nyeri, which is nestled between the scenery slopes of the Aberdares range to the west and the majestic peak of Mount Kenya towards the North- East which is the second highest mountain on the continent. The name Nyeri, originating from Nyiro, a Maasai word referring to color red, denoting red volcanic soil of the area, which is referred to as Nitisoi (Ngugi, 1988). And during the colonial times the name was changed to Nyeri by white colonial settlers.

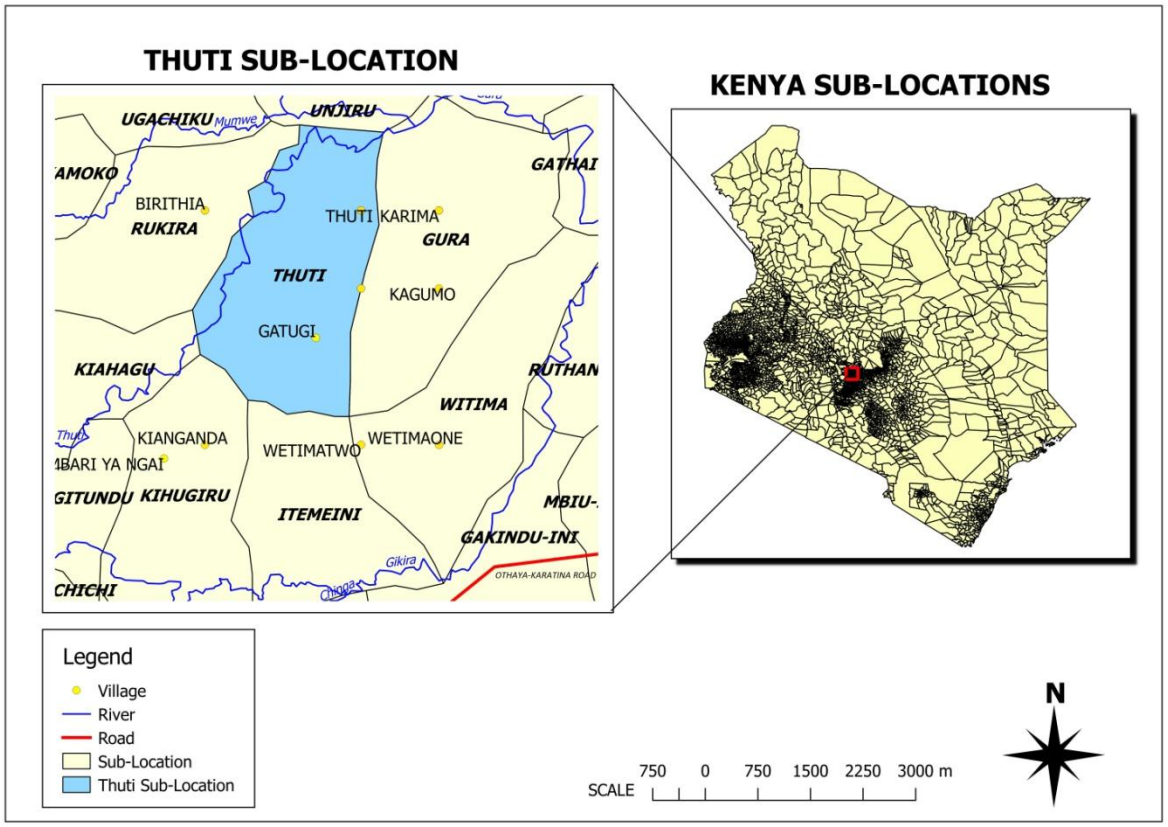

Figure 3.1: Map of Thuti Location

Source: (Survey of Kenya, 2017)

3.3. Biophysical features and land use

Othaya is located at 1850 meters above seas level, making it relatively cool and neat boosts with the lowest temperatures in Kenya of 12°C during the cold months while on the other hand, 27°C in January to March and September to October. The average annual rainfall ranges from 2,200mm in the most exposed eastern parts of the Aberdare ranges to about 700mm on the Laikipia plateau in the North (Jerneck, 2014).

The main economic activity in the region is coffee and tea farming as well as small subsistence farming. Majority of the residents in the area are unemployed and most of them are poor with a small group, with the middle class consisting of teachers, nurses, and other public servants (Njogu, 2011). To build a climate-resilient green economy,

Kenya's Vision 2030 mandate is to achieve middle-income status by 2030 and ensure sustainable development (Lewis and Pattanayak, 2012). Consequently, for this dream to become a reality, one of the priority areas identified by the Kenyan Government is to use efficient and sustainable energy amongst the rural households. And for the success of disseminating programmes in order to realize the potential benefits of improved cookstoves, factors influencing the household's adoption and usage are to be assessed (Puzzolo *et al.*, 2013).

The following are demographic figures of Thuti Sub-location, Othaya County as per 2009 population Census. Number of households; 1006, Density; 487, Area in Square Km; 7.5 and Total Population; 3650 (Male persons; 1716 and Female persons; 1934).

3.4. Research design

Choosing a design for a study involving selecting the most appropriate methods or techniques to solve the particular problem. Under study, it's a crucial step in research because it determined the outcome of the research. According to Cooper and Schlender (2013), research design is the bottom line of realizing goals of a research.

I used a cross-sectional survey design to collect, analyze and make conclusions about use of improved cookstoves at a single period. The data variables included respondent's age, and family size, price of cooking devices, education level, marital status, source of cooking devices, cooking energy/fuels, types of cooking place, house and socio-cultural factors. The research aimed at assessing the factors influencing adoption of improved cookstoves among the households in Thuti location, Othaya. With regard to data source and the researcher used both primary and secondary sources.

3.5. Sample population and sampling design

Population refers to an entire group of individuals, events or objects having common observable characteristics (Cooper and Schlender, 2013). He further postulates that, population is the aggregate of all that confirms to a gun specification. The target population to the population to which a researcher wants to generalize the results of the study. Sampling is the procedure in choosing a representative from a described inhabitant with the intention that the sample reasonably depicts that population of an area. According to Mike Mclendon (2006) sampling is the selecting a subset of units to be observed from a large aggregate called population.

3.6. Study population

The target population of this study constituted the 1006 households in Thuti Sub-location Othaya sub-county, Nyeri County. The households within the 10 villages, namely Gikeu, Mbuki, Kinaiyu, Gatugiini, Mbari Ya Ngai, Thuti, Kiangware, Karathi and Kagongo were surveyed as stakeholders to assess cooking devices they have, factors responsible for adoption of improved cooking devices and benefits associated with adoption of improved cooking devices as independent variables.

3.7. Sampling strategy and sample size

The study selected ten villages from Thuti Sub-Location by randomly picking the first household on the left and the third on the right among the villages. Since it's in these rural Villages of Thuti, most of improved cooking devices had been introduced and disseminated (Benson and Natalie, 2016). The results of the research could be generalized to all rural villages in Thuti Sub-location. Using random sampling, the sample size was 101 households from the nine villages of Thuti Location-10% of 1006

households. Therefore, this was achieved by the following formula as postulated by Smith, (2013).

Sample Size = (Z score) ^{2} – Standard Deviation (1- STD Dev.) divided by Margin of error. Taking 95% confidence level, 0.5 Standard Deviation and a Margin of error of plus or minus 5%.

$$(1.96)^2 \; x \; 99.5 \; (0.5)^2$$

$$(101) \; x \; 0.25) \; /.0025$$

101 Households were necessary for the study.

3.8. Research instrument

This researcher collected both primary and secondary data. The primary data interview schedules, focused group discussions and observation guides. The secondary data for example information on market access was reviewed through, literature search using books, journals, periodicals, and relevant dissertations.

3.8.1 Data collection methods

Both quantitative and qualitative approached were used due to the nature of the study. The study involved assessment of the types of cooking devices and energy used among the households which was assumed to have been influenced by factors such as cost and effectiveness of the cooking devices and energy used. The qualitative approach enabled the researcher to make an in-depth investigation of the variables related to adoption of improved cookstoves. Both qualitative and quantitative methods were used to collect data that comprise of structured and semi- structured interview checklist for focus group

discuss (key formant) and field observation. This was necessary because of the variety of information that was required to yield three objectives. Different methods and procedures were used to collect data as discussed below.

3.8.2 Interview

The researcher adopted the interview method as a result of successfulness, ability to capture both unofficial and official parameters (Kothari, 2005). The interview was made open and close ended questions. The open-ended questions were designed to collect information relating to actual and expected returns on respondents, study area characteristics and their relations to adoption of improved cookstoves among the households in Thuti.

More so, closed ended question captured information on respondent's response on adoption of improved cookstoves. This was grouped into four parts; the first part was meant to gather data on household features, part two was aimed at getting information on the type of cooking devices and energy used by households. Part three was designed to capture information on factors influencing adoption of improved cookstoves and part four was primarily concerned with determination of benefits associated with adoption of improved cookstoves (Rwegeshora, 2006).

To collect the data on variables that influence and determine the improved cookstoves adoption among the households of Thuti Location, a structured questionnaire was used. This was developed in English and translated in the field by data enumerators to enable the rural respondents understand in depth and give accurate information. Prior to data collection, questionnaire was pretested followed by reconnaissance (*See Appendix II*).

3.8.3 Key informant

Key stakeholders/informants of improved cookstoves were interviewed to enrich the study information collected. These included local administration, government officers like agricultural officers, forest officers, health Officers and CSOs focusing on stakeholder's efforts and where improved cookstoves dissemination on benefits and barriers of adoption plays an important role to influence the households.

3.9. Data analysis

The research used both descriptive and inferential statistics. The descriptive statistics of frequency, regression, cross tabulation, mean and deviation were used in analyzing the data collected through questionnaires.

These statistics were utilized to assess, evaluate and determine the type of cookstoves and energy/ fuels used, factors influencing adoption and benefits associated with the adoption of improved cookstove among household of Thuti location, Othaya Sub-county, Nyeri county Kenya.

3.9.1. Data presentation

Figures and cross-tables for example pie-charts and Histograms were utilized to effectively relay data for various variables in the study. Conclusion, recommendation and discussion were based on computed percentages, frequencies and extents of the data analyzed.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results on information on the households, the cooking devices used, factors affecting adoption of improved cook-stoves and benefits of adopting and using improved cookstoves among the households of Thuti Location, Othaya, Nyeri County.

4.2 Household characteristics

The data collection covered 10 villages with the numbers and frequencies for each village (Table 4.1).

Table 4.1: Respondents per villages

Name of Village	Frequency	Percentage
Thuti	23	22.8
Kagongo	5	5.0
Kinaiyu	10	9.9
Gatugi	9	8.9
Gikeu	15	14.9
Gatugiini	6	5.9
Mbariya Ngai	5	5.0
Kiangware	12	11.9
Karathi	5	5.0
Mbuki	11	10.9
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.2.1. Position of respondents in the household and household size

Among the respondents, 78% were women in the homestead with men making 13% while daughters, sons, relatives, grandmother and granddaughters accounted for 10%. The size of the households ranged between 1-2 at 24.8%, with most of households at 66% having between 3-5 individuals while few households had 6-8 individuals (8.9%). This study concurs with the findings of Karanja (2000) that family size of 1-3 and 4-6 people served to have adopted more energy saving cooking devices as compared to a family of size of 7-9 and 10-12 individuals. The results showed that households of between 3-5 members adopted the use of improved cookstoves at 67% followed by those of between 1-2 members at 25% for their cooking (Table 4.2, 4.3).

Table 4.2: Position of the respondents in the household and household size

Household head	**Frequency**	**Percentage**
Men	13	12.9
Women	79	78.2
Daughter	2	2.0
Son	3	3.0
Relative/Guardian	1	1.0
Grandmother	2	2.0
Grand daughter	1	1.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

Table 4.3: Cross tabulation of types of cooking devices used and household size

Types of cooking devices used	Household sizes			Total
	1-2	3-5	6-8	
Traditional three stones	7	14	2	23
Improved three stone	12	36	6	54
Multi-purpose stove-wood/charcoal	2	1		3
Metal casing jiko		1		1
LPG	1	1		2
Ceramic jiko		3	1	4
Jikokoa	1	1		2
Pot jiko		2		2
Biogas		1		1
Concrete insulated firewood cookstove	1	3		4
Scode firewood cookstove	1	1		2
No response		3		3
Total	**25**	**67**	**9**	**101**

Source: (Thuti Location, 2017)

4.2.2 Age of respondent

The results indicated that majority of the respondents surveyed were females (84.2%) while males were 15.8%. On age variation, 27.7% of the respondents were aged between 50-59 years, 30-39years and above 70 years were 22.8% indicating that women are more involved in cooking and cooking devices affairs in the families (Table 4.4).

Table 4.4: Age bracket of respondent

Age Bracket of Respondents	Frequency	Percentage
20-29	5	5.0
30-39	23	22.8
40-49	14	13.9
50-59	28	27.7
60-69	8	7.9
Above 70	23	22.8
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.2.3. Education level and household type

Technologies are knowledge intensive and require considerable management input (Chaudhuri, 2003). According to the result, those who had higher education levels-college Diploma and undergraduate had adopted new technologies were 8%, whereas those with lower education level were the majority at 75%. This is tallying with (Barnes *et al.*, 2011) who postulated in his research, that education is negatively related to adoption of improved cookstoves (Table 4.5).

Table 4.5: Cross tabulation of types of cooking devices used and education level

Types of Cooking devices used	Education level of respondents					Total
	Primary Level	Secondary Level	College Diploma	Undergraduate Degree	None	
Traditional three stones	8	9			6	23
Improved three stone	18	25	1	1	9	54
Multi-purpose stove wood /charcoal			2		1	3
Metal casing jiko	1					1
LPG		2				2
Ceramic jiko		2	2			4
Jikokoa	1				1	2
Pot jiko		2				2
Biogas	1					1
Concrete insulated firewood cookstove	2	1			1	4
Scode firewood cookstove	1		1			2
No response	2		1			3
Total	**34**	**41**	**7**	**1**	**18**	**101**

Source: (Thuti Location, 2017)

4.2.4. Nature of land holdings and farm size

The results indicate that 97% of the respondents owned family inherited land, 2% bought private and 1% rented household land for their dwellings and use (Figure 4.1).

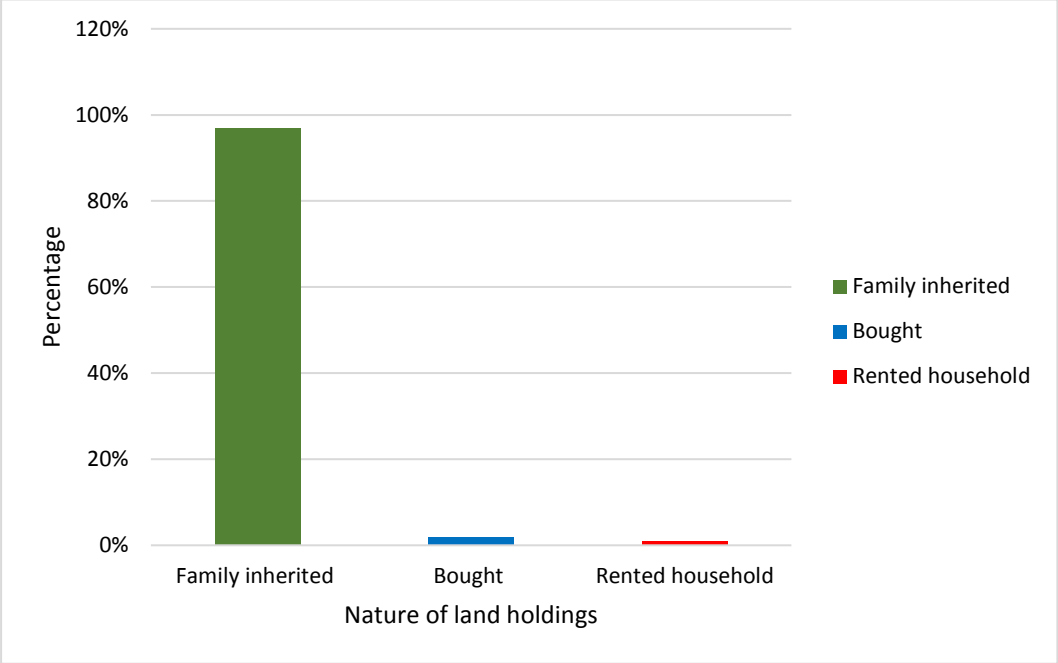

Figure 4.1: Nature of land holdings

The findings showed that majority of the households have land sizes of less or equal to an acre (45%), 1-2 acres at (30%), 1-3 acres (14%), while those with land sizes between 1-5 and above 5 acres represent (4%) each and 1-4acres (3%), (Figure 4.2).

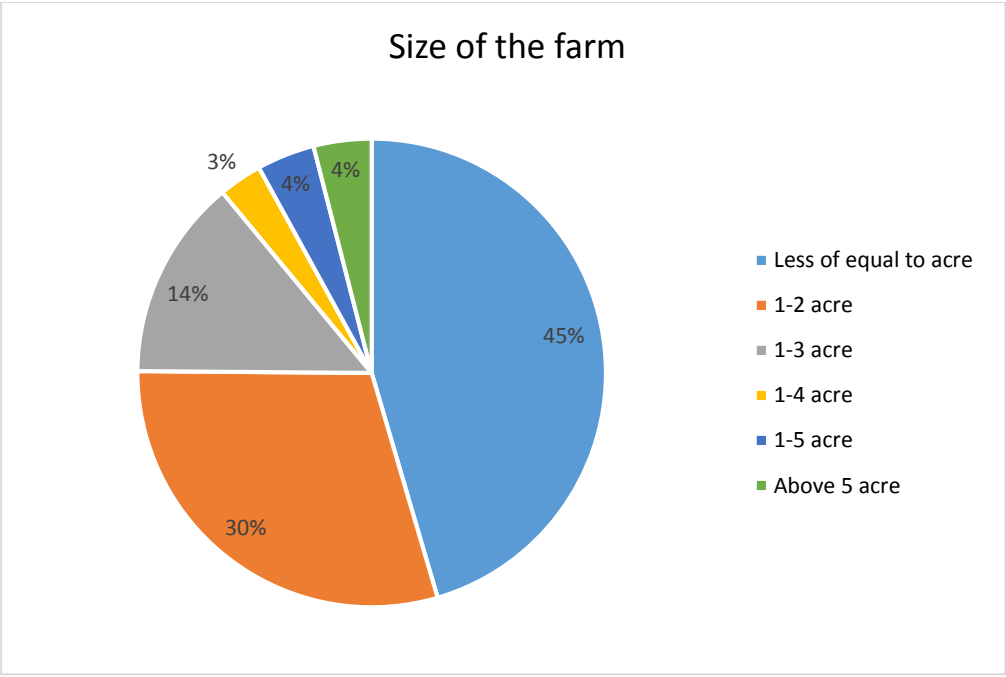

Figure 4.2: Size of the farm

4.3 Types of cooking devices and fuel sources

Different types of cooking devices were observed among the households in Thuti including traditional three stones, concrete insulated firewood cookstove, scode firewood cookstove, improved three stones, multi-purpose stove, metal casing jiko, LPG gas, ceramic Jiko, Jikokoa, Pot jiko and Biogas as the major cooking devices.

Among the 101 households surveyed, majority acknowledged having improved three stones as a cooking device at 53.5% while those still having the traditional three stones at 22.8%, followed closely by ceramic jiko and concrete insulated firewood cookstove at 4% each (Table 4.6).

Table 4.6: Types of cooking devices

Types of Cooking Device	Frequency	Percentage
Traditional three stones	23	22.8
Concrete insulated firewood cookstove	4	4.0
Scode firewood cookstove	2	2.0
Improved three stone	54	53.5
Multi-purpose stove-wood/charcoal	3	3.0
Metal casing jiko	1	1.0
LPG Gas	2	2.0
Ceramic jiko	4	4.0
Jikokoa	2	2.0
Pot jiko	2	2.0
Biogas	1	1.0
Not applicable	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.1. Type of cooking device used

According to DFID (2000), several types of cookstoves are used by households and these stoves are often associated with specific energy types. Traditional three stones, simple non-traditional for example clay pot-style, or simple ceramic liners, charcoal and gasifier stoves use solid fuels which are common in rural areas of most developing countries. In contrast, more modern cooking stoves, such as LPG, natural gas and electric are common in urban areas of both developing and developed countries. In this study, twelve different cooking devices were identified in the study area *(see Appendix I)* these were; traditional three stones, multi-purpose cooking stoves, wood/charcoal and improved three stones being the most common accounting for 26.7%, 22.8% and 20.8% respectively, as most commonly used cooking devices in rural Thuti (Figure 4.3).

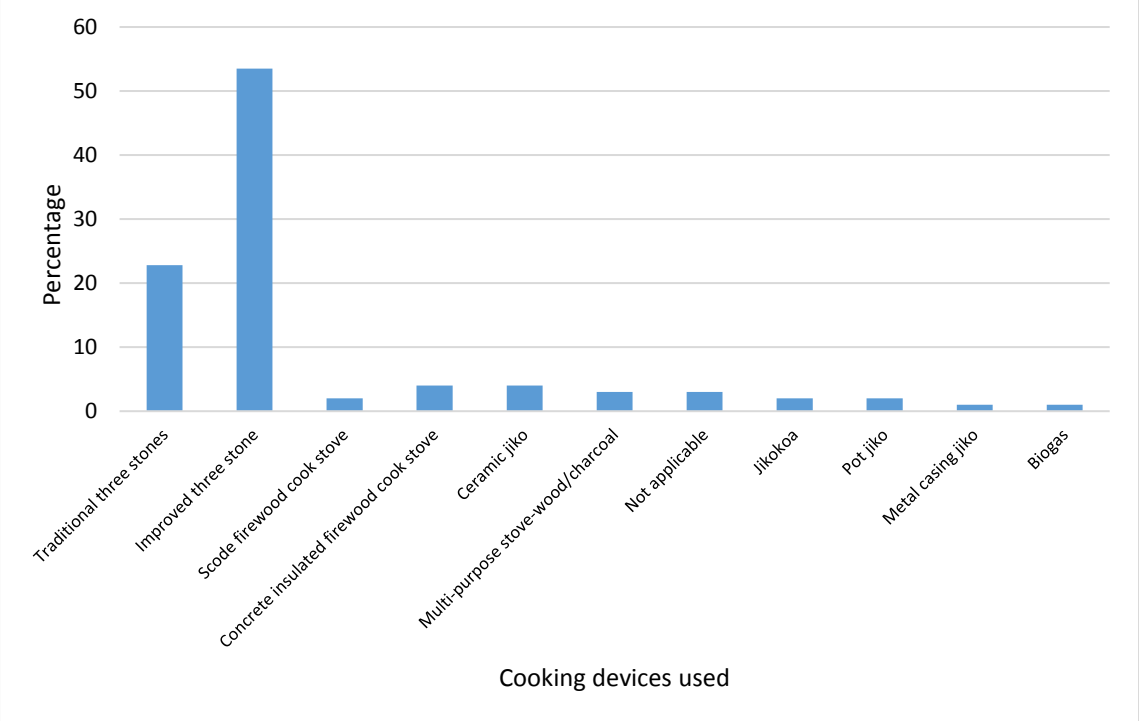

Figure 4.3: Types of cooking devices used in Thuti

4.3.3 Cooking dynamics in Thuti

The results showed that major changes in cooking devices switch occurred between 2006 and 2015 where adoption of improved three stones, concrete insulated stoves, multi-purpose/wood/ charcoal stoves, ceramic jiko, jiko koa, port jiko were realized (52.4%). The result further showed positive changes before 2000 to 2005 (24.7%). While above 2015, further switch of about 11% was realized (Figure 4.4).

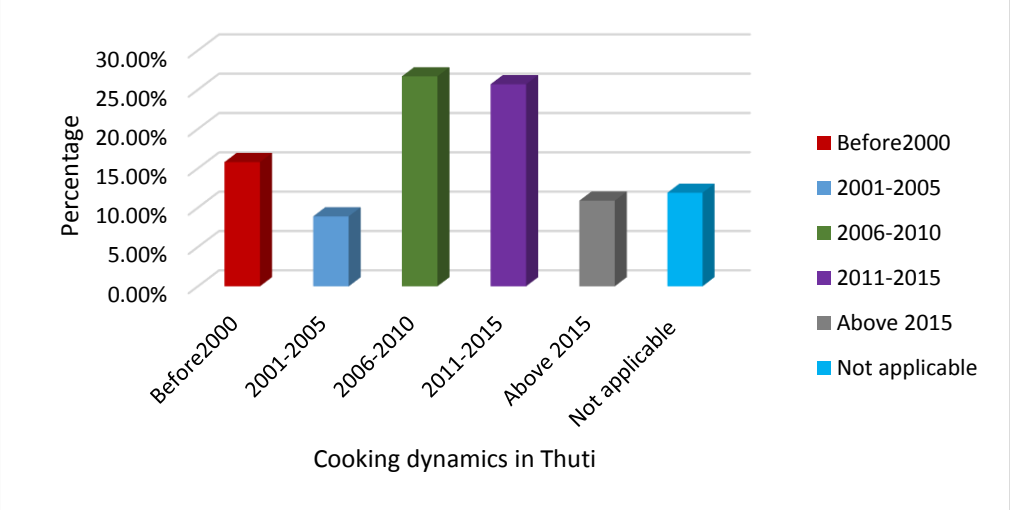

Figure 4.4: Cooking dynamics in Thuti

4.3.4. Source and its influence on cooking device

The result showed that about 37.6% of respondents indicated that the cookstoves were made at home, 29.7% from nearest urban centre- Othaya shopping centre and 12.9% got their cooking devices from nearby small shopping centre-Gatugi. This shows that the local households preferred the devices they are sourcing locally. This was facilitated by the availability of various dealers of improved cookstoves in Thuti. According to the results, about 42.6% of dealers were Jua kali, followed by FIPS Company Africa and Gikeu energy saver group based in Thuti village at 5% and 4% respectively (Figure 4.5).

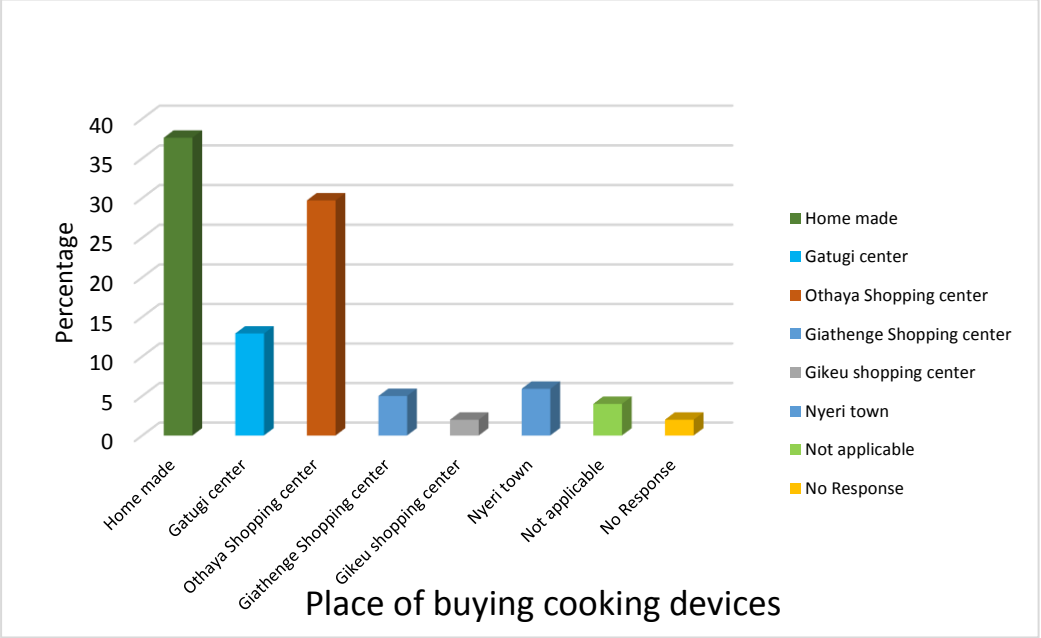

Figure 4.5: Place of buying and price influence on cooking device

The analysis on the prices of cooking devices revealed that those whose prices were less than 500/- were 29%, those priced between 500-1500/ were 43%. The study revealed similar findings by Puzzolo *et al.*, (2013) and Gebreegziabher *et al.*, (2010) that found price is one determinant factor that influences improved cookstoves adoption amongst the households (Figure 4.6).

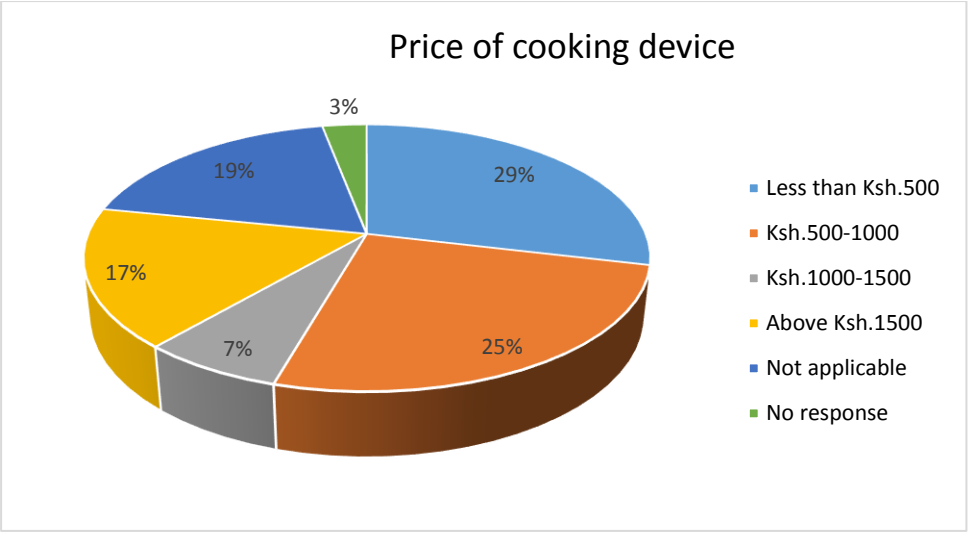

Figure 4.6: Price of cooking devices

4.3.5. Type of cooking energy/fuels

Among the 101 households surveyed, 43.6% indicated that they use firewood from own farm and 21.8% from own farm and firewood purchased for their cooking. For the quantity of cooking energy/fuel used per week, majority of the households use between 0-5Kg per week (72.3%) and 51-100Kg per week (13.9%). On the price, respondents indicated the use of energy/fuel monthly less than 500/- (56.4%) followed by between 500-1000/- (18.8%) while on distance covered to get cooking energy/fuels and preferred uses, the results showed that most of the respondents walk between 1-2kms (77.2%) and 70.3 % of the households, prefers use of energy/fuels for cooking and warning (Table 4.7).

Table 4.7: Type of cooking energy/fuels used

Types of Cooking Fuels/Energy Used	Frequency	Percentage
Firewood from own farm	44	43.6
Firewood purchased	18	17.8
Firewood purchased and from own farm	22	21.8
LPG Gas	9	8.9
Charcoal	2	2.0
Farm Residues-Maize stalks, dry leaves, Maize cobs / 1	1	1.0
Others	2	2.0
Decline to answer the question	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.6. Factors influencing choice of cooking devices

The results indicate that among the respondents surveyed on factors influencing their choice of cooking devices, 30.7% indicated the cooking device as economical, fuel

saving at 18.8% and being able to cook faster and therefore saves time while cooking at 17.8% and 11.9% indicated the availability of fuel wood as a factor influencing choice of cooking devices amongst the households.

Modi *et al.,* (2006) alluded that advancement towards the provision of greater access to modern energy services has been slow, due to a combination of interrelated circumstances. These include low income levels among the unnerved population, lack of financial resources for service providers to build the necessary infrastructure and reduce the first cost barriers to access, weak institutional, Financial, legal structures and government involvement. Improved cookstoves are more attractive in those households that experience a scarcity in wood fuel resources since they will benefit significantly from the performance of the stoves (Table 4.8).

Table 4.8: Factors influencing choice of cooking device

Factors that influences choice of cooking Device	**Frequency**	**Percentage**
Lack of finance	2	2.0
Traditional method	3	3.0
Fast in cooking	18	17.8
Fast and fuel saving	3	3.0
Economical	31	30.7
Fuel saving	19	18.8
Lack of alternative	5	5.0
Less smoke produced	2	2.0
Easy to use	3	3.0
Availability of fuel wood	12	11.9
Decline to answer the question	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.7. Place of cooking and reasons

Among the households surveyed, 70.3% cook indoors while 29.7% cook outdoors due to various reasons. Those who declined to give reasons for cooking outdoor were 70.3% while 18.8% cooked outdoor to avoid smoke in the house, 8.9% to provide enough space in the house. On the other hand, 57.4% of the respondents indicated protection from harsh weather conditions and 5.9% more secure when cooking with devices indoors (Table 4.9).

Table 4.9: Reasons for outdoor/indoor cooking

Reasons for outdoor cooking	**Frequency**	**Percentage**
To avoid smoke in the house	19	18.8
To avoid excess production of heat	2	2.0
To provide enough space in the house	9	8.9
No response	71	70.3
Reasons for indoor cooking		
Protection from harsh weather conditions	58	57.4
It's more secure	6	5.9
It's a culture	1	1.0
Privacy	1	1.0
Cooking device used is smoke free	4	4.0
Need a place to store utensils	1	1.0
Decline to answer the question	30	29.7
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.8. Cooking devices used during the day and night

The result showed that most respondents use improved traditional three stones during day time (40.6%) and traditional three stones at (25.7%) while about 75% citing reasons of being economical-cooking faster and fuel saving. This is also asserted by Slaski and

Thurber (2009) that the determinants of adoption of a new technology is inherent incentive or motivation because of human beings by nature of resistant connected with the perceived value of the new product or service. Furthermore, cooking at night is also influence by the number of family members present compared to during the day time-where most have either gone to the farms, businesses or other work-related activities and therefore requires a lot of cooking, warming of water for bathing among other variables (Table 4.10).

Table 4.10: Cooking devices used during day/night and reasons

Cooking Devices used during the Day	**Frequency**	**Percentage**
Traditional three stones	26	25.7
Rocket stove	2	2.0
Concrete insulated firewood cookstove	4	4.0
Ceramic jiko	1	1.0
Mud insulated cookstove	6	5.9
Scodejiko	2	2.0
Metal casing jiko	1	1.0
Improved traditional three stones	41	40.6
Multipurpose stove wood	4	4.0
LPG	3	3.0
Biogas	1	1.0
Kuni Mbili	4	4.0
Pot jiko	2	2.0
Not applicable	1	1.0
No response	3	3.0
Reasons for Use During the night		
Fuel saving	5	5.0
Saves time since is fast in cooking	27	26.7
Fast in cooking and fuel saving	23	22.8
Its economical	26	25.7
Fuel readily available	4	4.0
Lack of alternative	12	11.9
Not applicable	1	1.0
No response	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.9. Special occasions for cooking devices

A research conducted in Ghana pointed out that open fires is needed in fish-smoking processes (Lewis and Pattanayak, 2012). Failure to effectively address issues like ability to use cooking device for special cooking ensures that the new cookstoves will be adopted or not. According to the study, the results showed that 22.8% of the households indicated that it was economical to cook large quantity of food for visitors followed by 5.9% able to prepare food that take longer time for example, Githeri and Chapati. The results support similar studies conducted in Guatemala. Heltberg (2005), postulates that traditional cooking practices and food tastes might make people prefer fuel-wood, even in circumstances where fuel- wood used is compared to other efficient cooking devices. According to Masera *et al*., (2000), found out that people in rural Mexico continue to use fuel-wood even when they could afford to use cleaner and modern cooking devices and fuels because cooking tortitlas on LPG is more time consuming and negatively affects its taste (Table 4.11).

Table 4.11: Reasons for special cooking devices

Reasons for special cooking	Frequency	Percentage
Economical while cooking large quantity of food for visitors	23	22.8
To prepare food that take longer time e.g. Githeri and chapati	6	5.9
Warming during cold weather	5	5.0
When there is scarcity of fuel	1	1.0
Not applicable	1	1.0
Decline to answer the question	65	64.4
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.10. Cooking fuels and rainy periods

The result showed that majority of the respondents surveyed, use firewood and charcoal for their cooking during rainy periods at 97% and 3% declined (Figure 4.7).

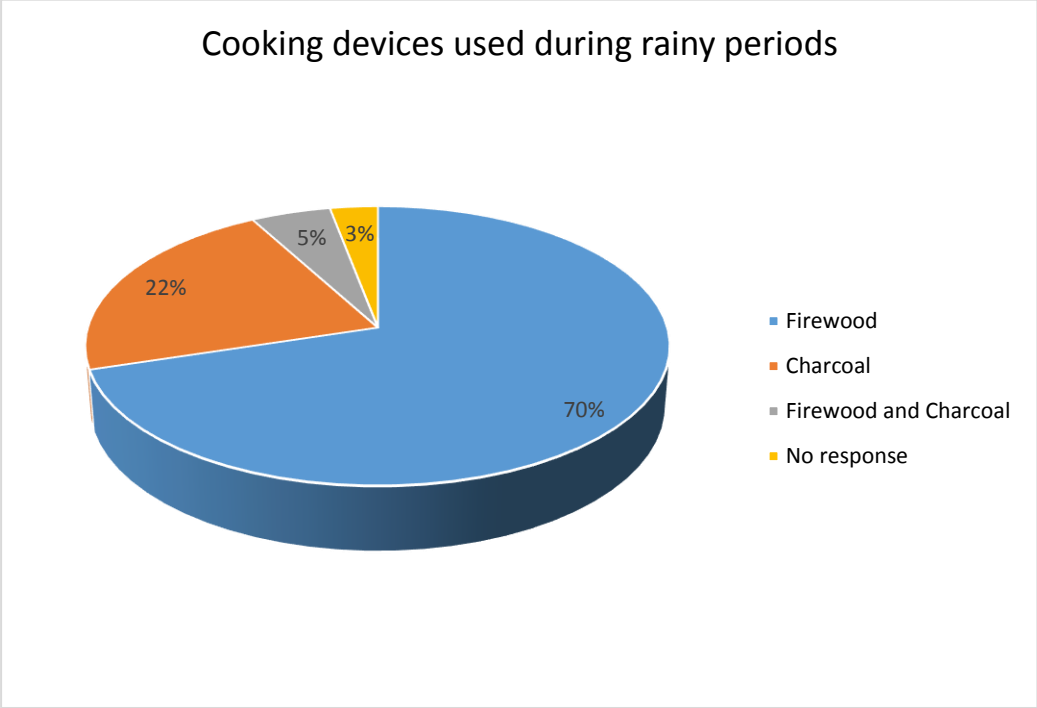

Figure 4.7: Cooking device used during rainy periods

According to the result majority of the respondents used the above cooking energy/fuel due to the provision of enough warmth, for being economical, readily available and scarcity of dry firewood at (42%, 19%, 15% and 10%) respectively. About 11% of the respondents indicated lack of alternative source of fuel, portability, and multipurpose for use as other reasons (Figure 4.8).

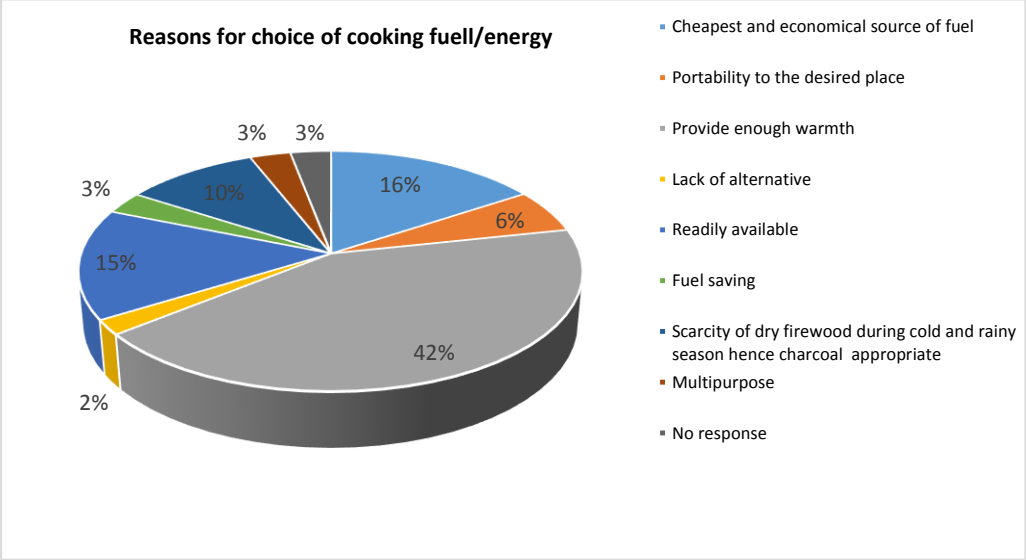

Figure 4.8: Reasons for choice of cooking fuel/energy

4.3.11. Challenges in getting cooking energy/fuels

The result indicated inadequate, unavailability of firewood and heavy to transport for long distances at 20% and 19% respectively followed closely by high prices of firewood at 12.9% as major challenges in getting cooking energy/fuels among the households (Table 4.12).

Table 4.12: Challenges in getting cooking energy/fuels

Cooking Fuel Challenges	Frequency	Percentage
High prices of firewood	13	12.9
None	21	20.8
Inadequate and unavailability of firewood	20	19.8
Take time to dry during wet season	9	8.9
Process of making biogas requires skilled manpower	1	1.0
Heavy and bulky to transport for long distances	19	18.8
Time consuming to fetch firewood	5	5.0
Lack of labour to fetch firewood	7	6.9
Tedious to split firewood	2	2.0
Requires a lot of firewood to cook	1	1.0
No response	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.3.12. Cooking fuel responsibilities

Among the respondents surveyed, majority responsible for collecting fuel were mothers at 74.3% followed by fathers at a distant 8.9%, more so, out of 101 household surveyed 52.5% indicated that fuel responsibilities do influence adoption of improved cookstoves. On challenges experienced using this fuel/energy majority of the respondents indicated that it produces a lot of smoke at 29.7% (Table 4.13).

Table 4.13: Cooking fuel responsibilities

Cooking Fuel Responsibilities	Frequency	Percentage
Mother	75	74.3
Father	9	8.9
Children	5	5.0
Laborers	5	5.0
Both (Father and Mother)	1	1.0
Entire Family members	3	3.0
Daughter	2	2.0
Well-wishers	1	1.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.4 Factors influencing adoption of cookstoves

On factors influencing adoption of cooking devices, majority of respondents surveyed in Thuti indicated cost effectiveness at 40% and availability of fuel at 27% as the major influencing factors. According to Asaduzzaman *et al.,* (2010) found out that the cost of modern fuel and lack of supply contributed limited adoption of improved cookstoves in rural Bangladesh. Use of new technology depends on its efficiency and effectiveness to perform a task. Improved cookstoves and clean fuels can save time by reducing fuel collection time and through more efficient cooking processes. This aspect is usually

highly valued by women and a direct benefit that adopters positively recognizes (Table 4.14).

Table 4.14: Factors influencing adoption of improved cookstoves

Types of factors	Frequency	Percentage
Availability of fuel	27	26.7
Lack of alternative	3	3.0
Time effectiveness in cooking	8	7.9
Lack of capital	2	2.0
Cost effectiveness	40	39.6
Durability and design	4	4.0
Level of income	1	1.0
Fuel saving	8	7.9
Reduced smoke	3	3.0
Accessibility	1	1.0
Climate change	1	1.0
No response	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.4.1 Socio – cultural factors

Out of the 101 households surveyed, the results showed that, 77.2% (78 households) had adapted whereas 22.8 % (23 households) had not adopters. Across cultural study conducted in Kenya, Nepal and Peru illustrated that cultural barrier influences improved cookstove adoption (Klasen *et al.*, 2013). For example, in India, users prefer to use large pieces and more wood, and to have a large flame when cooking, which conflict with more efficient cookstoves and designs (Troncoso, *et al.*, 2007). The results also showed that an increase in frequency of rice cooking in households reduces the likelihood of using fuelwood.

4.4.2. Household income and cookstove adoption

In the study findings, 61.4%, earn their income from subsistence farming, business 12.9%, assistance from children 8.9%, employment 7.9%, commercial farming 5.9%, and dairy farming 1%, indicating that farming is the main economic activity of Thuti People. On animals reared by households, the results indicated that 75.2% keep cows, 14.9% chicken, 1% keep goats, while those who do not keep any animal were 8.9 %.

The reasons for keeping these animals were given as source of income (89.1%), culture (1%) while those who declined were 9.9%. Indicating that this was a big supplement to the other sources of household income mentioned. Further, the results showed that majority of households earns below ksh.5000 (33.7%), followed by Ksh.5, 000-10,000 at (30.7%), Ksh.10,001-15,000, (9.9%) above Ksh.15,000 were (22.8%). This also revealed the relationship between adoption of clean energy for cooking. The result showed that those household whose average income was below 5,000 adopted and used improved three stones and traditional three stones cooking devices, while those with average household income is above 5,000, adopted and used clean energy like LPG, Biogas, Jiko Koa, Ceramic jiko among indicating a positive effect on adoption of new and advance technologies as shown in the cross-tabulation table below.

This study disagrees with Khamati (2000) findings of rural stoves devices programmes in Kenya, that the rural people are generally poor and that children and women collect their fuel for free. According to World Bank (2005), household income can be utilized as a yard stick to determine the available disposable income for use and adoption of new technologies for example the improved cookstoves (Figure 4.9).

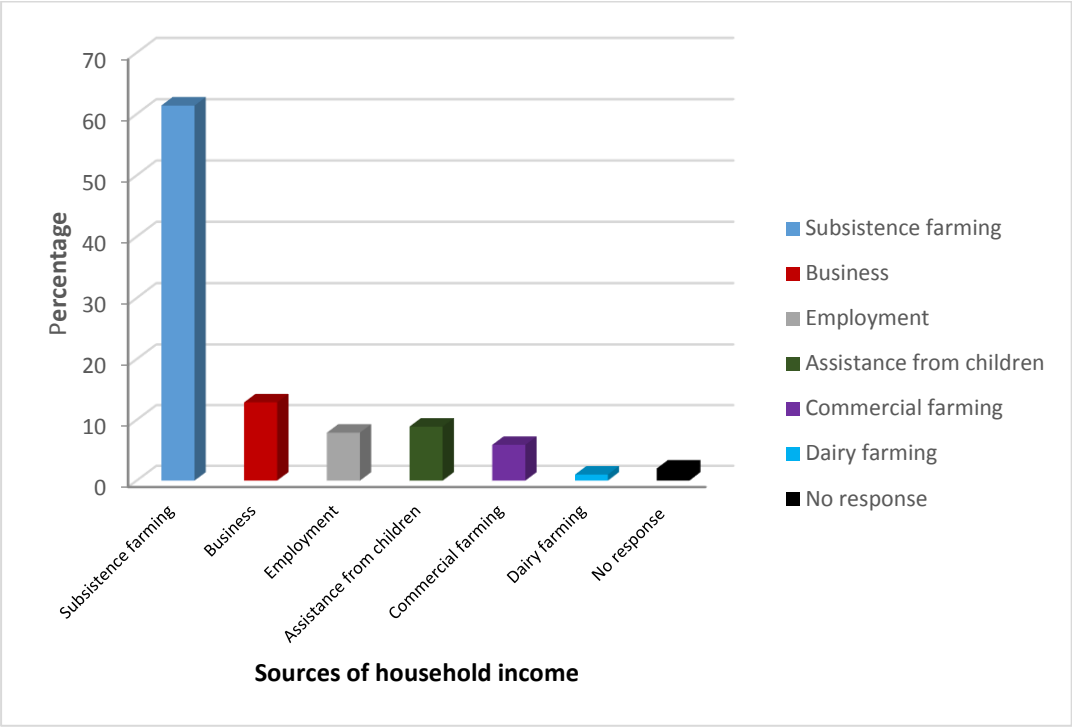

Figure 4.9: Source of household income

Table 4.15: Cross tabulation of types of cooking devices and average household income

Type of cooking Devices used	Below Kshs. 5,000	Ksh. 5,000-10,000	Ksh. 10,001-15,000	Above 15,000	No response	
Traditional three stones	15	6	1	1		23
Improved three stone	16	17	6	15		54
Multi-purpose stove-wood/charcoal	1	1	1			3
Metal casing jiko		1				1
LPG		1	1			2
Ceramic jiko				4		4
Jiko koa	1	1				2
Pot jiko		1		1		2
Biogas		1				1
Concrete insulated firewood cookstove	1	2		1		4
Scode firewood cookstove			1	1		2
No response					3	3
Total	**34**	**31**	**10**	**23**	**3**	**101**

Source: (Thuti Location, 2017)

Table 4.16: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	146.826[a]	44	.000
Likelihood Ratio	72.173	44	.005
Linear-by-Linear Association	97.749	1	.000
N of Valid Cases	101		
53 cells (88.3%) have expected count less than 5. The minimum expected count is .03.			

Source: (Thuti Location, 2017)

4.4.3. Reasons for buying the improved cook-stoves for cooking

Out of 101 respondents surveyed in Thuti, majority (69.3%) of the respondents bought the cooking devices for being cheap and economical while (21.8%) had no response. The results also indicated the frequency of use of improved cookstoves, where majority further indicated they use them three times a day at (43.6%) followed by twice a day at (33.7%) for their cooking in the household of which agrees with other studies conducted across the globe. Studies conducted by Puzzolo *et al.*, (2013), found that those specific factors of a product for example, cost, purpose, safety and performance affected stove fuel choices in Addis Ababa, Ethiopia (Figure 4.10).

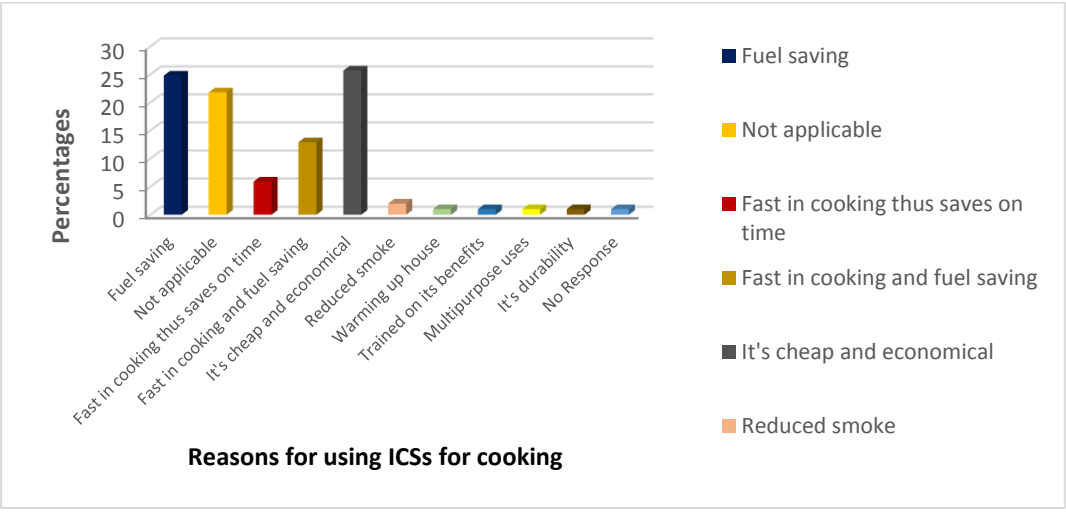

Figure 4.10: Reason for using Improved cookstoves for cooking

Table 4.17: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	84.808[a]	33	.000
Likelihood Ratio	85.277	33	.000
N of Valid Cases	101		
37 cells (77.1%) have expected count less than 5. The minimum expected count is .21.			

Source: (Thuti Location, 2017)

4.4.4. Improved cookstoves within reach to the households.

The study wanted to find out whether availability of the cooking devices influenced the households in choosing them for their use. Among the respondents surveyed, majority indicated that improved three stones are within their reach at 34% followed by multipurpose stone/charcoal and LPG Gas at 7% and 6% respectively. The results showed that most of the cooking devices used by the households were homemade and some obtained from the nearby markets of Othaya and Gatugi (Table 4.18).

Table 4.18: Cross-tabulation of improved cookstoves and sources

Types of cookstoves within reach	Local source at Othaya												**Total**
	Home-made	Othaya center	Gatugi Shopping Center	Gikeu Energy Saver group	Wakulima dairy society	Nyeri Town	Giathenge Shopping Center	Neighbour	Not applicable	FIPS Africa Company	Women Group	No response	
Improved three stones	11	11	3				4	4		1			**34**
None								1	17				**18**
Multipurpose stove/charcoal		4	3										**7**
Metal casing			1										**1**
Mud insulated firewood cookstoves	1		1	3									**5**
Concrete insulated firewood	2		2								1		**5**
Traditional three stones	1	1											**2**
Rocket stove		2											**2**
Kuni Mbili		2				1	1						**4**
Kenya Ceramic jiko		2				2							**4**
Biogas					1	1							**2**
LPG Gas		5	1										**6**
Scode insulated		1	2										**3**
Clay insulated cookstoves	2	1	1										**4**
Jiko koa	1												**1**
No response												3	**3**
Total	**18**	**29**	**14**	**3**	**1**	**4**	**5**	**5**	**17**	**1**	**1**	**3**	**101**

Source: (Thuti Location, 2017)

4.4.5. Smoke as a factor in Improved Cookstoves

The results showed that respondents acknowledging that indeed smoke is an issue were at par (45.8% each). When asked to justify why smoke is an issue, about 15% mentioned that smoke causes respiratory problems, discomfort and eye problems at 18%, coughing at 2%, allergies and smoke dirtying the house both at 1%. Others who declined to answer were 51.5% clearly indicating that people adopt improved cookstoves since smoke is not an issue once you adopt a new technology (Table 4.19).

According to Smith (2013), the use of improved cookstoves minimizes the prevalence of soot that covers cooking receptacles, walls and ceilings, clothes and persons, thereby increasing overall health through improved hygiene. Kurmi *et al.*, (2010), Po *et al.*, (2011) also finds that exposure to smoke from burning biomass fuels for cooking and/or heating is associated with increased risk of chronic obstructive pulmonary diseases (COPD).

Table 4.19: Types of smoke issues

Types of Smoke Issues	Frequency	Percentage
Causes respiratory problems	15	14.9
Eye problems	9	8.9
Coughing	2	2.0
Causes discomfort	9	8.9
Allergies	1	1.0
Not applicable	12	11.9
No response	52	51.5
Smoke will make her house dirty thus built even a chimney	1	1.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.4.6. Knowledge and perception

About 72.3% perceived improved cookstoves as beneficial and on the source information about improved cook-stoves, 45.5% and 22.8% respondent's got information from neighbors and seminar/advocacy meetings respectively, the results showed that the majority of respondents (46.5%) agreed to a great extent and 29.7% moderate, while trained people for repair and maintenance of improved cook-stoves, the results showed that majority were local jua kali dealers at 53.5% in Thuti village. This study agrees with other studies for example, Silk *et al.,* (2012), training local venders, having appropriate incentive and product integration effectively accelerated improved cookstoves implementation in Kenya.

India and Person *et al.,* (2012) studies in rural Kenya, finds that the decision to purchase improved cookstove by households was significantly influenced by the experiences of neighbors and relatives who had adopted the stoves. Likewise, Miller and Mobarak *et al.,* (2013) finds that the opinion of leaders within a community also does influence the adoption of improved cookstoves in rural Bangladesh.

On the extent at which dissemination of information on improved cookstoves influences adoption and usage amongst the households in Thuti, the result indicated 46.5% to a great extent, 29.7% moderate extent, large extent and low extent were 10.9% and 9.9% respectively. These results concur with other studies done in Pakistan and Sudan, where researchers postulated that awareness regarding the relative advantages of improved cookstoves has been significant factors for improved cook-stoves adoption in Sudan (Muneer and Mohamed, 2003) (Table 4.20).

Table 4.20: Sources of information on improved cookstoves

Source of Information on Improved cookstoves	Frequency	Percentage
Neighbour	46	45.5
Friends	16	15.8
Seminar/advocacy meetings	23	22.8
Spouse	1	1.0
Children	3	3.0
Jua kali dealers	3	3.0
Women group	2	2.0
Not applicable	4	4.0
No response	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.4.7. Improved cookstoves development programs in Thuti

To find out the existence of any development programs on Improved cookstoves amongst the households, analysis was done. Out of the 101 households surveyed, 24.8% and 8.9% indicated Wpower initiatives and FIPS Africa Company respectively as the major players in Thuti. According to Simon (2006) bridging the gap between extrinsic agencies and targeted village groups through local partners was imperative for acceptance of an improved stove project in Western India which can as well work fairly well in Thuti Village and accelerate adoption rate amongst the rural villagers.

This study concurs with other studies conducted on diffusion of improved cookstoves. For example, in India, energy requirements for cooking accounts for 36% of total energy consumption, yet diffusion of improved cooking devices is observed to be far below their estimated potential (Pohekar, 2005). To maximize the resources and take advantage of available technology, the diffusion process must be strengthening (Pine *et al.*, 2011). Depending on the level of influence, men, women and the Government are important in the diffusion process as postulated by (Ramirez *et al.*, 2013), in Honduras,

men were more effective over long distances whereas women over short distances after hearing about improved cookstove twice, active community members drove the process well (Table 4.21).

Table 4.21: Improved cookstoves development programs

Name of the Organization	Frequency	Percentage
FIPS Africa company	9	8.9
Gikeu energy saver group	3	3.0
Wpower Initiative	25	24.8
Led by an Individual called Mama chiru	7	6.9
Enena Group	4	4.0
Iriaini Tea factory	2	2.0
Not applicable	3	3.0
Doesn't know	6	5.9
Jua kali industry	1	1.0
No response	41	40.6
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.5. Benefits associated with adoption of Improved Cookstoves

4.5.1 Benefits of adopting of Improved Cookstoves

Historically, technology has clashed with user habits- how is it that the technology improvement exists as well as the knowledge of the adverse impacts from traditional cooking practices, yet adoption still lags? The missing link lies in the overall household acceptability of a new stove design relative to the traditional methods (Barnes *et al.,* 2012). Global Village Energy Partnership International suggests that there are three principal dimensions affecting adoption of any radically new product or service; motivation, affordability and the level of engagement required (GVEP, 2009).

Global analysis of cookstoves adoption reaffirms that each of the device is utilized for the cooking practices where it fits best-stacking. This concurs with my research in Thuti Villages, where the respondents were asked why they bought the improved cookstoves. The results showed that majority of the respondents (81%) bought them since they are economical and providing warmth, readily available, reduction of smoke at 7.9%, 4% and 3% respectively (Table 4.22).

Table 4.22: Benefits of adoption of improved cookstoves

Types of Benefits	Frequency	Percentage
Fuel saving	20	19.8
Fast in cooking hence saves on time	20	19.8
Fast in cooking and fuel saving	26	25.7
Cheap and economical	16	15.8
Reduced smoke	3	3.0
Provide warmth	8	7.9
Readily available	4	4.0
It's durable	1	1.0
No response	3	3.0
Total	**101**	**100.0**

Source: (Thuti Location, 2017)

4.5.2. Cooking energy/fuel preferences

The findings revealed that the choice of preferences of the households towards the cooking device dependent on the cost of the device. Majority of the households chose to use firewood from own production and firewood purchased because of the low cost incurred. The result for cross tabulation below showed a positive relationship (Table 4.23).

Table 4.23: Cross tabulation of cost and fuel/energy preferences

Costs	Preferred types of cooking energy/fuel						Total
	Firewood from own production	Firewood purchased	LPG Gas	Charcoal	Biogas	No response	
Less than 200	18	1	6		1		26
Ksh.200-500	15	2	9				26
Ksh. 501-1000	10	5	3	1		2	21
Above Ksh.1000	15	6	5		1	1	28
Total	**58**	**14**	**23**	**1**	**2**	**3**	**101**

Source: (Thuti Location, 2017)

4.6 Correlation and coefficient determination

To quantify the relationship and strength of the relationship between variables, the study used Karl Pearson's coefficient of correlation. This is a measure of the strength of a linear association between two variables and is denoted by ***r.*** which can take a range of values from **+ 1** to **-1. A** value of **0** shows that there is no correlation between the two variables, while a value greater than **0** indicates a positive association or significant (i.e. the value of one variable increases so does the value of the other variable). And a value less than **0**, shows a negative association (i.e. the value of one variable increases as the value of the other variable decreases)

4.6.1 Cooking devices and adoption of improve cookstoves

According to the table below, there is a positive relationship between the adoption of types of cooking devices and gender, average income of household, households size and cost of cooking devices (**r**=0.074, 0.989, 0.044) respectively. The results indicate that there is correlation between adoption of improved cookstoves and gender, average

of household income, household's size and cost of cooking devices in Thuti villages. This despite, all factors had a significant p-value **(p <0.05)** at 95% confidence level. From the Pearson's correlation coefficient, average household income was the most significant determinant where **r** = 0.989. This finding is consistent with Manyan *et al.*, (2009) who found out a significant relationship between average household income and economic status of rural household and adoption of biomass stoves. On the other hand, there was no significant relationship between age of respondents, education level, and land size as value **of r = .0.083, 0.082** and **0.026** showing non-significant (Table 4.24).

Table 4.24: Correlation analysis of types of cooking devices

Variable tested		**Type of cooking device**
Age bracket	Pearson Correlation	-.083
	Sig. (1-tailed)	.206
	N	101
Household size	Pearson Correlation	.044
	Sig. (1-tailed)	.330
	N	101
Gender	Pearson Correlation	.074
	Sig. (1-tailed)	.230
	N	101
Education Level	Pearson Correlation	-.082
	Sig. (1-tailed)	.207
	N	101
Land size	Pearson Correlation	**-.055**
	Sig. (1-tailed)	**.293**
	N	101
Cost of the cooking device	Pearson Correlation	**.192***
	Sig. (1-tailed)	**.027**
	N	101
Distance covered to buy your cooking Device	Pearson Correlation	**-.026**
	Sig. (1-tailed)	**.398**
	N	101
Average income of household	Pearson Correlation	**.989****
	Sig. (1-tailed)	**.000**
	N	101

****. Correlation is significant at the 0.01 level (1-tailed).**

***. Correlation is significant at the 0.05 level (1-tailed).**

Source: (Thuti Location, 2017)

4.6.2 Types of energy/fuels used for cooking

The results show that there is a positive correlation between adoption of cooking energy/fuels with types of cooking devices used for cooking, education level, farm size and average household income where value of *r = 0.454, 0.023,0.043* and *0.083*, where all these factors had a *95%* confidence level and *p* value **(p<0.05)**. Other factors such as household size, gender, age and cost of cooking devices showed a negative significance indicating that there is no relationship between adoption of cooking energy /fuels and them as can be seen in the table below-where value of ***r = -0.005, - 0.006, -0.035 and – 0.291, p > .0.05*** respectively (Table 4.25).

Table 4.25: Correlation of types of cooking energy/fuels used

Variables Tested		**Type of cooking energy/fuels used**
Type of cooking energy/fuels do you use	Pearson Correlation	1
	Sig. (2-tailed)	
	N	101
Household size	Pearson Correlation	-.005
	Sig. (2-tailed)	.964
	N	101
Gender	Pearson Correlation	-.006
	Sig. (2-tailed)	.950
	N	101
Age bracket	Pearson Correlation	-.035
	Sig. (2-tailed)	.725
	N	101
Education Level	Pearson Correlation	.023
	Sig. (2-tailed)	.823
	N	101

Farm size	Pearson Correlation	.043
	Sig. (2-tailed)	.668
	N	101
Type of cooking device used for cooking	Pearson Correlation	.097
	Sig. (2-tailed)	.337
	N	101
Type of cooking device used for cooking	Pearson Correlation	.454**
	Sig. (2-tailed)	.000
	N	101
Cost of cooking device	Pearson Correlation	-.273**
	Sig. (2-tailed)	.006
	N	101
Distance covered to buy cooking Device	Pearson Correlation	-.291**
	Sig. (2-tailed)	.003
	N	101
Type of cooking energy/fuels used	Pearson Correlation	.077
	Sig. (2-tailed)	.446
	N	101
Average income of household	Pearson Correlation	.083
	Sig. (2-tailed)	.408
	N	101

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

***. Correlation is significant at the 0.05 level (2-tailed).**

Source: (Thuti Location, 2017)

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSSIONS ANDRECOMMENDATIONS

5.1 Introduction

This chapter outlines the discussion of the key data findings, conclusion drawn from the results and recommendations made thereto. These were focused primarily to address the objectives of the study which included; assessing the cooking devices used among the households, analyzing factors affecting adoption of improved cookstoves and assessing the various benefits of adoption and usage of the improved cookstoves among households of Thuti Location.

5.2 Summary of findings

The study assessed factors influencing adoption of improved cookstoves amongst the households in Thuti Location, Othaya by taking 101 households respondents with main three purposes, assess the cooking devices and energy used among the households, factors affecting adoption of improved cookstoves and benefits associated with adoption of improved cookstoves among households in Thuti Villages.

On the size of the family, the study established that majority of the households surveyed were having between 3-5 individuals (66% of the respondents) followed by those with 1-2 individuals at about 25%, while those with 6-8 individuals at about 9%. Thereby indicating that these families do not require heavy cooking high rate of adoption can be achieved. This concurs with other researchers who argues that as the family size increases, food amount to be cooked increases and that also influences an increase in the amount of fuel/energy to be used to prepare the food. Educational levels of the

households were utilized as a proxy for awareness of the relative threats and benefits of using improved technology for household fuel purposes.

The more aware (educated) respondents were, the more likely they were to use efficient cooking technologies. However, from the results, we can deduce that the level of education might not have been a major factor for adoption of the new cooking devices in Thuti. The focus was more on females as they are the ones responsible for collection, choice and use of cooking devices and fuels for the households needs. Further, the results showed 84.2% of the respondents interviewed were females, while only 15.8% male concurring with other researchers that females are the victims of the adverse effects of preparing food and fuel/energy collection. On further assessment of the cooking devices owned and used, the result showed the main cooking device owned were the improved three stones cookstove at about 54% followed by traditional three stones at 22.8%. With Ceramic jiko and concrete insulated firewood cookstove at 4% respectively.

A further assessment was done to establish, which among the cooking devices owned, which ones are used by the households for cooking. The results indicated that 27% of the respondents uses traditional three stones, multipurpose stone-wood/charcoal at 23%, improved cookstove at 21%, LPG and Kuni-Mbili at 10% and 6% respectively. This indicates positive adoption rate since majority –about 60% of the rural households have graduated from the traditional cooking device to a more convenient and efficient cooking device, thus concurring with their reasons for choice and use as Fast in cooking, fuel saving and more economical for the family. The respondents also indicated that these improved cooking devices were Economical while cooking large

quantity of food for visitors and for the purpose of preparing food that takes longer time e.g. Githeri etc.

The study also found out that Firewood from own farm and purchased was the major energy/fuel used by the majority of the households at about 84% followed by use of LPG at 9%. This also concurred with the results that indicated that the majority of the respondents use Firewood at 70.3 % for their cooking during rainy periods in order to provide enough warmth in the house at 43% followed by being cheapest and readily available at 31%. Further determination of factors influencing adoption of improved cookstoves, the results showed that cost of the cooking device was key in adopting the new cooking device, with 53.5% agreeing and giving lack of Finances to purchase the device as major barrier to adoption and use. This was also facilitated by the availability of improved cookstove dealers in Thuti Location for example; about 43% of the respondents obtained their cooking stoves from the Local Jua kali followed by FIPS Africa and Gikeu Energy Saver Group at 5% and 4% respectively.

The study results also revealed that majority of the households got information on merits and demerits of improved cookstoves from neighbours, friends and seminars/advocacy meetings at about 85%indicating a high rate of adoption amongst households. This was also confirmed by the availability of various improved cookstoves development programs within Thuti Location including; WPower Initiatives at 25%, followed by FIPS Africa Company, Mama Chiru and Enena Group. Lastly the study assessed the benefits associated with adoption of improved cookstoves of which factors such as fuel saving, fast in cooking and saves time, cheap and economical, and reduced smoke while cooking resulted from the survey conducted.

5.3 Conclusions

This study found out that the majority of the households in Thuti Villages had adopted various improved cookstoves and a few households still uses the traditional three stones alongside the improved cookstoves. The overall view of existing literature indicates that a number of variables including socio-economic, health, behavioral, local environment, technologies, policies and access to infrastructure affects household cooking devices and fuel choice towards adoption of improved cookstoves. Although households with higher income and education are more likely to use modern cooking devices and fuels, their decision for cooking fuel choice and adoption of improved cookstoves are quite complex and multi-dimensional; deep understanding of the interaction of these factors is necessary for designing government plans, policies and strategies to improve access to modern fuels and adoption of improved cookstoves amongst rural households. For example, costs associated with improved cookstoves outweigh the perceived health benefits by adopting and using improved cookstoves and financial benefits from fuel savings.

5.4 Recommendations

Based on the findings and conclusion drawn above, the study makes the following specific recommendations;

a) Improved cookstove user's inputs must be included in the innovation and production process to make sure that the new technology is demand driven
b) Households should be empowered financially when it comes to adoption of improved cookstoves

c) Dissemination of information on the adoption of improved cookstoves in terms of benefits need to be improved through neighbours, seminars and meetings.

d) More research on energy saving cooking devices should be conducted and results implemented for better conservation and environmental sustainability.

e) The cost of biomass stoves and other clean energy cooking devices should be affordable to enable rural households to acquire them at low prices and to this end the Government and NGOs need to promote interventions that will enable low income earners to use higher-quality devices and low emission cooking energy/fuels.

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APPENDICES

Appendix I: Types of Cooking Devices Observed in Thuti Villages

Traditional Three Stone

Source: (Thuti Location, 2017)

Traditional Three Stone

Source: (Thuti Location, 2017)

Traditional Three Stone

Source: (Thuti Location, 2017)

Scode

Source: (Thuti Location, 2017)

Improved Three Stone

Source: (Thuti Location, 2017)

Improved Three Stone

Source: (Thuti Location, 2017)

Improved Three Stone

Source: (Thuti Location, 2017)

Improved Three Stone

Source: (Thuti Location, 2017)

Metal casing jiko

Source: (Thuti Location, 2017)

LPG jiko

Source: (Thuti Location, 2017)

LPG jiko

Source: (Thuti Location, 2017)

Ceramic jiko

Source: (Thuti Location, 2017)

Jiko koa

Source: (Thuti Location, 2017)

Concrete insulated firewood cookstove

Source: (Thuti Location, 2017)

Biogas digester

Source: (Thuti Location, 2017)

Appendix II: Household Questionnaires

I am a post graduate student at Wangari Maathai Institute for Peace and Environmental Studies, University of Nairobi, carrying out a research on; ***Assessment of factors influencing adoption of improved cookstoves among households of Thuti- Location, Othaya, Nyeri County, Kenya***. Your response in this questionnaire will be kept confidential and used for no any other purpose other than for academic purposes.

PART A: HOUSEHOLD CHARACTERISTICS

1. Way point

   Location ----------

   Ward ----------

   Village----------

2. Position in the Household;

   Mother [ ] Father [ ]

   Daughter [ ] Son [ ]

   Relative/Guardian

   Others specify ----------

3. What is the total number of household members in your family?

   1 – 2 [ ] 3 – 5 [ ]

   6 – 8 [ ] Above 8 [ ]

4. Respondent Gender.

   Male [ ] Female [ ]

5. Kindly indicate your age bracket

10 – 20 years	[ ]	20 – 30 years	[ ]
30 – 40 years	[ ]	40 – 50 years	[ ]
50 – 60 years	[ ]	60 – 70 years	[ ]
70 ears and above	[ ]		

6. Household Type;

Male Headed	[ ]	Single	[ ]
Widow	[ ]	Widower	[ ]

Others specify ----------

7. Education level

None	[ ]	Primary Level	[ ]
Secondary Level	[ ]	College Diploma	[ ]
Undergraduate Degree	[ ]	Master Degree	[ ]

Others specify ----------

8. What is the Nature of Land Holdings of your Household?

Family inherited	[ ]	Rented House/Land	[ ]
Bought/Private	[ ]	Settlement Schemes	[ ]
Government Land/House	[ ]	Trust Land	[ ]
Others, Specify	[ ]		

What is the size of your farm? ----------

9. Please indicate the type of house you live in

Traditional	[ ]	Semi-permanent	[ ]
Permanent	[ ]	Others specify ----------	

PART B: COOKING DEVICESAND SOURCES OF FUEL

A. Cooking Devices;

10. What type of cooking device do you use for cooking? Please list them

11. Why do you use them? Please explain.

12. When approximately did you started using them?

13. What changes have occurred with the cooking devices

    In the 70s ----------

    In the 80s ----------

    In 2010 to date----------

14. Where did you buy your cooking devices?

15. How much did it cost?

    Less than Ksh, 200

    Ksh, 200-500

    Kshs.501-1000

    Above Ksh. 1000

16. Does the price of cooking device influence your choice?

    Yes [ ] No [ ]

    Explain ----------

17. Are there dealers of improved cookstoves in Thuti?

    Yes [ ] No [ ]

    If Yes, which ones----------

18. When did the dealers of improved cookstoves come into Thuti?

19. Kindly indicate the Distance covered to buy your cooking Device from;

    1-3 Kms

3-6 Kms

6--8 Kms

Above 9 Kms, Indicate how many Kms----------

20. Where do you cook?

Outdoor [ ]

Why----------

Indoor [ ]

Why ----------

21. Which cooking devices do you use during;

Day Time ----------

Explain----------

Night Time ----------

Explain----------

22. Are there occasions that you that requires special cooking devices?

Explain----------

23. Does Thuti weather characteristics and patterns influence the adoption of improved cookstove?

Explain your answer----------

A. Cooking Devices

Fill in the appropriate column in the table below to the best of your knowledge as per the questions asked.

Types of Cooking Devices	Tick (√) the cooking devices you use	Who buys the Cooking Device?	Price of the cooking Device Kshs.	What factors influences your choice of the cooking Device?	How Long have you been using the cooking device you have ticked?
Traditional Three stones					
Kuni Mbili					
Jiko Koa					
Kenya Ceramic Jiko					
Jiko Poa					
Jiko Kisasa					
Uhai Stove					
Rocket Stove					
Paraffin Stove					
LPG Cookers					
Electric Cookers					
Solar Cookers					
Multipurpose Stove-wood/charcoal					
Any other Improved Cookstoves					
Any other Traditional Stoves					
Others specify					

B. Cooking Energy/Fuels;

Fill in the appropriate column in the table below to the best of your knowledge as per the questions asked.

Cooking Energy/Fuels	Tick (√) the cooking energy/fuel you use	Quantity of Cooking energy/fuel used per week/per cooking e.g. Kgs, Litters?	Price of the cooking Energy/Fuel Per Month Kshs?	Distance Covered to get Cooking Energy/Fuel?	Preferred Uses e.g. Food/Lighting/Warming of the house etc
Dry Cow dung					
Farm Residues –Maize stalks, dry leaves, Maize cobs					
LPG Gas					
Firewood from own farm					
Firewood purchased					
Charcoal					
Electricity					
Biogas					
Solar Energy					
Paraffin/Alcohol fuels					
Others specify					

24. Has there been changes in your households on the use of Domestic Energy/Fuel overtime? If Yes, explain----------

25. During the rainy and cold periods in Thuti area, which cooking fuels are likely to be used in the households? ----------

Explain your answer----------

26. What are the challenges in getting cooking Energy/Fuels for your cooking?

27. Are there enough suppliers of the cooking Fuels? Yes ------- No ---------

28. If Yes, which ones ----------

    If No, explain ----------

29. Who is responsible for getting the cooking Fuel for the Family? Does this influence adoption in the household? ----------

    Explain----------

30. What are the challenges experienced in using these Fuels?

PART C: FACTORS INFLUENCING ADOPTION OF COOKSTOVES

A. Socio-Cultural Factors

31. Are you using improved cookstove? Yes---------- No----------

    If yes, which one? ----------

    If No, why? ----------

    When did you start using it? ----------

32. Does the improved cookstove able to cook all types of food?

    Yes,

    Explain----------

    No.

    Explain----------

33. Kindly Tick (√) what you consider when choosing the type of cookstoves for your cooking

Type of Food to cook	[ ]	Cost	[ ]
Weather	[ ]	Availability in Thuti	[ ]
Others factors	[ ]		

Explain----------

34. Do you have specific food that must be cooked in a special way? ----------

Explain your answer ----------

35. Does your Wife/Husband/Brother/Sister/Friend encourage you to adopt any improved cookstoves?

Strongly Agree	[ ]	Agree	[ ]
Somehow Agree	[ ]	Disagree	[ ]
Strongly Disagree	[ ]		

36. What is the main source of income in the family?

Subsistence farming	[ ]
Employment	[ ]
Business	[ ]

Others specify ----------

37. What is the average income of your household?

Below Kshs.5000	[ ]	Kshs.5000 – 10000	[ ]
Kshs.10000 – 15000	[ ]	Above Kshs.15000	[ ]

38. What animals do you keep in your homestead?

Explain why----------

39. What is your cultural belief on cooking? ----------

B. Technology

40. Why did you buy the improved cookstoves for your cooking?

---

41. How frequent do you use the improved cookstove for your cooking?

Once a day [ ]

Twice a day [ ]

Three times a day [ ]

Others specify ----------

42. Which types of improved cookstoves are available within your reach?

Why?

Explain. ----------

43. Where do you get them from?

44. Tick the appropriate characteristics that describes the improved cookstove you are using for cooking;

Fuel Saving	[ ]	Firewood saving	[ ]
Durable and good design	[ ]	Portable/Fits my cooking area	[ ]

Others, explain----------

45. When looking for an improved cookstove, is Smoke an Issue?

46. Are there some health issues related to cooking using improved cookstoves? If Yes, which ones?

47. Does the issues mention in Question 46 above influence adoption of improved cookstoves in your household? If Yes, please explain----------

48. Are there trained people within the locality for repair and maintenance of improved cookstoves? Yes/ No

    Explain your answer ----------

49. Does this influence adoption of improved cookstoves? Yes/No.

    Explain, ----------

C. Knowledge and Perception

50. Are you/The people of Thuti Village aware of improved cookstoves, usage and their benefits?

    Strongly Agree [ ] Agree [ ]

    Somehow Agree [ ] Disagree [ ]

    Strongly Disagree [ ]

    Others (Specify) ----------

51. Are you aware of any improved cookstoves development programmes in Thuti? If yes, which one?
52. Have you ever received a cooking stove from an improved cookstove development programme?

    Yes [ ] No [ ]

    If yes, which one? ----------

    Are you using it or not? ----------

    Explain----------

53. Where did you learn/hear about the improved cookstoves?

    Neighbor [ ] Spouse [ ]

    Friends [ ] Seminar/advocacy meetings [ ]

Others specify----------

54. Does lack of knowledge about the improved cookstove affect its adoption in Thuti?

    Yes [ ] No [ ]

    Explain your answer ----------

55. What is the extent of information dissemination on improved cookstoves influence adoption among households in Thuti location?

    Very low extent [ ] Low extent [ ]

    Moderate extent [ ] Great extent [ ]

    Very great extent [ ]

PART D: BENEFITS ASSOCIATED WITH THE ADOPTION OF IMPROVED COOKSTOVES

A. Cooking Devices

56. What are the benefits and factors influencing adoption and usage of the cooking devices listed in the Table below?

Types of Cooking Devices	**What are the Benefits of adoption and usage of the cooking device you have ticked?**	**What are the factors influencing the adoption and usage of the cooking devices you have ticked?**
Traditional Three stones		
Kuni Mbili		
Jiko Koa		
Kenya Ceramic Jiko		
Jiko Poa		
Jiko Kisasa		
Uhai Stove		

Rocket Stove		
Paraffin Stove		
LPG Cookers		
Electric Cookers		
Solar Cookers		
Multipurpose Stove-wood/charcoal		
Any other Improved Cookstoves		
Any other Traditional Stoves		
Others specify		

A. Cooking Energy/Fuels

57. What is your preference for types of fuel? Using Likerts Scale of 1-5 (1 least and 5 most) List in order of preference from Most to Least preferred and give reasons for your Rankings.

Cooking Energy/Fuels	1	2	3	4	5	Reasons
Dry Cow dung						
Farm Residues –Maize stalks, dry leaves, Maize cobs						
LPG Gas						
Firewood from own farm						
Firewood purchased						
Charcoal						
Electricity						
Biogas						
Solar Energy						
Paraffin/Alcohol fuels						
Others specify						

58. Does the Government/Other Stakeholders help in Knowledge dissemination concerning improved cookstoves, adoption, uses and benefits to the local villages? Explain your Answer. ----------

59. Using the Likert's Scale of 1-5 (1 least and 5 most) Rate the benefits associated with the adoption of improved cookstoves below. Please indicate appropriately.

Indicators	**1**	**2**	**3**	**4**	**5**
a) Less smoke					
b) Improved health of family members					
c) Safety in the kitchen/cooking place					
d) Cleanliness and home improvement					
e) Social-Cultural influence					
f) Time saved in fetching firewood					
g) Conservation of environment					
h) Mothers can do more Domestic work compared to Fuel fetching					
i) Timely cooking					
j) Locally available dry farm residues					
k) Availability of raw materials for making cookstoves					
l) Availability of Cooking Fuels					
m) Stove design and durability					
n) Fuel/firewood savings					

(o) Others

Explain ----------

----------Thank you----------