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DEPARTMENT OF GEOGRAPHY & ENVIRONMENTAL STUDIES

FACTORS INFLUENCING ADOPTION OF IMPROVED COOKING STOVES: THE CASE STUDY OF RURAL HOUSEHOLDS IN BUSIA COUNTY, FUNYULA SUB-COUNTY, KENYA.

BY

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DECLARATION

This project paper is my original work and has not been presented for the award of a degree in this University or any other Institution of higher learning for examination.

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ABBREVIATIONS AND ACROYNMS

BLR	Binary Logistics Regression
CBO	Community Based Organization
CCS	Clean Cook Stoves
CIDP	County Intergraded Development Plan
DALY's	Disability Adjusted Life Years
EAC	Eat Africa Community
FAO	Food Agriculture Organization
FDG	Focus Group Discussion
GACC	Global Alliance for Clean Cook stoves
GHG	Green House Gas
GIZ	Deustsche Gesellschaft fur Internationale Zusammernarbeit
GOK	Government of Kenya
GTZ	German Agency for Technical Co-operations
HAP	Household Air Pollution
HDI	Human development Indicator
HIV/AIDs	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
ICS	Improved Cook Stoves

IEA	International Energy Agency
IGAD	Inter Governmental Authority on Development
KEBS	Kenya Bureau of Standards
KCJ	Kenya Ceramic Jiko
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
KNEP	Kenya National Energy Policy
LPG	Liquid Petroleum Gas
MoREP	Ministry of Renewable Energy and Petroleum
NGO	Non-Governmental Organization
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Science
SSA	Sub-Sahara Africa
UN	United Nation
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children Education Fund
WEO	World Energy Outlook
WHO	World Health Organization

ABSTRACT

Biomass fuels remain the highest in Kenya with 89 percent of the rural households highly depending on fuel wood as their main source of energy as compared to 7 percent in the urban household. Globally, there is an increased focus on the Improved Cook Stoves (ICS) and clean fuel adoption by the various international organizations such as Global Alliance for Clean Cook stoves (GACC) due to their potential benefit to household health, local and regional climate. However, despite all this effort, its adoption rate has been met at a low rate and therefore, this study aimed at finding the influence of socio-economic, stove-related and institutional factors to adoption of ICS within Funyula sub-County, Busia County. The study used Energy Ladder Theory to explain drivers to household fuel and stove choice, Diffusion of Innovation Theory to explain societal system, nature of communication, individuals that adopt ICS, and lastly Theory of Subsidization on how to pave market-based economy on the adoption of ICS that can help achieve social goal and highlight appropriate corrective measures where ICS adoption programs are regarded as wasteful. The study used both qualitative and quantitative data collection method. For quantitative data, a sample of 90 respondents was selected using systematic random sampling technique where at every 58th household, one household was selected. For the qualitative data, 7 Focus Group Discussions with a total of 10 member per-discussions and 2 Key Informant Interviews were selected using purposive sampling. Data collected were analysed using descriptive, correlation and Binary Logistic Regression. The results confirmed the hypothesis that socioeconomic, stove related and institutional factors are statistically significant at P-value less than 0.05. Furthermore, using descriptive analysis, the study found that 61%, 67% and 63% respectively of the respondents accepted that socioeconomic, stove related and institutional factors contribute to an increased ICS adoption. In addition, the study also found stove-related factors as being an important variable compared to the institutional and social economic variables. Based on the results the study identified a number of recommendations and suggested areas for further research. The overall findings of the study recommended the need to strengthen both market and policy-based strategies to increase ICS adoption in the area. With regard to suggested areas for further studies, the study recommended that empirical studies to be conducted on the effect of non-effective ICS on health and environment; economic implications of ICS on rural households; the role of government and CBOs on the effective implementation of ICS in rural households; and the evaluation of Juakali artisans on the production and design of ICS for rural communities.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Energy is very significant in meeting our basic needs mainly for cooking, heating, boiling water and lighting. About half of the global population is dependent on traditional fuel and stoves to meet their energy needs (Klasen et al., 2013). UNEP (2006); Puzzolo, Stanistreet, Pope, Bruce & Rehfuess, (2013) find these fuels and stoves to be inefficient and are estimated to contribute about a third of global carbon monoxide emission, black carbon and other pollutants in biomass smoke affecting global climate change. In developing countries, unprocessed biomass such as; wood, biochar, charcoal, animal dung among others serves as the main source of energy (The International Energy Agency [IEA], 2010). According to IEA (2006), there were 2.5 billion people in developing countries (especially rural areas) that relied on biomass to meet their energy needs. The report further suggested the figure would even rise to over 2.7 billion by 2030.

Today, middle-income countries face a major challenge to access to clean and efficient household energy (Debbi et al., 2014). In Sub-Saharan Africa, unprocessed biomass is the primary energy source used by about 80 percent of the households (World Bank 2011). In addition, wood consumption is about 300 million tons and dependence is highest in the areas where people have low-income activities or are close to the forest resulting in increased demand hence unsustainable harvest of fuel wood as the source of energy (Rysankova et al., 2014; Ndung'u, 2009). Combustion of these fuels consumes more energy than any other services as emphasised by The IEA (2006); Daioglou, Van and Vuuren et al., (2012) thus producing smoke that negatively impacts on health contributing to the global burden of disease and imposing time burden on women and children. Lim, Vos, Flaxman and Daniel

(2012) estimates about 3.5 million premature deaths occurs as a result of Indoor Air Pollution due to incomplete combustion of solid fuels.

According to (The World Energy Outlook [WEO], 2004) about 52 percent of the global population relies upon traditional fuel and stove technology for their household activities (cooking, heating and lighting). Over half of the population live in Sub-Sahara Africa and Developing countries (Table 1) below. In many parts of this region, more than 76 percent of the population in rural areas relies upon solid fuels followed by Indonesia at 72 percent, Indian at 69 percent, the rest of Asia at 65 percent, and least country being North Africa at 6 percent. Poor households in the Middle East and Latin America are also very dependent on fuel wood (IEA, 2008).

The table 1.1 shows the difference between rural and urban biomass fuel consumption. For example, in Sub-Saharan Africa, there is a high reliance on biomass consumption with over half the population thus emerging to be the highest among the developing countries followed by Indonesia and least being North-Africa. According to IGAD (2007) Projections, increased population growth will result to slow transition to modern energy thus increasing biomass dependency by over 1.4 billion.

Table 1.1 People Relying on Biomass Resources as their Primary Fuel for Cooking, 2004

	Total population		**Rural**		**Urban**	
	%	**(Millions)**	**%**	**(Millions)**	**%**	**(Millions)**
Sub-Saharan Africa	76	575	93	413	58	162
North Africa	3	4	6	4	0.2	0.2
India	69	740	87	663	25	77
China	37	480	55	480	10	52
Indonesia	72	156	95	110	45	46
Rest of Asia	65	489	93	455	35	92
Brazil	13	23	53	16	5	8
Rest of Latin America	23	60	62	59	9	25
Total	**52**	**2528**	**83**	**2147**	**23**	**461**

Sources: WHO (2006).

In African countries, 80% of their energy supply is heavily dependent on traditional biomass such as animal dung, fuel wood, biochar, among others (GACC, 2011). Jeuland and Pattanayak (2012) found that over-dependence on these fuels contribute to massive negative impact on health and environment. According to the World Health Organization [WHO], inefficient combustion of these fuels is linked to Household Air Pollution [HAP] increasing the risk of pneumonia in children under the age of 5, lung cancer in adults among other illnesses (Bruce & Smith, 2012). In sub-Saharan Africa, Household Air Pollution was the second-highest risk factor for disability-adjusted life years (DALY's) and the third highest driver of premature deaths in 2010 (Lim et al., 2012). If no action is taken by 2030, an estimated 870,000 people will die from infections related to solid fuel cooking (Rysankova, Hyseni, Kammila & Kappen, 2014).

Access to clean modern cooking fuel is a global challenge and therefore, efforts to develop, adopt and use improved biomass cook stoves are the best intermediate solution of improving the way biomass is supplied and used in addressing the adverse impacts of open-fire (GIZ, 2013). In developing countries, intervention for disseminating Improved Cooking Stoves (ICS) date back in the 1970s by the governments, donors and Non-Governmental Organizations since it had a promising impact on health and environment (Gifford, 2010; Puzzolo et al., 2013). Many empirical case studies and experiments in developing countries claim to attest to ICS benefits. For example, In India, since the launch of Environ-fit cook stove in 2008 over 80,000 stoves have been sold and positive impact has been felt on health, the social and economic status of over 300,000 people. In China, Dewan et al., (2013) find there is a reduction in time for fuel wood collection and cooking, while in Senegal, Bensch & Peters (2013) find that introduction of ICS has led to a reduction in charcoal consumption. Similar findings are depicted in Sir-Lanka (GVEP, 2009).

Like many Sub-Sahara African **(**SSA) countries, Kenya's energy supply is heavily dependent on traditional fuels such as fuel wood and charcoal that account for over 76% of the total energy consumption (Kenya Institute for Public Policy Research and Analysis [KIPPRA], 2010). This heavy dependence results in unsustainable harvest of wood and usage as fuel depleting the country's forest resources (World Agroforestry Centre, 2014). In Kenya, about 89 percent of rural and 7 percent of urban households regularly use firewood, giving a national average of about 70 percent of all households. The average annual per capita consumption is approximately 741kg for a rural household and 691kg for urban household (Kenya National Energy Policy [KNEP], 2012). In addition, a report by KIPPRA (2010) shows that rural dwellers heavily depend on firewood and approximately 76 per cent of them obtain their firewood through the free collection, 17 per cent regularly purchase it, while 7 per cent supplement their free collection by purchasing some firewood.

Traditional fuel and stoves have been used in Kenya by many communities to meet their energy needs for over decades. Inefficient design of these stoves allows escape of heat and smoke which later on are estimated to contribute to global disease burden and climate change (IEA, 2006; UNEP, 2006). For instance, in Kenya HAP causes annual deaths of 14,300 people and 14.9 Million direct health impacts on people (WHO, 2009). Improved cook stoves (ICSs) have long been the evident efficient instrument that would benefit human health, local environment, and global climate through reductions in fuel wood harvesting and particulate emissions (Lewis & Pattanayak, 2012). Global initiatives such as the Global Alliance for Clean Cook stoves (GACC) aim to reduce smoke exposure from cooking and heating practices (GACC, 2013). Several other international bodies such as The United Nations, The World Bank have shown their concern towards the adoption of clean stoves and have raised funds to foresee its implementation (Puzzolo et al., 2013).

Few efforts have been devoted to understanding how ICSs are actually adopted for a sustained long-term use (Melsom et al., 2001). Collaboration between the implementing organization, community and product designer could help develop cost-effective energy stoves that are well designed and installed (Foell, Pachauri, Spreng & Zerriffi, 2011). This will also ensure that the socio-economic and institutional aspects are well incorporated to ensure long-term sustained use and stove maintenance (Puzzolo et al., 2013). In addition, it will mitigate the environmental and health impacts of traditional stoves (GIZ, 2013; see also Ruiz, Masera, Zamora & Smith, 2011).

1.2 Statement of the Problem

Most households in Busia County rely on biomass fuels (firewood, charcoal, biomass residue) among others to meet their energy requirements with a total of about 84 percent using firewood and 12 percent using charcoal (Kenya National Bureau of Statistics [KNBS], 2013). Modern fuels such as Liquid Petroleum Gas (LPG) and electricity account for less than 5 percent since they are expensive and only the rich can afford, while Biogas and solar account for the least since they have not been sufficiently exploited (KNBS, 2013). Over 90 percent of the population largely rely on traditional stoves and fuels despite the health impact associated with it such as pneumonia among children under the age of 5 and lung cancer among the adults. Women and children are mainly tasked with gathering fuel wood which has a significant opportunity cost, limiting them the opportunity to improve their education and engage in income-generating activities (Victor, 2005; World Energy Outlook [WEO], 2004).

ICS was developed to address the health and livelihood impacts of cooking with the traditional three stone (GIZ, 2013). In Kenya, interventions to disseminating ICS date back to the 1970s and it has long been identified as a promising option to benefit human health, the local and global climate as a result of decreased deforestation and emissions thus the introduction of a Kenya Ceramic Jiko (KCJ) that predominately used charcoal and wood-burning stoves 'Maendeleo' (Arnold, Kohlin and Shepherd, 2003; Eckholm, 1975). According to Ndung'u (2009) these were alternative strategies that could provide fuel wood saving of up to 43 per cent and 60 per cent less smoke compared to a three-stone fire respectively. However, Muchiri (2008) estimates its penetration to be slow with about 60 percent and less than 5% respectively in rural areas. Urban area estimates of KCJ are about 80 percent (UNEP, 2006).

In the study area, several NGOs have initiated projects which have produced and disseminated ICS through the local stakeholders (Community Based Organizations). In addition, Ministry of Energy and Petroleum has also played a key role by launching programs on ICS. Despite its availability, it is not yet clear what really influences the uptake of this technology among different households. Observations made by Makonese, Chikowore and Annegarn (2006); Puzzolo et al., (2013); Delahunty-Pike, A (2012) shows that, institutional factors (market development, subsidy, policy mechanism, standardization) have been given little attention despite the fact they play a key role to stove implementation and dissemination both at short and long-term. Rehfuess, Puzzolo, Stanistreet, Pope & Bruce, (2014) and Mobarak et al., (2012) observe that other factors such as stove (quality, durability, cost, size and design) if well implemented by integrating the user could be a promising factor to enhancing ICS adoption. Therefore, this study seeks to identify factors influencing adoption of ICS and strategies that can help increase its uptake in Funyula sub-county, Busia County.

1.3 Research questions

1. What are the socio-economic factors influencing adoption of improved cooking stoves among rural households in Funyula sub-County, Busia County, Kenya?
2. Which stove related factors are important for adoption of improved cooking Stove among rural households in Funyula sub-County?
3. What are the institutional factors influencing adoption of improved cooking stoves among rural households Funyula Cub-county?

1.4 Overall objectives

The overall objective for this study is to find out factors influencing adoption of Improved Cooking Stoves among rural households in Funyula sub-County, Busia County, Kenya.

1.4.1 Specific objectives

1. To examine the socio-economic factors influencing adoption of improved cooking stoves among rural households in Funyula sub-County.

2. To evaluate the stoves related factors influencing adoption of improved cooking Stove among rural households in Funyula sub-County.

3. To examine the institutional factors influencing adoption of improved cooking stoves among rural households in Funyula sub-County.

1.5 Hypothesis

1. H_O Socio economic factors have no significant influence on adoption of improved cooking stoves among rural households.

   H_1 Socio economic factors have significant influence on adoption of improved cooking stoves among rural households.

2. H_O Stove related factors have no significant influence on adoption of improved cooking stoves among rural households.

   H_1 Stove related factors have significant influence on adoption of improved cooking stoves among rural households.

3. H_O Institutional factors have no significant influence on adoption of improved cooking stoves among rural households.

H_1 Institutional factors have significant influence on adoption of improved cooking stoves among rural households.

1.6 Justification of the study

Access to clean, cheap, modern reliable and sufficient energy provides the opportunities for developing countries to eradicate poverty and achieve economic development (Barnes et al., 2011). Global initiatives have shown their concern especially in developing countries like Kenya and have raised funds to foresee the implementation and adoption of clean stoves (GACC, 2013). Therefore, this study is in line with the Kenyan governments' effort to achieve the vision 2030 agenda and the UN Sustainable Development Goals. The outcome of this research will be useful to the policy makers in the formulation of policies in relation to training and regulation of ICSs quality. At the county level, it will help the rural market developers to design and develop stoves of significance to the community. In addition, it will enlighten the consumers on the benefits of ICSs and to the future researchers; it will equip them with knowledge as they carry out their research study on Sustainable Energy.

1.7 Scope of the study

The study area was limited to cover the rural households of Funyula Sub-County, Busia County. It covered specifically on the social-economic, stove related and institutional factors that influence ICS adoption at the household level. The study also examined strategies related to ICSs adoption. Theories such as diffusion of innovation, energy ladder, the theory of subsidy and fuel stack helped in answering the research questions.

1.8 Limitation of the study

The study was limited to cover only the charcoal and fuel wood burning stoves. It focused on the rural household and organizations that deal with ICS. A household size of 98 was proposed for this study, but due to in-cooperation of some respondents, the sample size for the study covered was only 90 households. A similar problem was encountered with the key Informant. The few available NGOs that deal with ICS within the county closed down and there was only one NGO so far dealing with ICS. This further became a challenge because the singled out NGO failed to respond to the questionnaire claiming to be busy and that the questions were not related to what they deal with. Therefore, I managed to handle only the MOREP and the Juakali sector.

1.9 Operational Definitions and Concepts

Improved Cook Stoves; Is a stove technology that is more efficient and releases fewer fuels emissions as compared to the traditional open "three stone'' fire.

Traditional Stoves; Refers to the use of "three stone'' fire which predominantly consume a lot of fuel wood, degrade environment and cause health impact to human.

Biomass; these are fuels derived from organic matter

Adoption; in this context refers to the decision by an individual or individual in a household to acquire and use improved cook stove

Clean Fuels: They are also modern fuels such as (LPG, Electricity and Biogas) with significantly low levels of emission and reduced environmental implications.

1.10 Outline of the chapters

This research paper has five chapters. The first chapter focuses on the background of the study, states the research problem, defines the research questions and objectives and identifies the scope and the limitation of the study. The second chapter reviews the literature related to the study, an introduction of ICS in Kenya, types and benefits of ICS, empirical studies and determinants to stove adoption. Theoretical and conceptual framework were also explained. Chapter three outlines the research methodology. This included study area description, research design, data sources and types, and steps used in data collection, sampling procedure and sample size, data collection procedure, data analysis and model specification. The fourth chapter presents the analysis and discussions and the final which is, chapter five gives the summary, conclusion and recommendation of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature related to the study based on the following areas: Household energy consumption in developing countries; Household energy consumption in Kenya, Improved cooking stoves, types, benefits and the factors affecting the adoption of improved cooking stoves such as the socio-economic factors (i.e. age, education, household income, price, household size, cultural preference and believes); the stoves related factors (i.e. type of stove, durability, size, cost) and the institutional factors (i.e. stove certification, market development ,extension services, financial support and subsidized, programs and policies).

2.2 Household energy consumption in developing countries

The world total primary energy accounts for over 9 percent with an increased dependency of more than two billion in developing countries (FAO, 2011). Therefore, energy plays a crucial role in contributing to an improved social economic status of many people in developing countries. The transition to modern fuels began in the 1990s and the uptake has been slow especially in most low-income countries (Bonjour et al., 2013). As of 2011, close to 2 billion people lacked electricity and about 3 billion people relied on unprocessed biomass mainly in rural areas of developing countries to meet their energy needs (IEA, 2013a). This is about half of the global population still relying on traditional fuels for their cooking and heating (Bonjour et al., 2013; Legros, Havet, Bruce & Bonjour, 2009; Rehfuess, 2006).

Projections by IGAD (2007) shows that there will be a higher dependency on biomass with over 1.4 billion people due to increased population growth and slow transition to modern energy. Most of these people live in Sub-Saharan Africa and Asia. Moreover, even the oil-rich countries in Africa depend on biomass to meeting their energy requirements. Therefore, this means that the number of people without clean cooking source could remain almost unchanged by 2030 (IEA, 2013a). According to Daioglou et al., (2012) and a report by IEA (2006), household cooking consumes more energy as compared to heating and lighting in low-income developing countries, this accounts for over 90 percent of the household energy consumption.

Despite a worldwide fall in household's reliance on solid fuels, Asia and Africa are notably known for an increased usage per person (Bonjour et al., 2013). In sub-Saharan Africa, about 90 percent of the rural population and half of the urban are highly dependent on biomass to meet their energy demands (WHO, 2006). According to IEA (2014) over 95 percent of people in sub-Saharan countries have no access to modern energy with countries such as Ethiopia, Tanzania, Kenya and Nigeria leading with the highest fuel wood consumption percentage of 96, 90, 76 and 67 percent respectively.

According to World Health Organization (2005), achieving a shift from traditional to modern fuel is still a challenge as households still use a combination of fuels such as traditional, intermediate, and modern to meet their energy demands, despite the change in income levels. In rural households of developing countries, Kerosene, electricity and natural gas represent a small share of the total household energy consumption as compared to solid fuels, biogas, and LPG, despite the fact that they are mainly used for cooking, lighting and heating (Malla, Bruce, Bates & Rehfuess, 2014). These findings are further supported by Daioglou et al., (2012) who find that households in rural areas mostly use traditional fuels for cooking leading to a high demand since they are easily available and affordable.

2.3 Household Energy Consumption in Kenya

Over 70 percent of Kenyans highly depend on biomass while the remaining 30 percent rely on other fuels (Ministry of Health [MOH], 2007). Therefore, this shows that, in Kenya, biomass fuels are the largest primary source of energy as it provides 76 percent of the Kenya total energy consumption followed by petroleum at 21 percent and electricity at 9 percent (KIPPRA, 2010).

According to the MOH (2007); KNEP (2012) statistics, Firewood is most commonly used for cooking in rural households at 89 percent as compared to the urban households at 7 percent. This has led to an increased average annual per capita consumption of approximately 74 and 69 percent respectively. On the other hand, charcoal is about 47 percent at the national level with over 82 percent and 34 percent usage of both urban and rural households respectively, raising a 156kg and 152 kg per capita consumption in both urban and rural areas respectively (KNEP, 2012).

Electricity represents a small share of consumption especially in rural areas as only a small percentage (3.8) of rural households have access (KNEP, 2012). LPG is expensive as it is used by only 7.8 percent of the population raising an average per-capita consumption of 3.6 percent in rural areas and 9.7 percent in urban areas. Kerosene and Farm residue represent 92 and 21 percent respectively (Practical Action, 2010). According to World Agroforestry Centre (2014); FAO (2013) statistics, overreliance on fuel wood consumption has led to unsustainable harvest decreasing forest cover (thus impacting adverse effect on the environment. The forest cover is way below the 10 percent cover.

2.4 Improved Cook Stoves Programs

The Improved biomass stoves were first developed to address the energy crisis. Later on, it was identified as a promising option to benefit human health, the local and global climate as a result of decreased deforestation and emissions (Arnold et al., 2003; Eckholm, 1975). Since then, many ICSs have been developed and promoted by donors, non-governmental organizations and some private sectors in developing countries (Puzzolo et al., 2013). According to Inyat (2012), the development and dissemination of ICS is a solution to the end-user especially in developing countries where electricity is expensive and unaffordable.

Many regional programs and global initiatives have shown their concern especially in developing countries like Kenya and have raised funds to foresee the implementation and adoption of Clean Stoves (GACC 2013; Puzzolo et al., 2013). According to a report by WHO; UNDP (2009), since the development and dissemination of improved cook stoves over 828 million households in developing countries are depending on them with 116 million are from China, over 13 million in the rest of East Asia and about 22 million from South Asia. Sub-Saharan Africa, Latin America and the Caribbean come at 7 and 8 million respectively (World Bank, 2011).

2.4.1 Improved cook stove programs in Kenya

Given the substantial health and environmental impacts of traditional cook stoves, Kenyan government, various donors, non-governmental organizations and private sector have made numerous efforts to make the clean cook stove programs a success. (Practical Action, 2010). ICSs promotion in Kenya began in the 1980s following the UN conference on the new and renewable energy sources. The initial dissemination involved several stakeholders including The Ministry of Energy, GIZ (formerly GTZ), Practical Action (formerly Intermediate Technology Development Group), Bellerive Foundation, USAID and UNICEF and programs such as the Kenya Renewable Energy Programme and Women and Energy Project which aimed to develop, design and disseminate ICS through providing training and technical assistance to local artisans (Practical Action, 2010).

For decades, designs of ICSs have been widely introduced but an ideal ICS has not been established and universally accepted (Silk et al., 2012). In Kenya, ICS designs through training of the local artisan have resulted to increased production centres thus increased demand (Practical Action, 2010). Currently, dissemination is geared towards the establishment of sustainable markets by intervening the demand side through awareness and marketing campaigns and the supply side through training of small-scale producers (Martin et al., 2011).

According to Teodoro (2008) there have been various success stories especially in Kenya that serves as evidence on ICS programs. Barnes, Smith and Van (1994) find that community involvement in development, design and marketing are the best reason for the success of ICS. For example, Winrock International (2011) ranks Kenya as the best in Africa in terms of ICSs adoption as compared to other countries with about 30-40 percent of the households. Teodoro (2008) attributes its success to good market development in terms of design, quality, size, cost durability, availability and technology.

2.4.2 Types of improved cook stoves in Kenya

Kenya Ceramic Jiko (KCJ) adapted from the Thai Bucket Stove was the first stove (that uses charcoal) to be developed in Kenya. According to the (Kenya Bureau of Standards [KEBS], 2005), the KCJ cost KS 300. Over the years the design has improved and today it has become a widely used stove available in the Kenyan market. Mandeleo stove cost KS 200 and Jiko Kisasa, both low cost fixed wood burning stoves were also introduced through early stove dissemination activities.

These stoves can be assembled in homes using locally available materials. Later on, rocket stove technology (that uses firewood) was introduced through GIZ both in a portable and fixed variety offering a high efficiency although at a higher cost to the end user. Over the decade's local innovation in stove design has occurred resulting in new variations such as the multipurpose, Kuni Mbili and Uhai stove (Practical Action, 2010).

Technology Factsheet, the main difference of any ICS over a traditional stove is the use of an insulating material such as clay or mud to conserve heat and make it more efficient. Two main parameters that can be used to distinguish between ICS types are, **the type of fuel used** (e.g. charcoal or firewood) and whether the stove is **portable** or **fixed** (Developing Energy Enterprise Project East Africa (DEEP-EA), 2010).

For example, in Uganda and Western Kenya, commonly found stove is Fixed firewood stoves with a mud or cement brick construction simply because, they are usually built up in situ, or can be made very cheaply using local materials (DEEP-EA, 2010). They work by directing hot gases from a fuel-wood fire; it has a fire box and air inlet; a hot-fuel passage and a chimney to direct smoke away.

Across East Africa are the Standalone, portable stoves. Their portability makes them suitable for both retail/distribution as a take-home product, and mass manufacture away from the point of use. Typical standalone stove features a ceramic liner which has passages at the base for air to flow into a top chamber that has an open top and with smaller openings at the sides of both chambers and a Steel cladding which has doors to regulate air flow with handles for portability and pot supports (DEEP-EA, 2010).

2.5 Benefits of Improved Cook Stoves

Efforts to develop, adopt and use improved biomass cook stoves are the best intermediate solution in addressing the adverse impacts of open-fire (GIZ, 2013). Many empirical case studies and experiments conducted in various parts of developing countries attest to the benefits of improved cook stoves in health, the physical burden to women, children and environment, e.g. Asia, Latin America and Africa.

2.5.1 Health

Exposure to indoor smoke as a result of incomplete combustion of these fuels contributes to HAP which is considered as the 3rd largest contributor to global burden of disease worldwide (Lim et al., 2012). Indoor smoke releases toxic compounds such as; particulate matter and black carbon that are associated with adverse health risk particularly to women and children (Bonjour et al., 2013; UNDP & WHO, 2009). Furthermore, it can lead to lung impairment and fatal respiratory problems (Bruce & Smith, 2012).

The World Health Organization statistics links HAP to annual deaths of 14,300 people and 14.9 Million direct health impacts on people in Kenya. Balakrishnan, Cohen & Smith, (2014) find that in India, it causes 1.04million premature deaths and 31.4 million DALYs. Therefore, according to WHO (2010); Lozano et al., (2012) projections, the death toll related to use of inefficient cook stoves are expected to surpass those from HIV/AIDs, Tuberculosis and Malaria by 2030. Clean Cook Stoves (CCS) offers great opportunity for the prevention of IAP adverse health effects (Martin et al., 2011). For example, Epstein et al., (2013) in their study Household fuels, low birth weight, and neonatal death in India finds that infants born in households that use Clean Cook Stoves such as LPG are more likely to be healthy as compared to those in solid fuel or coal households.

In Peru and India, Adetona et al., (2013); Parikh (2011) find that there are physical burden and health impacts on women that use traditional cook stoves as opposed to those that use clean cook stoves. In Latin America and Asia, Smith-Siversten et al., (2009) in their field experiment study on stationary chimney replacing traditional open fires, find that there is a reduction in levels of exposure to HAP and risk of respiratory symptoms. Similar findings are depicted in rural Mexico by Masera et al., (2007); Guatemala Diaz et al., (2007) whereby they observed significant reductions in a headache and eye infection.

Despite the fact that ICS was developed to address the health impacts, scholars have argued that there is limited evidence to support ICS benefits on health. According to GACC (2011), the absence of internationally recognized Clean Cook Stoves (CCS) standards and limited country testing capability has affected the scale-up efforts resulting to false claims of health benefits and heating efficiency by manufacturers. Therefore, it still remains unclear to just how much emissions must be reduced to provide substantial health benefits.

2.5.2 Environment

Cooking with traditional biomass contributes to 18 per cent of current global (GHG) emission (Bond, 2009). According to the previous studies, black Carbon released during incomplete combustion of biomass is also linked to greater global climate change (Bond et al., 2013). Over the years, extensive analysis has disapproved biomass extraction as a major cause of deforestation (Arnold et al., 2003). For example, EAC (2006) find that reliance on solid fuel contributes to annual deforestation of 3-4% in Kenya, 2% in Tanzania and 2% in Uganda. In Peru, Ektvedt (2011) indicates that preparation for rainy seasons leads to massive deforestation for fuel use especially in dense forest cover. In India, Defries and Pandey (2010) in their study on Urbanization, the energy ladder and forest transitions find that fuel demand leads to local degradation but not large-scale deforestation.

Empirical studies conducted to determine the impact of ICS on the environment have proved that its introduction has highly benefited the environment. For example; Bensch and Peters (2013) study in Senegal found that the ICS dissemination in the area induced substantial reductions in charcoal consumption. In contrast, Mwampamba (2007); Chidumayo and Gumbo (2013) found that in many SSA countries, there is growing concern of charcoal used for cooking and its environmental consequences including deforestation. In Haiti, cooking with briquettes made from charred agricultural waste is helping to reduce deforestation unlike traditional wood-based charcoal (USAID, 2014).

2.5.3 Burden of fuel collection

There are significant socio-economic impacts due to the opportunity cost of spending several hours per day gathering fuel wood (WHO, 2006). In developing countries, women and children are responsible for fuel collection, which is time-consuming and an exhausting task. The average fuel wood load in sub-Saharan Africa is around 20 kg but loads of 38 kg have also been recorded (Rwelamira, Phosa, Makhura and Kristen, (2000). It is established that women can suffer serious long-term physical damage from strenuous work without sufficient recuperation (WHO, 2006). This risk, as well as the risk of falls, bites or assault, rises steeply the further distance from home women have to walk. Since the introduction of ICSs in various developing countries, there has been a change and the difference felt by women and children in terms of fuel collection.

Brooks (2014) in his study using the Heckman two-step estimator find that in India, use of Clean Cook Stoves results in a reduction of 23 percent hours spent collecting fuel wood. This is further supported by Lewis et al., (2014) in his study on the perception of rural households in the introduction of ICS and he finds in Uttar Pradesh, fuel wood collection is mainly a task of men and children and according to them, ICS has reduced their time spent to collect fuel wood. According to the UN Millenium Project (2005), there are important development benefits to be gained through expanding access to modern development services. This means that access to clean energy is a key to the achievement of the Sustainable Development Goals (SDGs).

2.6 Factors affecting adoption of improved cooking stoves

Studies by Delahunty-Pike, A (2012); Malla et al., (2014); Puzzolo et al., (2013) have identified several socio-economic, factors, such as income, price, education, size and age of the households, time spent at home, ownership, and type of dwellings as having impact on ICS adoption. Institutional factors such as subsidy, policy mechanism, standardization and stove quality, durability, the cost in terms of time over-use and design (size) also affect the adoption of ICSs. According to Mobarak et al., (2012); Rehfuess et al., (2014), all these factors if well implemented and fully integrating the user, will bring out positive results.

2.6.1 Socio-economic

Income: It is argued that, the higher your income levels, the better the fuel choice and the lower the income level, the poorer the fuel choice. With this notion, the transition to energy consumption pattern is expected to change and people tend to shift fuel from charcoal to kerosene to LPG and finally natural gas (Mishra, 2008). This upward shift is most notable in urban areas as people in rural areas mostly rely on solid fuel because of its availability and affordability (Masera et al., 2007). Studies carried out in rural India by Bansal, Saini and Khatod (2013) Guatemala and China by Heltberg (2005) among others show that household income has a positive impact on the type of fuel use. Baiyegunhi and Hassan (2014) in rural Nigeria find a positive relation between raising income and fuel transition.

In Burkina Faso, Ouedraogo, (2006) observes a positive correlation between income and fuel wood consumption. According to the world bank statistics, households do not switch to modern energy even with increased income but rather consume a combination of fuels which may include solid fuel with non-solid fuels energy depending on their budget, preference and needs. This then led to the concept of fuel stacking (use of multiple fuel or stoves), as opposed to energy ladder. According to Puzzolo et al., (2013) in their Systematic review found that socio-economic status of a household is a positive indicator to stove adoption which is a contrast to Sehjpal, Soni and Kumar (2014) in their study in rural India where they find that household income is less significant compared to other social and cultural factors in choosing cleaner fuels.

Education: Pundo and Fraser (2006) in their study in rural Kisumu County Kenya found that education level of wife significantly influences the probability of switching from fuel wood to charcoal or kerosene. Heltberg, (2004) in his study examining factors determining household fuel choice in Guatemala found that education level of the household head had a very significant negative impact on wood consumption while at the same time encouraging demand for LPG (a clean fuel). Lewis and Pattanayak (2012) in their review found that education level of a household head has a positive and significant impact on the adoption of ICS. Lay, Janosch and Jana (2013) found that education level has an influence on fuel choice with a higher probability of using modern fuels than traditional and intermittent.

Inyata (2011) found that education level of a customer highly influences adoption of ICS. Mekonnen and Kohlin (2008) and Gebreegziabher et al., (2010) observe that higher education (secondary and post-secondary) in Ethiopia attracts households to use electricity and kerosene than wood and charcoal as cooking fuel. Baiyegunhi and Hassan (2014) in Nigeria found that higher education level induces a shift of household energy use from traditional to modern. Osiolo (2009) study, enhancing household fuel choice and substitution in Kenya found that cross-cutting factors such as gender of household head, education level, fuel price, and distance to fuel source are factors considered by household in making decisions.

Household size: Plays a major role in fuel choice decision simply because, increased household size results to increase in energy demand thus increase in a number of people to collect firewood in terms of labour. Puzzolo et al., (2013) in his study found inconsistency. In rural Nigeria, a household with larger size uses fuel wood as an alternative choice (Nnaji et al., 2012). Ozcan, Gullay and Ucdogruk (2013) indicate that larger households prefer traditional fuels over modern fuels. Guta (2012) shows an insignificant finding of the relationship between household size and fuel choice. Similar findings are depicted by Helberg (2004) where fuel stacking theory is used in larger households. Positively, Lewis and Pattanayak (2012) observe that there is a probability of household size to influence adoption of ICS. Baiyegunhi and Hassan (2014) find a significant relationship between household size and fuel choice. In Central and Eastern Uganda, the probability of household to adopt biogas technology increases with gender and age of household head, increasing the number of cattle, increasing the household size and increasing the cost of traditional fuel (Walehwa et al., 2009).

Cultural belief: Puzzolo et al., (2013) in his systematic review found that most households prefer preparing their meals using traditional stoves so as to achieve a preferred smoky taste of the food. In India, IEA (2006) found that baking bread using woodstoves is highly preferred by households. In Nepal, Lohani (2010) find that their traditional laws prohibit them from cooking animal meat in an enclosed house especially where people sleep, thus they prefer cooking the meat from outside. A similar finding is depicted in Burkina Faso whereby Ouedraogo (2006) find preparing staple traditional meals increases the likelihood of using fuel wood. This shows the significant influence of traditional stoves to rural households despite the introduction of ICSs. Although such beliefs may seem trivial at first, they influence both choices for existing stoves and decision to adopt new ones.

Community interaction: More recent statistics have shown that people may take up new technology due to learning from others observed experiences or social influence (Conley & Udry, 2010; Dearing, 2009). According to Barnes et al., 2012; Person et al., (2012) in rural Kenya and in Indian, they observe that purchase of ICS by household was influenced by the experience of neighbours' and relatives who have adopted. In Bangladesh, Miller and Mobarak (2013) and Pine et al., (2011) find that opinion within the community influence ICS adoption. Factors such as free or subsidize have raised arguments with various empirical studies indicating abandonment of usage. For example, Jeuland and Pattanayak (2012) empirical evidence finds that subsidizing or free distribution does not guarantee high usage but rather individual prosperity through the village. This is further supported by Tronscoso et al., (2007) in their study on Social perceptions about a technological innovation for fuel wood cooking in rural Mexico where they found that, usage of ICS could be motivated by the aesthetic value.

Age: Role of age in household fuel choice as per the various empirical findings still remain contradictory. Some studies depict the positive correlation between age and fuel choice. Gebreegziabher et al., (2012) and Guta (2012) basing their observations in Ethiopia concluded that the older a person the higher the chances of adopting cleaner cook fuels. In India, Farsi, Filippini and Pachuauti (2007) observe household head with older age are more likely to prefer Light Natural Gas (LNG) to wood. Similar findings are shown by Ozcan et al., (2013) in Turkey. Negative results by Baiyegunhi and Hassan (2014) in Nigeria shows that age of household head had no influence on fuel choice.

2.6.2 Stove related factors

Many have argued that lack of demand for ICS especially amongst low-income populations is driven by the perceived value of stoves' health, efficiency, productivity, environmental benefits, and cultural beliefs (GACC, 2014). Without addressing these issues, GACC (2011) report shows that cook stoves will never be adopted. However, according to Levine et al., (2013) creation of demand amongst the low-income households will enhance adoption of stoves and fuel technology. Stove quality is determined by its design, performance and durability (GACC, 2014).

Stove design plays a key role in its adoption and sustained use. A review study by Rehfuess et al., (2014) finds that majority of the initial ICS programs had specific design problems that led to the use of traditional stoves and therefore, GACC recommends proper training of entrepreneurs on how to improve the quality of their products (GACC, 2013). In South Asia and Sub-Saharan Africa Ruiz-Mercado (2011) notes that most of the ICS projects are being developed with a focus on technology and cosmetic designs, with no end-user integration.

Gifford (2011); Troncoso (2011); Pandey (2010) observed that many a time, the products that were disseminated did not consider any input from the target users in the design aspect such as entrance of fuel wood enlargement, stove being too small unable to fit all pots and grate removal and were therefore ill-suited for actual cooking resulting to most common complaint amongst stove users. Therefore, according to Puzzolo et al., (2013) integrating needs of the target population when designing increases the chances of stove adoption. Stove durability is another factor to be considered. Incidences of stove cracks and improper stove installation has led to a negative impact on stove functionality and sustained use (Chowdhury et al., 2011; Troncoso, 2011).

Other factors such as stove convenience, safety and ability to provide warmth during cold seasons play a virtual role in ICS adoption (Puzzolo et al., 2013). For example, stoves must be able to allow usage of small-sized fuel wood and be able to cook food for a large gathering (Troncoso, 2011; Pandey, 2010). According to GACC (2014) enhancing global adoption should focus on both demand and supply of the clean cook stoves. In addition, indirect investment such as rural electrification, development of a sustainable market, the creation of good leadership and cross-sector cooperation could help scale up the use of clean biomass stoves (Barnes et al., 2010; Astae, 2013a).

2.6.3 Institutional factors

Stove certification by standard agencies has been reported as a way of enhancing its adoption since it will meet the required design specification, fuel efficiency and emission (Puzzolo et al., 2013). Enforcement mechanisms such as dissemination of stoves and stove parts from designated suppliers, exclusive use of accredited manufactures and Penalties to non-compliant with the standards, limited government control on fuel and raw material pricing will be effective to stove adoption (Rehfuess et al., 2014). Sesan (2014) in his Boiling Point issue 64 finds that, biomass fuel tends to be neglected and their management is often ignored at government level as most national energy-related policies remain targeted at electrification. These negligence poses political and institutional risks in developing countries (including Kenya) and can negatively impact on the enabling environment which can have detrimental impacts on the development and implementation of improved cook stove projects.

Successful programs involve proper planning and implementation at all stages from raw material to end user adoption with interaction and co-ordination among the various stakeholders (Rehfuess et al., 2014). The absence of interaction among the various stakeholders and program actors both at local, regional and national level negatively impact stove adoption (Puzzolo et al., 2013). Previous reviews have shown that poor policies despite the availability of good programs especially in African countries affect stove adoption rate. Therefore, Puzzolo et al., (2013) observe that stove builders should be well trained to produce a good product for the end-users since improper construction is widely reported to be a barrier. Education, awareness, good infrastructure, well distribution channel and support for research and development as well as finance will also contribute to the success of ICS (GIZ, 2008).

Policies that do accommodate biomass are often related to forestry resources and are poorly coordinated with insufficient communication between government ministries (such as energy, agriculture, forestry etc.) Sesan (2014). He further stated that taskforce has been formed especially for ICS (e.g. Clean Cook Stove Association of Kenya, Ugandan National Alliance on Clean Cooking, National Cook Stove Taskforce Tanzania and National Cook Stove Taskforce Malawi) involving a range of actors including government, NGOs, and private sector but insufficient integration across sectors is said to create confusion among members, ICS producers and end-users. Inefficient user training on stove use, cleaning and maintenance negatively affect long-term use leading to its rejection (GIZ, 2008). According to Puzzolo et al., (2013) community Involvement, especially women, throughout the process of design and distribution creates a sense of ownership thus positive relation to adoption. This is further supported by Lim et al., (2013) who finds community health workers to play a critical role in creating demand, implementing, facilitation, delivering and monitoring of these cook stoves and related services thus making ICS available and sustainable option for the rural poor.

After sale service is very important and plays a key role in stove adoption. Monitoring and quality control should be well articulated in relation to stove production, installation and post-installation support (Puzzolo et al., 2013). Other factors such as price subsidize on stoves, financial incentives for stove construction and maintenance, other promotional offers and consumer finance through microcredit loans positively affects stove adoption (Rehfuess et al., 2014). For example, GTZ experience in Africa and Latin America clearly show the role of subsidy both direct and indirect. Large subsidize is said to devalue user perception on IS, leading to poor stove maintenance (Rehfuess et al., 2014; Puzzolo et al., 2013). Therefore, according to Jeuland and Pattanayak (2012); Lewis and Pattanayak (2011), subsidize or free distribution of ICSs does not guarantee high usage (See also Ingwe, 2007). In contrast to these findings introduction of price incentives and consumer microfinance loans successfully led to the adoption of ICS in rural Bangladesh.

Creation of awareness to consumers through appropriate strategies of differentiating between stove quality and sub-standard stove quality is very important for stove adoption (DEEP-EA 2010). Media campaigns are the best ways to channel demand of ICS through positive promotion in terms of its benefits (Puzzolo et al., 2013). Bhattacarya and Cropper (2010) propose that the best source of information is from the people who have already interacted with the technology. For example, Person et al., (2012) in Kenya and Barnes, Kumar and Openshaw (2012) in Indian find that community interactions carry the greatest weight to stove adoption.

Poor information dissemination techniques, lack of stove branding by manufactures and lack of wide marketing campaigns around the benefits of clean stoves creates a difficult environment for entrepreneurs to sell their products (DEEP-EA, 2010). Supply chain, on the other hand, plays a key role in stove adoption and if well established, can lead to massive ICS adoption (Puzzolo et al., 2013). For example, availability of raw material, stove parts and a good distribution channel increases its adoption. Therefore, consumer awareness of quality cook stoves, efficiency and maintenance is low and there is a need for it to be incorporated into the cook stove programs (DEEP-EA, 2010).

2.7 Theoretical and Conceptual Framework

A theory is defined as a reasoned statement supported by evidence and is meant to explain a systematic relationship among certain phenomena (Kombo & Tromp, 2006). Mugenda (2008) defines a theory as a framework for explaining phenomena by stating construct and laws that interrelate these constructs. On the other hand, a theoretical framework is defined as a collection of interrelated ideas based on theories derived and supported by evidence and it tries to explain and clarify the issues (Kombo & Tromp, 2006).

Household fuel and stove choice can be explained using various theories. One of the theories used is the Energy Ladder theory. In developing countries, this theory has been extensively used in explaining drives to household fuel and stove choice. The theory places more emphasis on income in both explaining and determining household fuel and stove choice (Masera et al., 2000). It implies that a key driver to fuel and stove adoption is influenced by income raise which is likely to cause a shift of energy use from traditional to a more sophisticated or rather modern cleaner fuel at the household level (Heltberg 2005). Masera et al., (2000); Puzzolo et al., (2013); Kowsari (2013) criticize these theory through their observation in that, there are more other factors apart from income that influence stove and fuel choice adoption.

Research has shown that in many parts of developing countries households in both urban and rural areas do not switch to modern "cleaner'' fuel and stove technologies but rather consume a combination of fuels both (solid and Non-solid) (World Bank, 2003). This kind of combination then led to the development of Fuel Stack theory that implies the use of multiple fuels by households. World Bank (2003) observed that, this combination arises depending on one's preference, budget and needs. Multiple fuel use is not only driven by income but it cross-cuts other factors such as family size, education, age and culture among others

(Mekonnen & Kohlin, 2009). Price fluctuation of commercial fuels Leach (1992) and the frequent shortage of modern fuels are also considered to positively contribute to fuel stacking concept. This therefore led to the development of more other theories that try to explain further.

Diffusion of Innovation theory focuses on the conditions which positively or negatively affect adoption of a new idea, product or practice within a certain society. Rogers (2003) advanced this model and it has been extensively used in assessing the impacts of technology diffusion and barriers or drivers to technology adoption. According to Rodgers (2003) this theory observes that in a societal system, nature of communication, individuals and early adopters of certain technology can act as drivers or barriers to new technology adoption either informally by their attitudes or behaviour or formally. As observed by Kuuya (2010) cost, societal and environment are factors to be considered for a technology spread within an area. For instance, Person et al., (2012) observed that in rural Kenya ICSs adoption is positively influenced by early adopters who are either neighbours or relatives of ICS owner/producers/distributors. Therefore, diffusion is largely dependent on a range of factors such as social, cultural, economic and environmental and for it to achieve its goal, it must begin with research and development which will lead to market development through promotions and finally market diffusion (Lunds, 2006).

The theory of subsidization has widely been used in standard economic theory as a way of improving market economies. In many cases, it has been associated with bridging the economic injustice of the poor and underprivileged and overseeing correctiveness of market inefficiency especially in the allocation of goods and services. The public subsidy provided have the potential of meeting both equity and efficiency goal at a community set-up. However, very few promote economic equity. In many rural areas, success stories of ICSs projects are highly attributed to the use of subsidy in keeping the price affordable (Rai, 2009).

He further says, direct subsidized (price of a stove) offers little impact to stove adoption as compared to indirect subsidize (training of constructors, covering the cost of research and development and marketing). Puzzolo et al., (2013); Jeuland and Pattanayak (2012); Lewis and Pattanayak (2012) observed the negative impact of subsidy, especially to the end user. According to Rhefuess et al., (2014) large subsidize results in poor stove usage and maintenance and also affects the user perceived value on the stove. Therefore, the economic approach of subsidization through proper program design and analysis is seen to help achieve the social goal and highlight correctiveness where they are regarded as wasteful.

2.7.1 Conceptual Framework for Factors that Influence Adoption of ICS

Mugenda Mugenda (2008) defines a conceptual framework as a tool that helps a reader understand the proposed relationship between the variables studied and shows the same graphically or diagrammatically. The above theories and literature helped in the formation of the conceptual framework for this study as shown below.

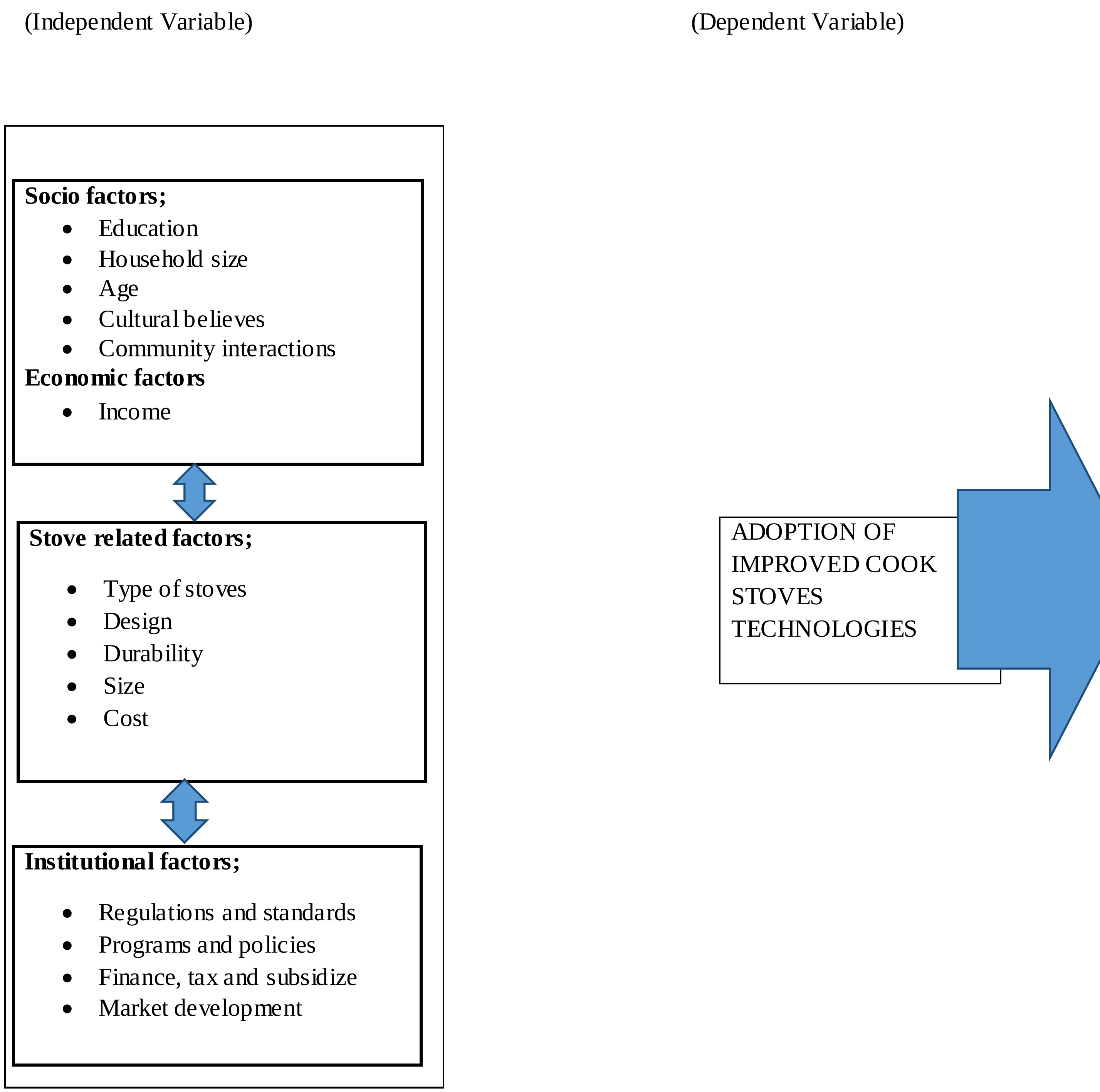

Figure 2.1 Conceptual Framework for Factors that Influence Adoption of ICS

Source: (Researcher, 2017)

Socio-economic factors such as income, education, price, household size, age, cultural believes and community interaction play a key role in the adoption of cleaner energy sources. They influence individuals' ability to adopt and use new technology. Therefore, an individual ability to access information and knowledge about a certain technology could highly influence one decision to adopt.

Other factors such as stove quality, design, size and cost are also looked into by a potential consumer before the purchase of a stove. Research carried out by GACC identified a gap in the quality of cook stove manufactured and therefore, it recommended proper training of the entrepreneurs on how to improve their products and increase its demand (GACC, 2011).

Institutional factors, in particular, can influence the adoption of an ICS technology through its policies and programs, regulation and standards, market development and finance, tax and subsidize. These factors are more so a channel for the adoption of ICS technology. They are expected to promote the technology adoption through proper policies implementation, programs, and finance, subsidize, after sale service, development of proper supply chain, proper regulation of products and market advertisements.

Having knowledge of the existence of a product in the market and its benefits to the consumer tends to increase its adoption through demand. Therefore, Poor information dissemination techniques, lack of stove branding by manufactures and lack of wide marketing campaigns around the benefits of clean stoves creates a difficult environment for entrepreneurs to sell their products (DEEP-EA, 2010). Therefore, by integrating all these factors, demand for will increase ICS thus reducing disease burden.

2.7.2 Research Gaps

Various studies have been carried out in developing countries to distinguish the variables that determine household fuel and stove decision. In Kenya, studies carried out particularly in the both urban and rural areas have attempted to distinguish the determinants of fuel and stove adoption with major concentration on the socio-economic factors and little concern on stove-related and institutional factors. Accordingly, this study tends to fill in the literature gap by examining the selected independent variables (stove-related factors, institution factors and socio-economic factors) and how they impact the adoption of ICS innovation among the rural households.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter deals with the methods of study. Description of the study area, data types and sources, research design, target population and sampling procedure, data types and instruments and finally, data analysis and presentation.

3.1 Description of area of Study

3.1.1 Geographical Location

Busia County is one of the 47 Counties in Kenya. It is located in the Western Kenya and covers an area of approximately 1683sq km. It comprises of 7 sub-counties which are; Teso North, Teso South, Nambale, Butula, Budalang'i, Funyula and Matayos. The county boarders L. Victoria to the South West, Uganda to the North, West and North East, Bungoma and Kakamega Counties to the East and Siaya County to the South and South East. It is located between latitude 00º 01' and 00º 47' North of equator and longitude 33º 57' and 34º 26' East of Greenwich Meridian. Its head quarter is in Busia town (Government of Kenya [GOK], 2013).

The study was conducted in the 10 villages of Namboboto ward that is Luanda, Buloma, Namboboto, Mudoma, Lugala, Nyakhobi, Ludacho, Mango, Sibinga and Ganjala in Funyula Sub-County the current Busia County, Kenya. This area was chosen because it's a representation of a typical rural environment in Kenya. The people living in these areas don't have access to electricity and are heavily reliant on biomass as their source of energy (firewood, biomass, biochar, etc) dominate as the cooking practice is three-stone open fire. Unsustainable utilization of environmental resources especially forest has led to unsustainable livelihood characterized by poverty and climate change within the area. Another reason is that various non-governmental organizations have penetrated the community with modern ICS technologies but only a few people are known to have adopted them (GOK, 2013).

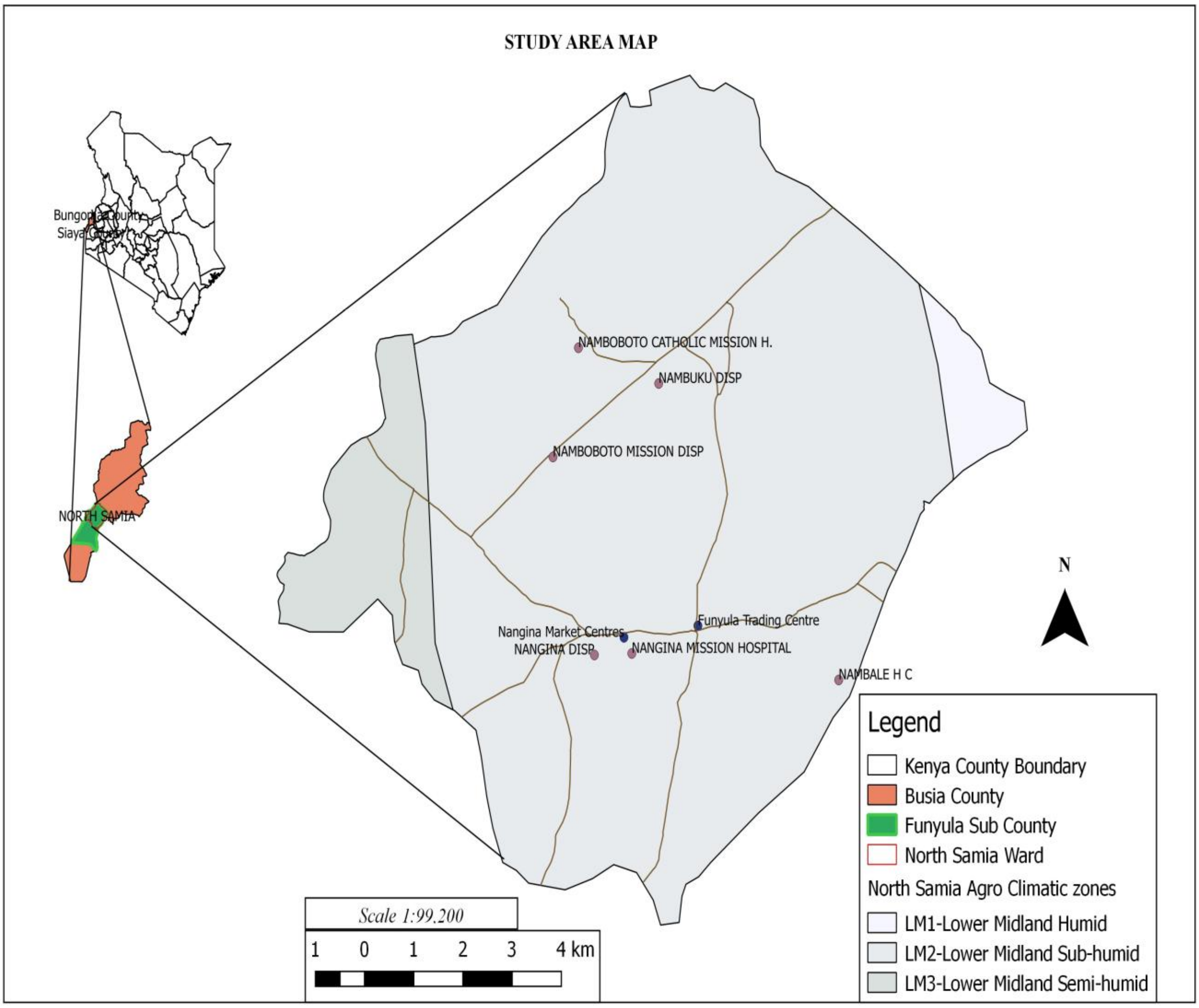

Figure 3.1 Map of Funyula Sub-County, Busia County.

Source; Survey of Kenya (2011)

3.2 Ecological and Topographical Features of Funyula Sub-County

Most parts of Busia County falls within the Lake Victoria Basin. The altitude is undulating and raises to 1,130m above the sea level at the shores of Lake Victoria to a maximum of about 1,500m in the Samia and Teso North hills. Some areas of the county (Butula and Nambale sub-counties) are characterized by planes with low flat divides with laterites and shallow incised swampy systems. However, these areas have fertile soils suitable for agricultural production of various crops including maize, coffee and sugarcane, tobacco, cassava.

The dominant agro-ecological zone is Low Midlands (LM) with about four distinct subzones that support different agricultural activities. These subzones are; LM1, LM2, LM3 and LM4 which represent sugarcane, marginal sugarcane, cotton and marginal cotton zones (GOK, 2013).

The central part especially Butula and Nambale sub-counties are occupied by a peneplain marked by low flat divides of approximately uniform heights, often capped by lateritic and a shallowly incised swampy drainage system (GOK, 2013).

The southern part is covered by a range of hills comprising the Samia and Funyula Hills which run from the north east to the south west culminating at Port Victoria; forming a very conspicuous topographic feature. The southernmost part of the county is covered by the Yala Swamp which is a down warped area associated with the formation of Lake Victoria. The area forms a colony of papyrus growth and is broken by irregular water channels and occasional small dams with grassy islands (GOK, 2013).

3.2.1 Climatic conditions

Busia county receives an annual rainfall of between 760mm to 2000mm with areas along the shores of L. Victoria receiving the lowest rainfall while the areas within Budalang'i and

Funyula receiving the highest. The long-term rain is at its peak between late March to late May while the short rains fall between August and October. The months of December to February are known to be dry and receive scattered rainfall. This bimodal rainfall pattern highly affects those that use fuel wood as the main source of fuel as they have to succumb smoke from the wet fuel wood (GOK, 2013).

The temperature ranges from a minimum of 26ºc to a maximum of 30ºc within an annual mean temperature of between 14ºc to 22ºc. Due to its proximity to the L. Victoria, the county experiences high humidity as a result of high rate of evaporation between 1800mm to 2000mm annually (GOK, 2013).

3.2.2 Population Characteristics

County population is 836,453 with 125,622 females and 390,830 males respectively (KNBS, 2009). By 2017, the total population is estimated to grow to a total of 953,337 people with 496,983 females and 456,356 males (County Integrated Development Plan [CIDP], 2012). This population statistics is an indicator of future environmental challenges in terms of resource availability such as land, water, energy among others. Therefore, this calls for proper community sensitization on resource use and adoption of better technologies especially in the energy sector so as to reduce death caused by use of fuel wood and at the same time promote the county economy (GOK, 2013).

3.2.3 Forest

The county has natural forest covering the hills of Samia in Funyula and Budalang'i Sub-Counties while the other parts of the county have farm wood that has been integrated with agriculture farming. Tree survival is high due to the frequent rainfall and the county has two gazetted and re-planted forests mainly located in Budalang'i and Samia totalling to 523.8ha.

Forests in the area are mainly used for fuel purpose (firewood and charcoal), honey, medicinal and production of electricity poles. Deforestation is a major problem due to the high demand for fuel wood at household level for cooking and lighting purposes. Strategies to increase forest cover have highly been initiated by various stakeholders such as National Environment Management Authority and ICRAF. Non-governmental organizations have also initiated ways to reduce fuel wood demand by construction fuel-efficient stoves (ICS) and disseminating within the community both at household and institutions (schools) but only very few are using the stoves (KNBS, 2010).

3.3 Socio-Economic Characteristics of Funyula Sub-County

3.3.1 Economy

Busia County Human Development Indicator (HDI) is measured through life expectancy, infant mortality, adult literacy, school enrolment, gender parity and GDP per capita. The poverty level in the county is placed at 64.2 percent higher than the national poverty level which stands at 45.9 percent. Efforts to bring this level down are needed by strengthening the economic and social sectors in the county through placing adequate, reliable and efficient energy alternatives for industries, institutions and households (KNBS, 2010).

Life expectancy in the county is estimated at 47 years compared to national average of 56 years. The literacy level stands at 75.3 percent of persons aged 15 years and above compared to the national figure of 79 percent. In 2012, primary school gross enrolment of children aged between 6 to 13 years was 81 percent while in secondary school, it was 20 percent of children between 14 to 17 years. This low enrolment can highly be attributed to poverty since the children are tasked with fuel wood collection making them miss school and inadequate physical infrastructure among others (GOK, 2013).

3.3.2 Health

Health facilities within the county are inadequate, unevenly distributed and lack essential medical facilities and staff to attend to emergencies. The five most common diseases within the county in order of prevalence are malaria, Respiratory Tract Infections, Skin diseases, Diarrhoea and typhoid. Most of these diseases are preventable hence, preventive measures should be implemented such as clean energy sources and proper sanitation. This can only be achieved through community sensitization on use of clean fuel technologies such as (ICS) which will help reduce respiratory infections and maintain the household hygiene (KNBS, 2010).

3.3.3 Energy

The main source of energy in the county is firewood with over 97.85 percent of the households relying on it for cooking and heating (KNBS, 2013). Kerosene and LPG are used respectively at 1.9 and 0.45 percent of the households. The majority in the county 89.55 percent rely on kerosene as their main source of lighting and only 3 percent use electricity for lighting. The low level of electricity distribution and connectivity is highly attributed to the high cost of installation especially the transformer (GOK, 2012). Therefore, there is need to lower the cost in order to enhance rural electrification and at the same time encourage the use of cleaner and environmentally friendly energy sources such as ICS (KNBS, 2010).

3.3.4 Education

The county has 459 early childhood development centres, 450 and 105 primary and secondary schools respectively, 17 youth polytechnics and 3 universities constituent colleges. Due to high school enrolments, students need a clean environment to study and this can be achieved through the use of clean energy efficiency technologies like the ICS. Also, the increased number of educational institutions raises demand for fuel wood for preparing the meals thus reducing the natural forest cover within the county. Therefore, there is a need for the institutions to adopt to use of energy efficient stoves (ICS) which will highly reduce the fuel wood demand, protect the environment and reduce respiratory infections associated with fuel wood smoke (GOK, 2013).

3.3.5 Housing Types

The main housing types in the county are the mud houses which stand at 81.1 percent, followed by bricks/blocks at 9.48 percent and finally the stone houses at 0.7 percent. For roofing purposes, about 46.4 percent of the population use iron sheet and the remaining 53.6 use grass. The type of housing has always been linked to the type of fuels used within the household. For instance, mud or brick and block houses tend to use mainly fire wood as the main source of energy for both cooking and lighting as compared to those in permanent houses who use charcoal for cooking and have accessibility to electricity (KNBS, 2010).

3.4 Research design

This study adopted descriptive study method of research as explained by (Hendricks & Pregitzer, 1993). It is conducted in communities in order to establish a range of social issues (Mugenda, 1999). Therefore, this study was conducted in the rural area of Funyula sub-county Busia County, Kenya in order to collect information on factors influencing adoption of ICS and identify the measures that can be put in place to enhance its adoption.

The study applied both qualitative and quantitative data collection tools. The qualitative data collected enabled the researcher to get an in-depth understanding of reasons to slow adoption of ICS. The household questionnaire was designed to accommodate both closed and open-ended questions. It was subdivided into four major sections as per the objectives. The first section had information on socio-economic characteristics (Income, Education, Household size, Age, Cultural believes and Community interactions) of people within the study area.

The second section was concern with stove usage and the House hold perception towards the ICS technology. Section three touched on government policies, programs, finance, and market.

3.5 Target population

In this study, the target population comprised of the households in the rural area, Non-governmental organizations concern with ICS, Ministry of Renewable Energy and Petroleum (MoREP), and the Juakali artisans both at the sub-County and county level. The sampled respondents at household level were mainly women since they are the ones always involved in the kitchen most of the time. As for the other organizations, only one person was interviewed.

The sampling frame was a list of households in Funyula sub-county, Namboboto ward. Systematic random sampling was used to identify the households.

3.6 Sampling procedure and sample size

Namboboto ward was purposively sampled and selected from other wards like Nangina, Bwire and Ageng'a Nanguba wards within Funyula Sub-county because the researcher had prior knowledge on the ICS promotions within the area by various organizations. Also, this area is a typical selection of the households was done through systematic random sampling. Every household was selected until a sample size of 90 was achieved.

Purposive sampling was used to identify the focus group discussion individuals and the key informants. According to Gay and Arrasian (2003), purposive sampling involves selecting a sample based on experiences or knowledge of the desired study. The key informants identified were from institutions concern with ICS such as NGOs, MoREP and Juakali artisan. For the FDGs, it was mainly those with knowledge on ICS.

The sample size of 98 households was randomly selected from a list of 5701 households based on the statistics carried out by (KNBS & Society for International Development [SID], 2013).

The sample size was obtained by using Yamane, (1967) formula as quoted by Israel (1992).

$$n = \frac{N(CV)^2}{(CV^2 + (N-1)e^2}$$

Where

n = Sample size

N = population

CV = Coefficient of variation (0.5)

e = Tolerance of desired level of confidence take 0.05 at 95% confidence level

Therefore:

$$n = \frac{5701(0.5)^2}{(0.5^2 + (5701-1)0.05^2}$$

$$n = \frac{5701(0.25)}{(0.25 + (5700)0.0025}$$

$$n = \frac{1425.25}{14.5}$$

$$n = \frac{1425.25}{14.5} = 98.2$$

Expected Sample size n=98 households

However, due to research limitations, the obtained sample size for this study was 90 households. The villages were sampled by use of non-proportionate quota sampling. This method was used so as to ensure that the villages in the study area were well covered and represented.

Table 3.1 Sampling Matrix

County	Sub-County	Ward	Village	Sampling Unit
Busia County	Funyula Sub-County	Namboboto ward (5701)	Luanda	9
			Buloma	9
			Namboboto	9
			Mudoma	9
			Lugala	9
			Nyakhobi	9
		Nangina ward (3879)	Ludacho	9
			Mango	9
		Agenga Nanguba ward (5151)	Sibinga	9
			Ganjala	9
		Bwiri ward (3680)		
	Total		10 Village	90 Households

Source: (Author, 2017)

3.7 Data Types and Instruments

The study used both qualitative and quantitative methods of data collection which was gathered from both primary and secondary data sources.

3.7.1 Primary Data

It was collected mainly by use of the questionnaire which was administered orally to the various selected household. The questionnaire contained both closed and open-ended questions. The close-ended questions were mainly administered at the household level with a few open-ended questions. The questionnaire contained variable under study. These variables were income, education, age, price of ICS, household size, cultural believes, community interactions, types of stoves, design, size, cost, durability as programs and policies, market development, finance tax and subsidy.

The open-ended questionnaire was structured to collect data on both stove related (cost, size durability and design) and institutional factors like (program and policies, regulation and standards, market development, finance tax and subsidy).

3.7.2 Secondary Data

It was collected from the existing published and unpublished information sources such as; books, government official reports, journals and various institution. Secondary data provided a supplement information from those obtained in the primary data. It also provided background information on the energy situation in the country, ICS technology, programs and policy issues related to ICSs adoption, factors affecting ICSs adoption and market development strategies which also formed the basis of the research objectives.

3.8 Data Instruments

Focus Group Discussions (FGD)

It involved interviewing a small group of respondents drawn from the similar background but who were believed to represent the general populations' opinion towards the ICS technologies. For this research, a total of 7 FGD was conducted with a representation of 10 members. Both users and non-users of ICS with equal representation of both male and female. A topic guide to aid the discussion was prepared with a focus to explore the range of issues.

Key Informant Interview

Was used to explore variables under investigation. The semi-structured interview scheduled was used by the Busia county office of MoEP, NGOs and Jua kali artisans that deal with ICS technologies in their respective workstations. Key factors of the interview were the institutional factors like how, what and where the stove is disseminated, market development (awareness), financial support services (subsidize, tax) policies and programs in place, regulation and standardization and extension services provided by the institutions to both producers and potential users.

Questionnaire

Was administered face to face to the selected households within the study area. Both the open and closed-ended questions were used because of their ease of administration. The questionnaire was developed as per the study objectives and administered to the selected households within the study area. It also captured data on socio-economic; (education, age, cultural belief, community interaction, income), institutional (market development and programs), and stove-related (cost, design, durability, types of ICS and size).

Observations and Photography

They enable the generalization of the first-hand information that are uncontaminated by other factors. Apart from interview and discussions, this study also employed the use of direct observations to capture and evaluate the type of ICS available and designs both at household and organization. Camera or rather photography helped to capture the types and designs of ICS on the ground that are of interest in regard to the study.

3.9 Data Analysis and Presentation

Data were analysed using descriptive statistics by use of tables and graphs. All the data collected from the field as in the questionnaire, FGD and in-depth interviews were filtered of any error or omissions and analysed as follows; The primary data extracted from the questionnaire was fed into the excel sheet. The data was organised, coded, tabulated and summarised using computer software SPSS version 21.0.

With the aid of SPSS, data was first analysed using descriptive statistics and presented in the form of frequencies tables, pie-chart and graphs. The data collected from the key informant interview and FGDs were analysed by use of intensive textual analysis. Furthermore, bivariate correlation and binary logistics regression on SPSS was used to establish the relationships between the dependent and independent variable.

The binary logistic regression model was used to test the hypothesis. It predicted the effects of the independent variable on the dependent variables at 95% confidence level. The Logistic regression model has two practical advantages (Fox, 2010). The first one is its simplicity: the equation of the logistic is very simple. The second is its interpretability: the inverse linearizing transformation for the logit model is directly interpretable as log-odds. By taking in to consideration these advantages, the researcher preferred to use binary logistic regression model to predict the effects of independents variables on the dependent variable.

The BLR model:

$$\ln\left(\frac{p}{1-p}\right) = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3$$

Where;

$\ln\left(\frac{p}{1-p}\right)$ = the dependent variable Y* i.e. the Probability of adopting ICS

Bo = the intercept/constant of the dependent variable

B_1 = the intercept or constant of independent variable socioeconomic factor

X_1 = independent variable socioeconomic factor

B_2 = the intercept or constant of independent variable stove related factor

X_2 = independent variable stove related factor

B_3 = the intercept or constant of independent variable institutional factor

X_3 = independent variable institutional factor

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the data collected from the field with subsequent analysis. The chapter is segmented into; demographics of the household respondents, socioeconomic, stove related and institutional factors influencing household adoption to ICS. The chapter further presents the strategies that can be used to influence adoption of ICS.

4.1 Demographic Characteristics Household Respondents

The gender of all the household respondents was 90 females from rural households in Funyula Sub-County. Women as part of household setup contribute to the choice of adopting biogas cooking technology and traditional fuel for cooking (Walehwa et al., 2009).

Out of the 90 household respondents, 82 were married, 3 widows and 5 were divorcees. Considering that majority of the women are married, this ultimately position them as second hand in household critical decision making in the procurement of household cooking stove. This confirms Walehwa et al., (2009) fact that male-headed household may limit the choice and type of cooking stove that is used by the household because women usually need to consult before making a decision on the stove to adopt.

4.2 Socioeconomic Factors Influencing Household Adoption to ICS

This section analysed age, education, household size, income, cultural beliefs, and community interactions of the households to stove adoption.

4.2.1 Age of household respondents

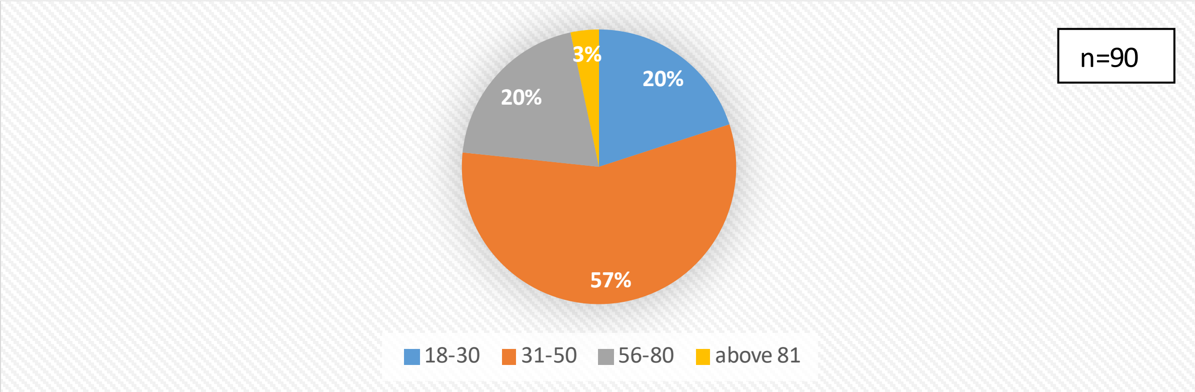

Figure 4.1 Household respondents' age

Source: (Fieldwork, 2017)

From 4.1 majority of the Household respondents, 57% were aged 31-50 years; 20% were aged 18-30 years; 20% aged 56-80 years; and only 3% was aged above 81 years.

Table 4.1 Household respondents' age and ICS ownership

Age (Years)	ICS Ownership		
	Yes	No	Total
18-30	7	11	18
31-50	38	13	51
56-80	15	3	18
above 81	0	3	3
Total	60	30	90

Source: (Fieldwork, 2017)

From table 4.1: age plays a crucial role in explaining a new technology adoption despite some contradicting studies carried out. Assumptions are, the older you are the wiser you are and therefore; the more exposed you and vice versa. The mean age of all the household respondents is 40 years i.e. between 31 to 50 years out of which 38 are ICS owners. This confirms a study by Karanja (1999) which found out that middle aged group are more adaptable to conservative technologies.

Pearson correlations between ICS ownership and age showed that the coefficient of correlation (r) is -0.130 at *P-value* 0.223. This meant that age is negatively correlated to increased adoption of ICS and not statistically significant due to a *P-value* greater than 0.05.

4.2.2 Education of household respondents

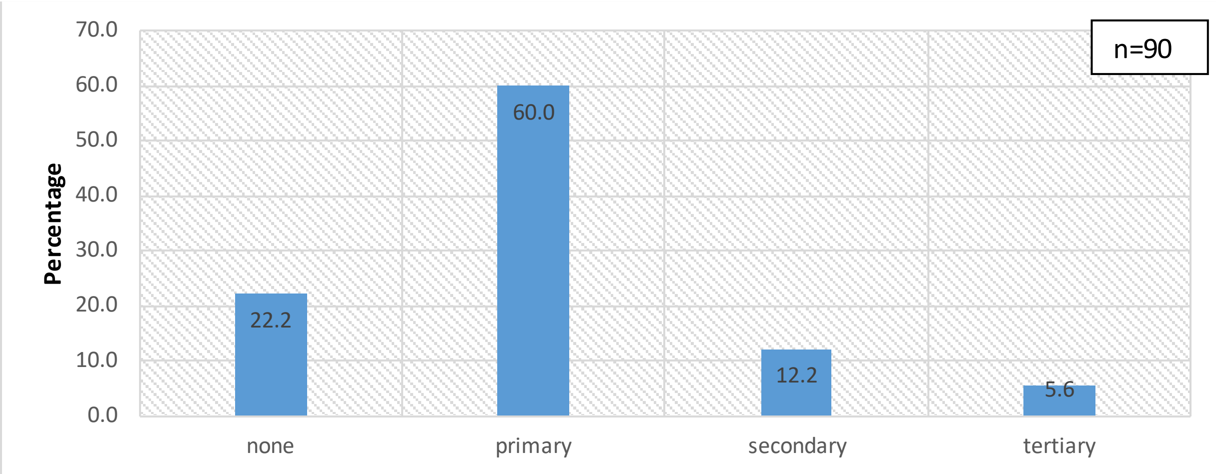

Figure 4.2 Household respondents' educational attainment

Source: (Fieldwork, 2017)

The figure 4.2 shows that most of the household, 60% have primary school education; 22% have no form of formal education; 12% secondary school as the highest level of education; and 6% had tertiary education.

Table 4.2 Household respondents' educational attainment and ICS ownership

Level of education attained	ICS Ownership		
	yes	No	Total
none	13	7	20
primary	36	18	54
secondary	6	5	11
tertiary	5	0	5
Total	60	30	90

Source: (Fieldwork, 2017)

From table 4.2: education is an important tool for adoption of any technology within a community or rather household set-up. An educated person can either positively or negatively interpret an information to his/her benefit. Findings within the study showed majority of the ICS owners had primary education. This meant that the household respondents' majority were basically educated enough to not only operate ICS but also make additional and reasonable contribution to the study. Cotlear (1990) stated that basic formal or informal education provides a fundamental knowledge required for the adoption of technologies like ICS. Thus, disagreeing that the higher the educational level the higher the adoption of ICS.

Pearson correlations between ICS ownership and level of education showed that the coefficient of correlation (r) is -0.073 at *P-value* 0.494. This meant that level of education was negatively correlated to increased adoption of ICS and not statistically significant due to a *P-value* greater than 0.05.

4.2.3 Household size

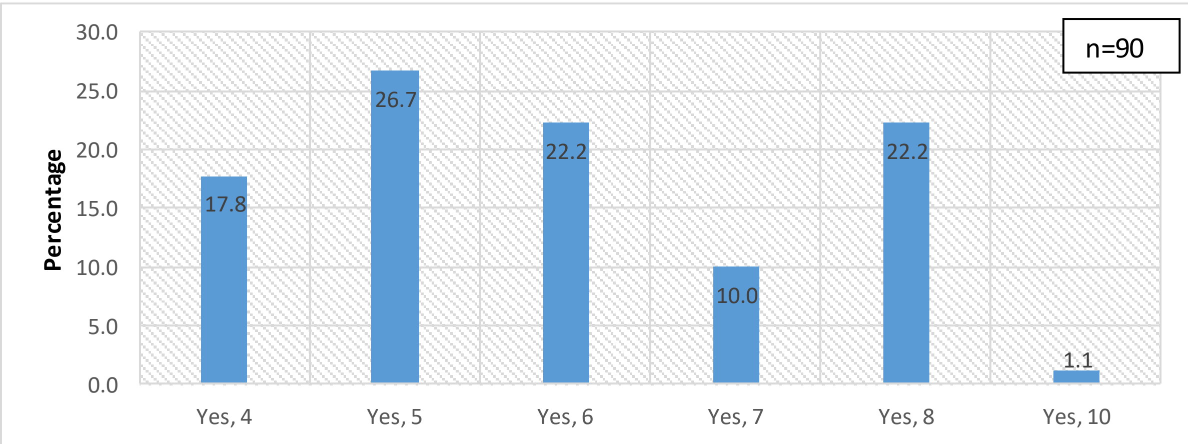

Figure 4.3 Household size that living and eat with responmdents

Source: (Fieldwork, 2017)

Figure 4.3 shows household size in this study was considered as the number of individuals living and feeding within the household: 27% household respondents stated a size of 5 persons, 22% household respondents stated a size of 8 persons, 22% household respondents stated 6 persons, 18% household respondents stated 4 persons, 10% household respondents stated 7 persons, and 1% household respondent stated 10 persons that are living and feeding with them in their respective households. The mean living and feeding household size for all the households is 6 persons.

Table 4.3 ICS ownership and Household size that living and eat with responmdents

How many people including yourself eat and live within your household	ICS Ownership		
	yes	No	Total
4	11	5	16
5	16	8	24
6	18	2	20
7	5	4	9
8	9	11	20
10	1	0	1
Total	60	30	90

Source: (Fieldwork, 2017)

The table 4.3 shows that the households 45 living with 6 persons and below were the majority that own ICS while those with the size of 7 and above were about 15. This confirmed Karanja (1999) study that household size of at most 6 persons as best influenced adoption of conservative technology. As observed in this study, the ICS ownership decreased as the household size increased from 6 persons i.e. the household with a large family size were mainly dependants on traditional three stone to prepare meals.

Pearson correlations between ICS ownership and household size showed that the coefficient of correlation (r) is 0.145 at *P-value* 0.173. This meant that household size is positively correlated to increased adoption of ICS and not statistically significant due to a *P-value* greater than 0.05.

4.2.4 Income of Household

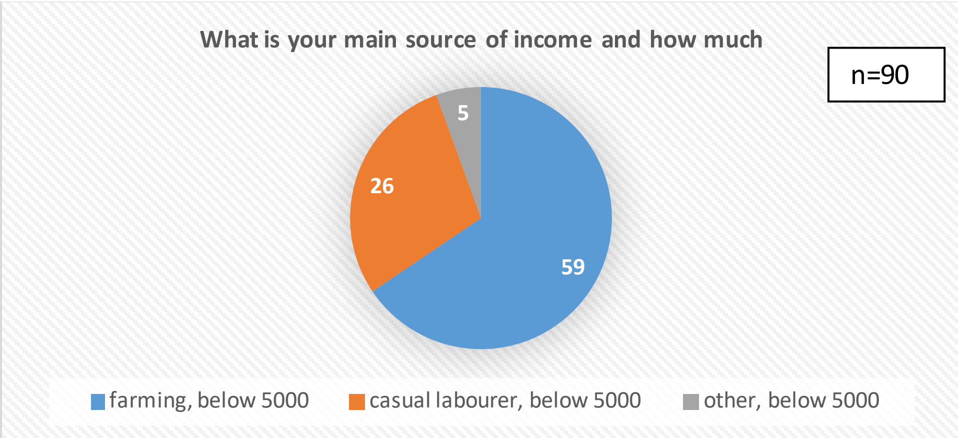

Figure 4.4 Households' main source of income and amount

Source: (Fieldwork, 2017)

Figure 4.4 shows that income of the households across all their respective income sources falls below 5000 Ksh. Majority of the households, 59% stated that their main sources of income is farming; 26% indicated casual labour; and 5% indicated other low-income earning sources which they did not specifically identify in this research.

Table 4.4 ICS ownership and Households' main source of income

what is your main source of income	ICS Ownership		
	yes	No	Total
farming	30	29	59
casual labourer	25	1	26
other	5	0	5
Total	60	30	90

Source: (Fieldwork, 2017)

The table 4.4 shows that majority of those that own ICS and majority of those that do not own an ICS are farmers. An FGD conducted showed that majority of the household are small scale farmers. They manage only a small portion of farm to sustain their family, and thus, cannot raise money as much as 3500 to purchase an effective ICS since the cost of a good ICS is too high to afford.

The households' low-income status is an indication why most of them consider the cost of ICS as expensive even though the average mean cost of an ICS is 470 KS. This can also be because the wood fuel based ICS are so expensive because of the material used in preparing them and in addition, produced less by MoEP for distribution usually in the urban setups due to very low patronage from the rural areas. Therefore, very few households especially within the rural area can afford them. This study also affirmed a study by GTZ (2008) which found that the income level of rural households that heavily depended on conservative cooking technologies as usually very low.

Spearman's correlations between ICS ownership and the main source of income showed that the coefficient of correlation (r) is -0.460 at *P-value* 0.000. This meant that main source of income is negatively correlated to increased adoption of ICS and statistically significant because the *P-value* is less than 0.05.

4.2.5 Cultural belief of household respondents

Majority of the households, 63% stated that they have no knowledge of any cultural practice that have effect on the ownership of ICS; while 37% stated that there is cultural belief that affects the ownership.

Table 4.5 ICS ownership and households' cultural practice that affects households' ICS ownership

Do you have any cultural practice that could affect ICS ownership	ICS Ownership		
	yes	No	Total
yes	25	8	33
no	35	22	57
Total	60	30	90

Source: (Fieldwork, 2017)

According to table 4.5, 35 out of 60 of the ICS owners say cultural belief doesn't play a significant role to stove adoption as compared to 25 of the households.

Pearson correlations between ICS ownership and cultural practice showed that the coefficient of correlation (r) is 0.147 at *P-value* 0.168. This meant that cultural practice is positively correlated to increased adoption of ICS and not statistically significant due to a *P-value* greater than 0.05.

Further response from the households indicated that there is cultural belief that affects the adoption of ICS. These practices featured the superiority of traditional stoves being able to cook food properly and in large quantity citing specifically the required heat during preparation of Ugali and the loss of normal food taste when using an ICS. A typical traditional three-stone cook stove is shown in Plate 4.1 below.

An FGD revealed that culturally, fires woods are usually gathered and charcoals are sold but in some cases the firewood are sold as well. Considering that the effective ICS in circulation are made of charcoal and wood fuel: the purchase of ICS increases their cost of buying charcoal and to an extent fuel woods thus forcing many households to continue using the 3 stone stoves.

Plate 4.1 A household with the Common traditional 3-stone stove

One of the discussant stated that: *"Here in our village, we have never seen anyone selling kuni, we pick fuel wood freely. Using of stoves like Maendeleo/ kuni mbili, upesi and kcj* *forces one to purchase good fuel wood also purchase charcoal if using kcj which is very expensive and not culturally accepted''.*

A study by Muchiri (2008) confirmed the norm that women are culturally the cook in rural households and are believed to be the ones to search for cooking fuel sources and most often, those fuel sourced are only useful on energy insufficient stoves. Those energy insufficient stoves are non-effective and cheap ICS as observed in this study.

4.2.6 Community interaction of household respondents

Period of stay in the village

All the household respondents have lived in the village where the study was conducted for more than 10 years. This means that the household respondents have lived long enough in their respective localities or villages to make representative facts about ICS over the years and engage in community interaction that could possibly influence adoption of ICS.

Member in Social group

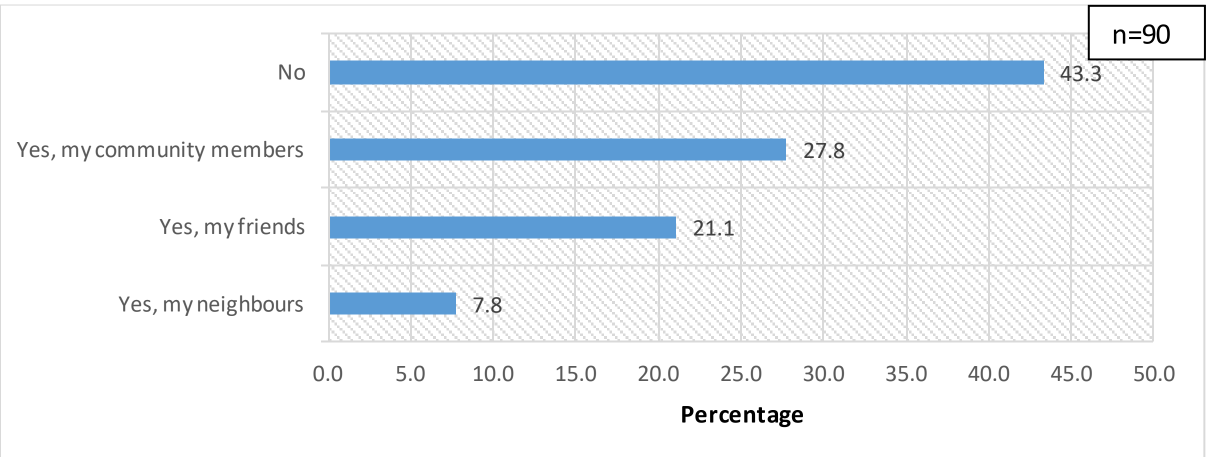

Figure 4.5 Households' belonging to social group

Source: (Fieldwork, 2017)

From the figure 4.5, most of the households, 47% said they belong to social groups while 43% said they do not belong to social groups.

Table 4.6 ICS ownership and Households' belonging to social group

Are you a member of any socio organization	ICS Ownership		
	yes	No	Total
Yes	43	8	51
No	17	22	39
Total	60	30	90

Source: (Fieldwork, 2017)

The table 4.6 shows that the majority of those that own ICS (43) belong to social groups while the minority of those that do not belong to social organization.

Half of the households (51%) stated that they participate in local activities and associations while the other half 49% stated otherwise. The households were averagely active in the participation in their respective local activities and associations.

Pearson correlations between ICS ownership and membership in social group showed that the coefficient of correlation (r) is 0.428 at *P-value* 0.000. This meant that membership in social group is positively correlated to increased adoption of ICS and statistically significant because the *P-value* less than 0.05.

Membership in different organizations

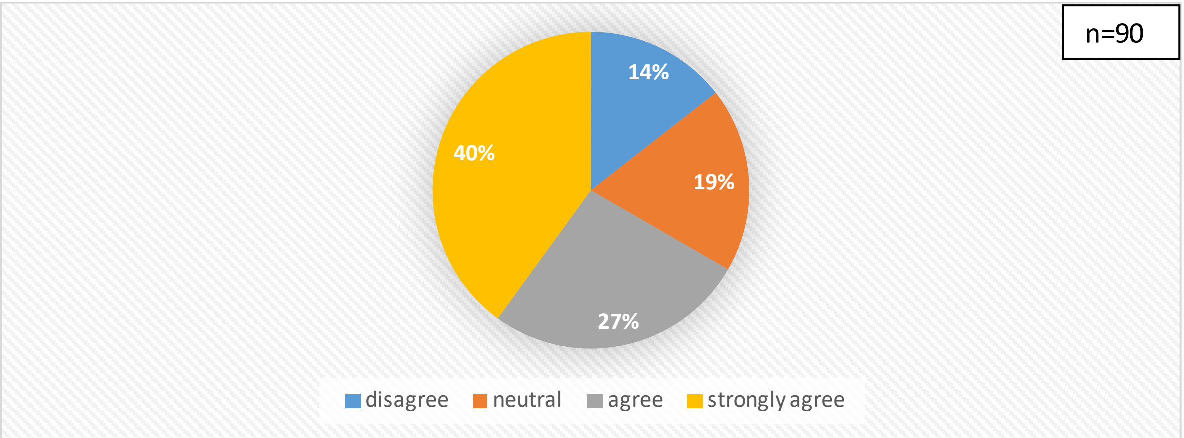

Figure 4.6 Households believe membership in different organizations affects ICS adoption

Source: (Fieldwork, 2017)

The figure 4.6, majority of 67% households supported the idea that membership into different organizations affects the adoption of ICS. Further inquiry from the 67% households showed that (38% households) believed that they can get facilitation/loan to buy ICS at a cheaper price; and (22% households) said information exchange, interaction and sharing of innovative ideas and knowledge.

Social Information exchange

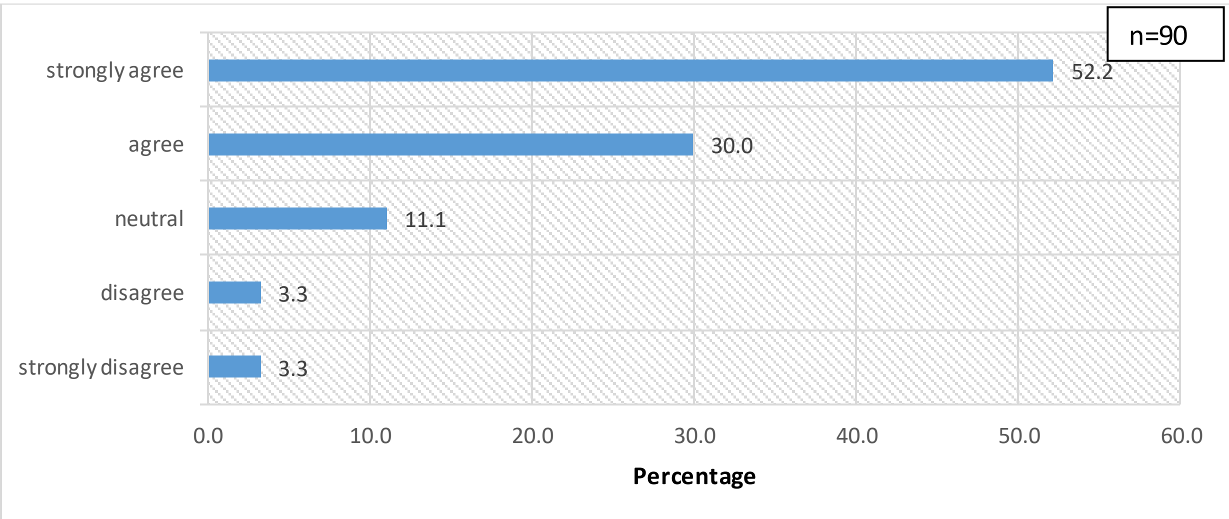

Figure 4.7 Socio-information exchange affects households' ICS adoption

Source: (Fieldwork, 2017)

The figure 4.7 shows that the majority of the households, 82% supported the statement that social information exchange affects the adoption of ICS. Further inquiry from 82% of those households, 42% stated that the information was composed of education and knowledge interactions through sharing new ideas. And additional 10% households stated that such social interactions featured hearing news on the impact and importance of ICS.

An FGD discussant stated that: *'Many women envy each other that they cannot tell you who made for them a good meko or where they bought it'*.

This could be among the reasons why there is a gap in information sharing among women on how to get a long-lasting ICS. This is mostly experienced to those households which cannot afford the portable ICS like (Charcoal and wood fuel) hence not aware of where they can locate a good technician to develop for them a good fixed wood fuel stove.

Table 4.7 ICS ownership and Households' Socio-information exchange

By socio information there will be information exchange that can affect ICS adoption	ICS Ownership		
	yes	No	Total
Strongly disagree	0	3	3
Disagree	0	3	3
Neutral	10	0	10
Agree	16	11	27
Strongly agree	34	13	47
Total	60	30	90

Source: (Fieldwork, 2017)

The table 4.7 shows that the majority of those households' that strongly agreed social information exchange to influence the adoption of ICS were (34 persons). Overall, those households that accepted information exchange affects ICS adoption were the majority of those that own ICS.

Pearson correlations between ICS ownership and social information exchange showed that the coefficient of correlation (r) is -0.219 at *P-value* 0.038. This means that social information exchange is negatively correlated to increased adoption of ICS and statistically significant because the *P-value* less than 0.05.

Neighbours' influence on ICS adoption

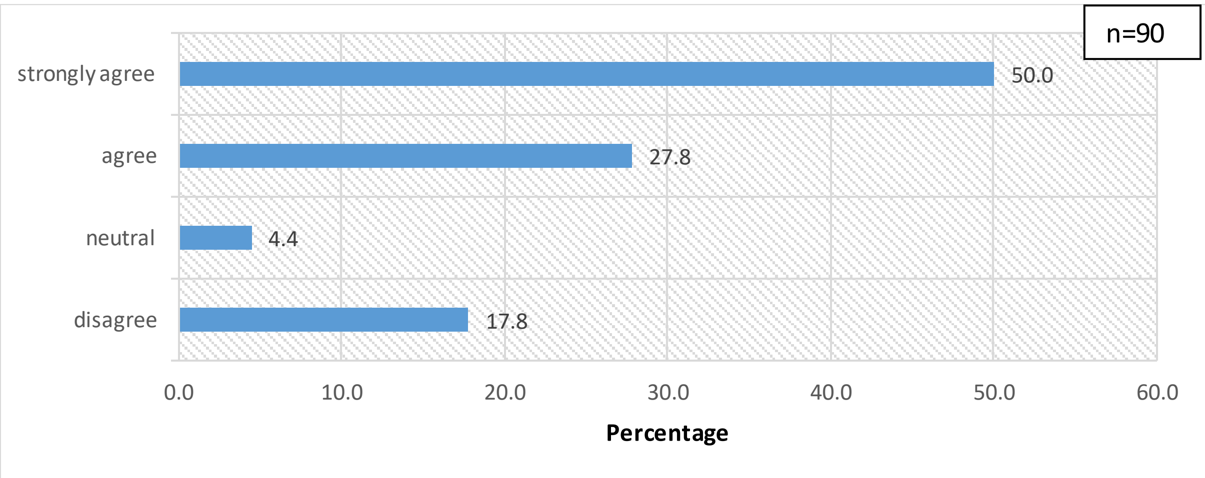

Figure 4.8 Households' neighbours have influence to their adoption of ICS

Source: (Fieldwork, 2017)

From figure 4.8, most of the households 78% supported that neighbours had influence on others to adoption of ICS. Most of those that believed neighbours had influence on the adoption of ICS further commented that it's so because, a neighbour would share their positive experience and influence others to purchase and benefit from the experience.

Table 4.8 ICS adoption and influence of Households' neighbour

Neighbours have influence to others on the adoption of ICS	ICS Ownership		
	yes	No	Total
Disagree	16	0	16
Neutral	4	0	4
Agree	12	13	25
strongly agree	28	17	45
Total	60	30	90

Source: (Fieldwork, 2017)

The table 4.8 shows that the majority of those who owned ICS accepted neighbours influence on ICS adoption. This study found that, membership into social groups and influence of neighbours through information exchange increased the adoption of ICS (Person et al., 2012; Conley & Udry, 2010).

Pearson correlations between ICS ownership and neighbours influence showed that the coefficient of correlation (r) is 0.296 at *P-value* 0.005. This meant that neighbours influence is positively correlated to increased adoption of ICS and statistically significant because the *P-value* less than 0.05.

4.3 Stove Related Factors Influencing Households' Adoption of ICS

This section analysed the type, size, design, durability, and cost of ICS used by the households.

4.3.1 Stove characteristics and influence on ICS ownership

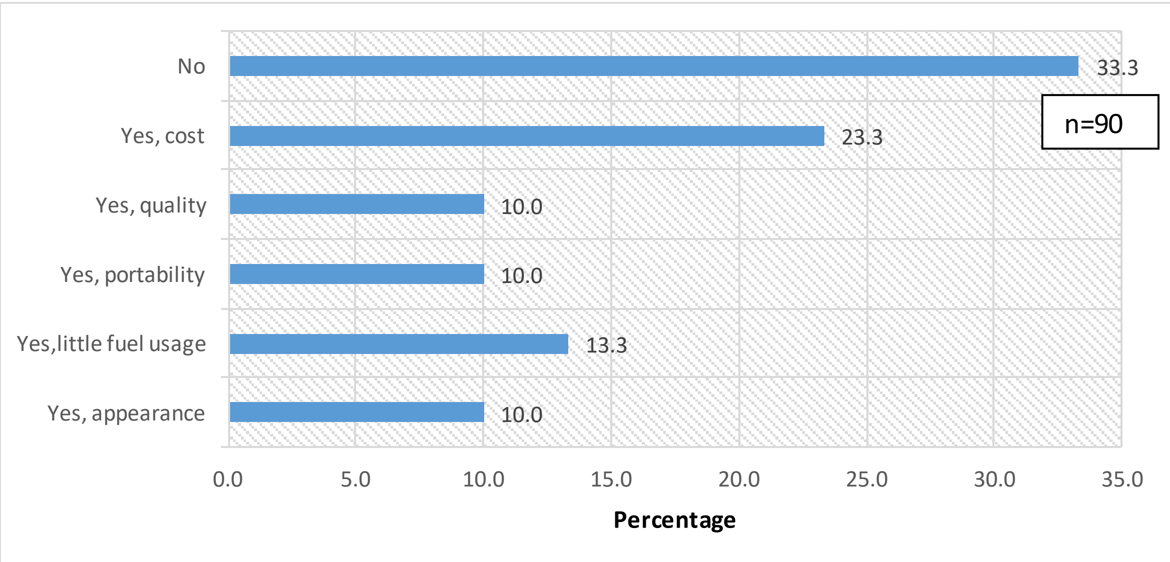

Figure 4.9 Household's ownership of ICS and characteristics of ICS

Source: (Fieldwork, 2017)

The figure 4.9 shows that the households' majority, 67% have ICS in their households while 33% do not have. Those that indicated they have no ICS stated that the reason being cost of stove, fragility of the stove,the long duration it takes to prepare food, and lastly that most ICS are small which ultimately limit the size of a meal prepared in a family.

Pearson correlations between ICS ownership and stove characteristics showed that the coefficient of correlation (r) is 0.782 at *P-value* 0.000. This meant that stove characteristics were positively correlated with increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

An FGD conducted in Funyula constituency showed that there is poor adoption of ICS. About 80% of the people during the discussion said not many people in the community own ICS. They stated that some people are not aware of the existence and the advantage of ICS while some know about it but cannot be convinced by their efficiency.

4.3.2 Type of ICS

Household main source of ICS fuel

The households' main source of cooking fuel was chiefly firewood as identified by the households' majority, 83% and 7% of the households identified charcoal.

Considering that most of the stoves produced by the MoEP are charcoal fuel based, (Author, personal communication with MoEP, 2017) this could not serve the interest of the households' majority. Therefore, this study confirmed the study by Smith and Peel (2010) that rural households are dependent on solid cooking fuels i.e. charcoals and firewood.

Types of cook stoves used by households

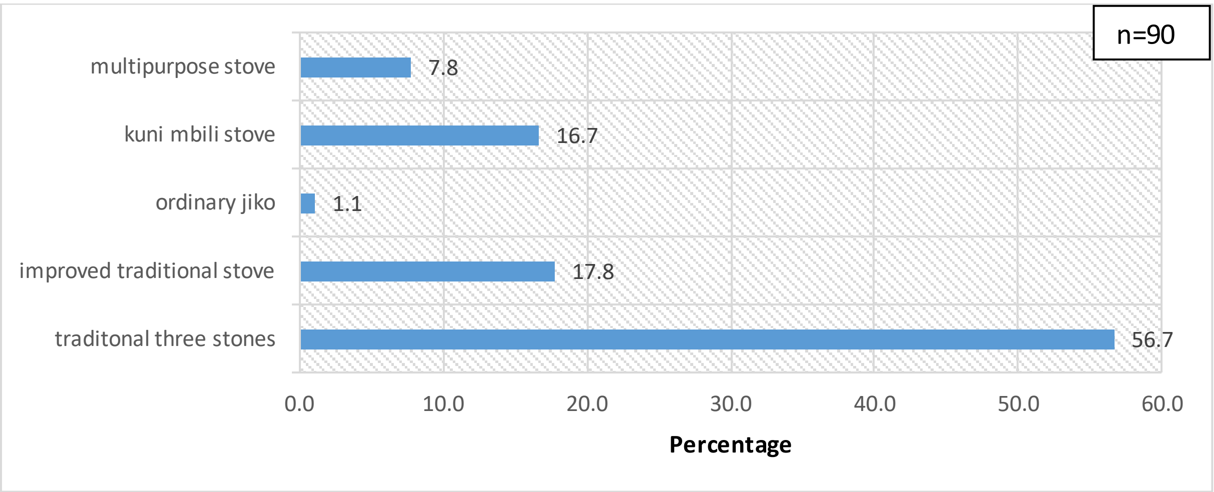

Figure 4.10 Types of cook stoves used in household's your household

Source: (Fieldwork, 2017)

The figure 4.10 shows that most of the households, 57% stated that they use traditional three-stone in their households; 17% Kuni mbili; 18% improved traditional stoves; 8% multipurpose stoves; and 1% ordinary jiko. The Kuni mbili and Ordinary jiko ICS are shown in Plate 4.2 and 4.3 respectively.

Plate;4.2 Typical Kuni mbili stove used by a household.

Plate4. 3 An ordinary jiko made by the juakali artisan

Types of ICS currently championed by MoREP include charcoal and wood burning stoves like Uhai, KCJ, Metalic, and Maendeleo (as shown in Plate 4.4 to 4.9) which were designed to replace traditional stove (Author, person communication MoREP, 2017). Also, the GOK (2013) confirmed that the rural households in Kenya are highly reliant on traditional three stone cook stoves.

Plate 4.4 A man carrying a sample of Uhai Jiko

Plate 4.5 Metallic stove with a portable crater for charcoal and fuelwood use

Plate 4.6 Metallic stove with the crater for charcoal fuel use

Plate 4.7 Metallic stove without the crater for wood fuel use. Smallest size cost KS 700 and the price increases with the stove size

Plate 4.8 Unfinished/incomplete Maendeleo wood fuel stoves produced by MoREP

Plate4 9 Maendeleo stoves produced by MoREP. Price ranges from 600-4000 based on size

The Juakali produce KCJ, Kuni mbili, Uhai jiko and ordinary jiko which are mostly bought at an average price of 1280 KS by rural households. The Juakali produce less of quality and number of Kuni mbili and Uhai stoves because they are costly to produce; expensive to the consumers; and very few customers are willing to purchase these kinds of stoves at a higher price. (Juakali interview with Author, 2017). The Plate below shows KCJ made by Juakalis

Plate 4.10 KCJ made by the Juakali artisans

Preferred cook stove of households

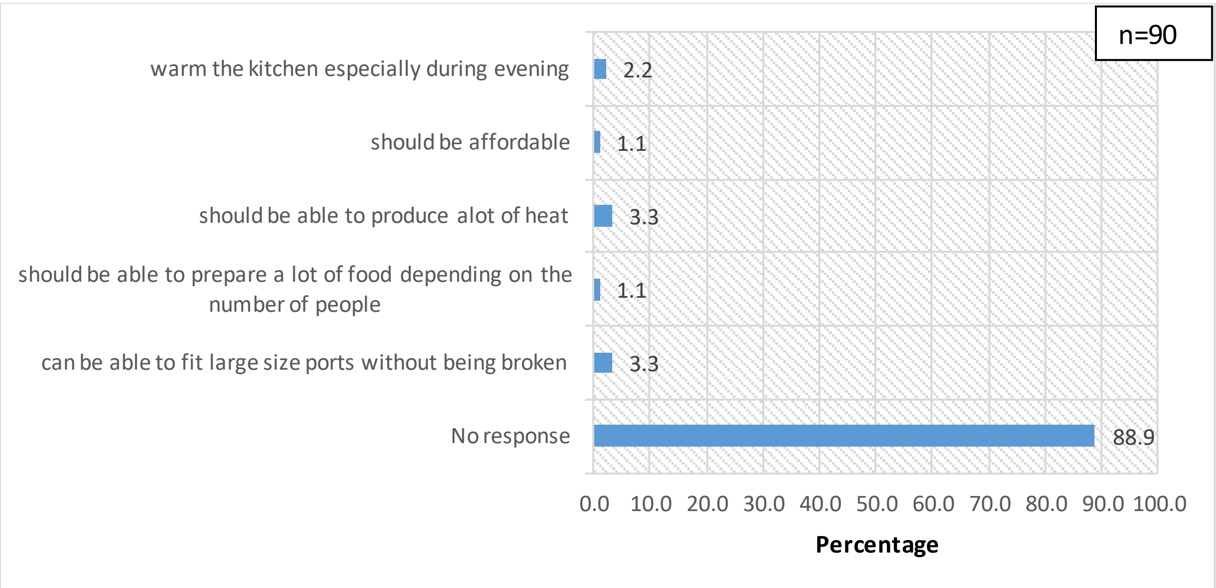

Figure 4.11 Households' ideal stove

Source: (Fieldwork, 2017)

On the choice and preference of stoves as shown in figure 4.11, only 11% of the households stated that they prefer an ideal stove that can keep the kitchen warm especially in the evenings, produce a lot of heat, able to prepare a lot of food, and lastly able to fit and hold large pots.

4.3.3 Size of ICS

Out of the households questioned on whether the size of ICS affect cooking: 21% of the households stated that it affects while 43% said it does not.

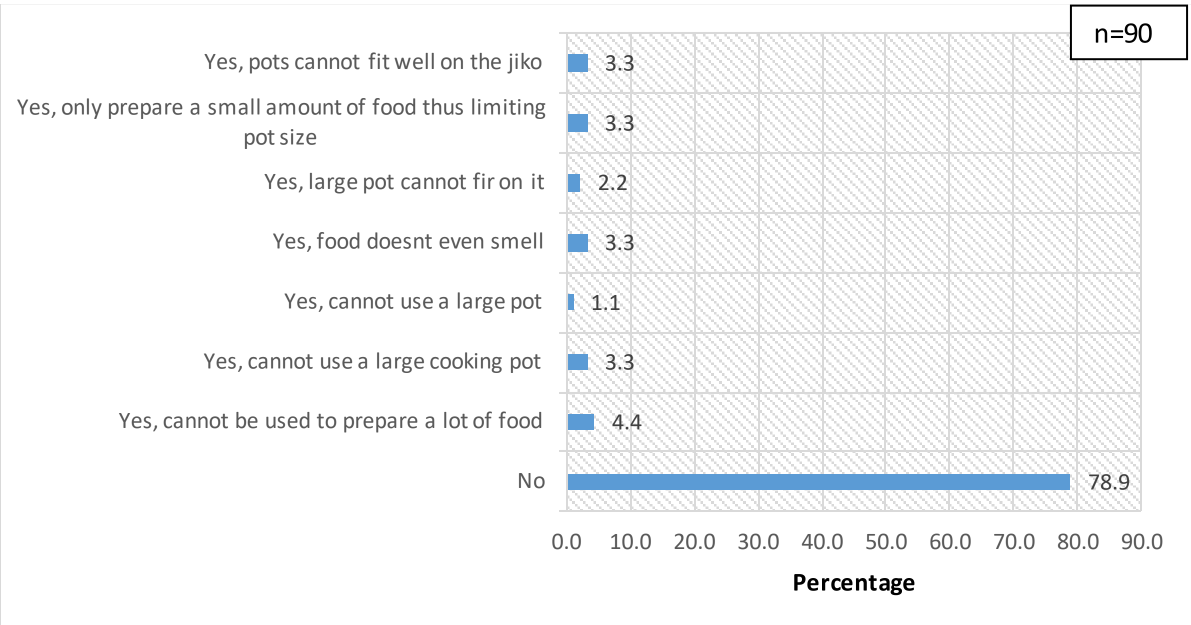

Figure 4.12 How does ICS SIze infulence households' cooking?

Source: (Fieldwork, 2017)

The figure 4.12 shows that the 21% of the households indicated that the size of ICS affected cooking and stated a few number of reasons which included: pots not fitting well on the jiko, amount of food that can be prepared, and limitation on the use of large pot on small ICS.

Studies by Rehfuess et al., (2014); Mobarak et al., (2012) on cook stove are confirmed by the households' in this study in that quality, durability, cost, size and design influenced the adoption of ICS.

4.3.4 Design of ICS

Out of the 67% households that uses ICS: 29% stated that their ICS design fits and beautifies the surroundings while 14% said the design does not. From various studied reviews, we find that stove design played a key role to the adopters in the sense that, they would eventually go back to traditional stoves Rehfuess et al., (2014). From the FGDs, issues surrounding design were raised in the sense that, the stove made were mostly focused on technology and not designed as per the adopter wish and this makes it so difficult for them to purchase the stove.

4.3.5 Durability

Household's period of ICS usage

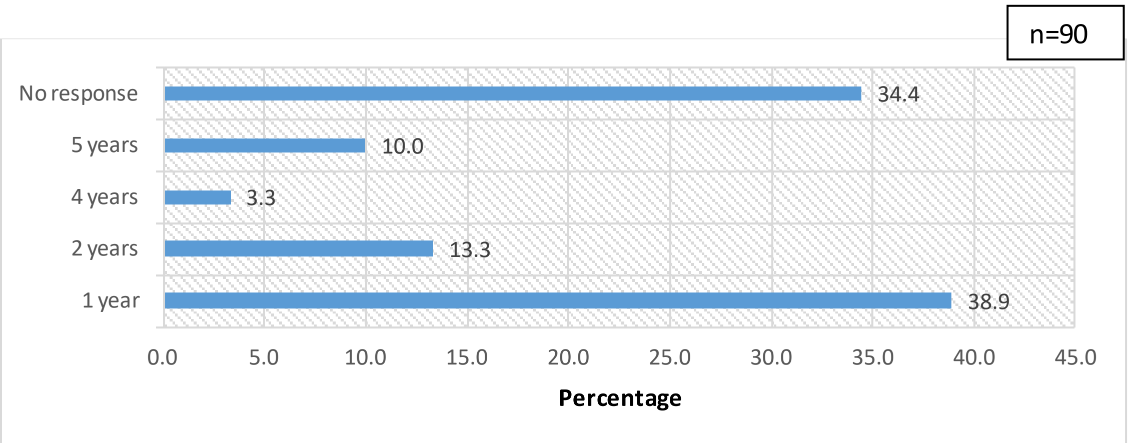

Figure 4.13 Period for which households have been using ICS

Source: (Fieldwork, 2017)

Out of the 67% households that own ICS as shown in figure 4.13, 39% of the household stated that they have been using ICS for 1 year; 13% for 2 years; 10% for 5 years and 3% for 4 years. 1% of those that own did not respond to the question. The average mean since the period the households have been using ICS is 2 years.

Repair of ICS owned by the households

Out of the 67% that own an ICS, 41% have never repaired their ICS while 29% stated that they have done some repairs on their ICS. However, having 29% out of 67% that have repaired their ICS; this meant that the ICS needs routine repairs.

An FGD revealed that, as quoted by one of the discussants

> "T*echnicians that make/repair stove lie that they have the skills to make the stove and charge you as high as 4000. Only for them to make very poor meko, which when you put a heavy sufuria on top on it, especially when preparing ugali, it breaks down"*

A study by Smith-Silvertsen et al. (2009) in Guatemala revealed that the breakdown of factory-made ICS is not uncommon as technicians on a weekly frequency visits rural household to repair ICS. This study found a similar issue on traditional/home-made ICS as pointed out by 29% households and some members of the FGD indicated that those who have ICS experienced a frequent breakdown. An interview with Juakali revealed that they are challenged in producing a quality stove and repairs are the highest complains they receive from their customers (Author, personal communication with juakali artisans, 2017). Plate below shows a traditional ICS.

Plate 4. 11 Fixed ICS observed in some households. Just 6 months old but have developed cracks and broken pot holder is observed.

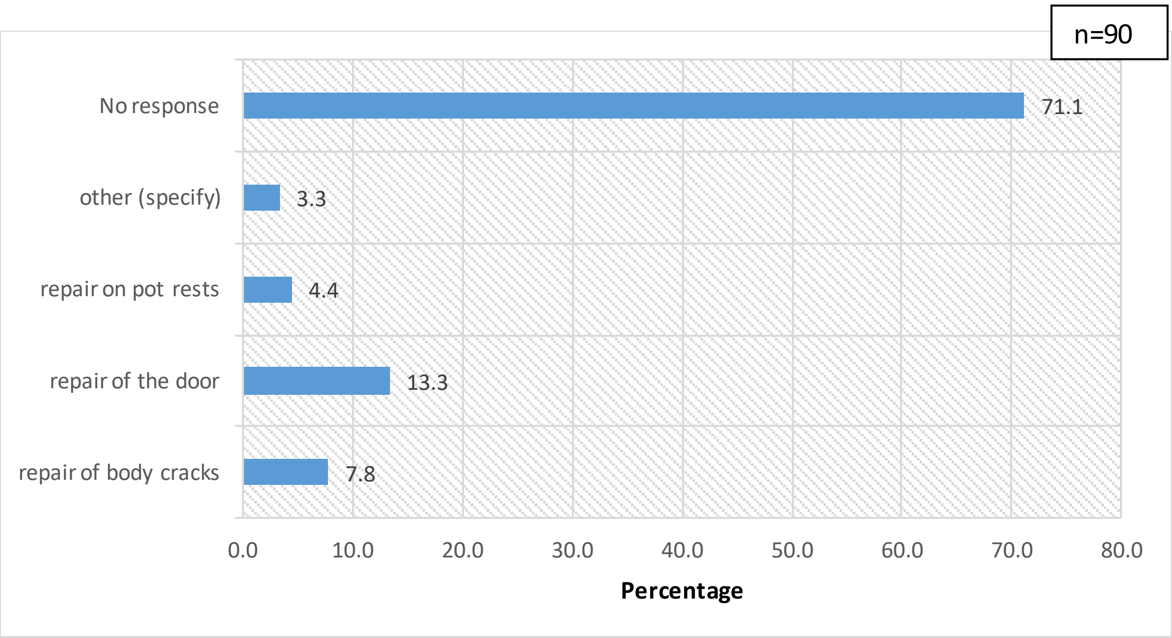

Figure 4.14 Kind of ICS repair by households

Source: (Fieldwork, 2017)

Out of the 29% households that have repaired their ICS as shown in the figure 4.14, 13% was on the door of the ICS; 8% was on body cracks; 4% on the pot rest; and another 3% on other stove-related issue.

An FGD conducted indicated that there are poor technicians that make and/repair ICS as quoted by 55% representation of the discussant. In these part of the constituency, there are no well-qualified technicians who can develop/design/fix a good ICS hence, most of the developed stoves have resulted to several faults (breakage of pot holders, cracks on the stove) making the user abandon the ICS after it gets spoiled.

Replacement of ICS

Out of the 67% households that own ICS: 9% stated that they have replaced their ICS while 33% said they have never replaced theirs. Thus, an indication that the rate of continued use of ICS over a period of 2 years by the households is averagely 50%.

Out of the total households that were asked if they had replaced their ICS with the same model as shown in the figure below: 84% had no response to the question while 16% stated that they have not replaced their ICS with the same model.

Since the households (9%) that replaced their ICS were part of the 16% households that indicated to have replaced their ICS with a different model, thus then the majority of the households that replaced their ICS did not replace their ICS with the same model. Also, considering that none of the households has ever done the same model replacement, the ICS models used by the households ‘usually traditional/home-made’ are not satisfactory or good enough for them to be bought again or recommended for use.

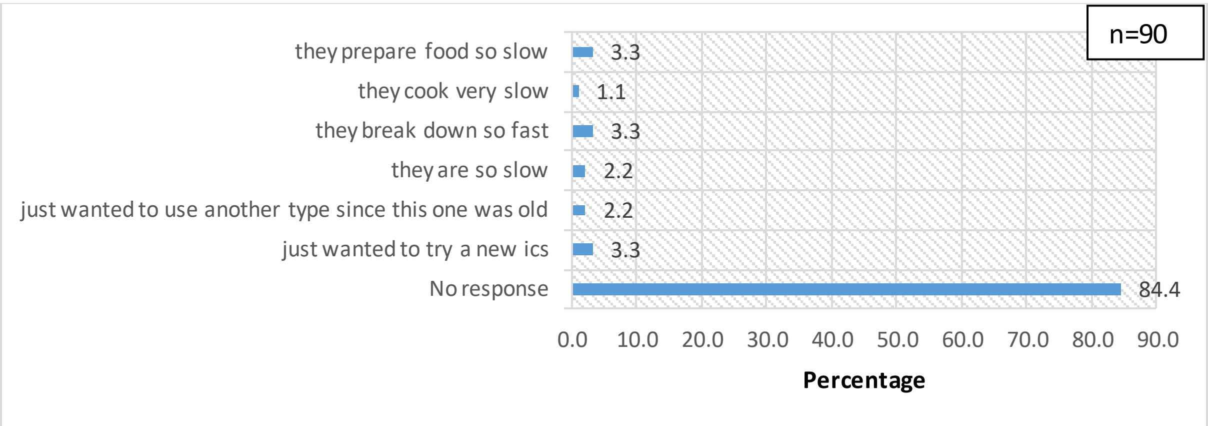

Figure 4.15 Reason why same model was not used during households's ICS replacement?

Source: Fieldwork, 2017

The households that did not replace their ICS with same model stated that: the previous model they used was slow in food preparation and cooking, and they breakdown easily; and others stated that they wanted to try new models of ICS.

4.3.6 Cost of ICS

Price in households' locality

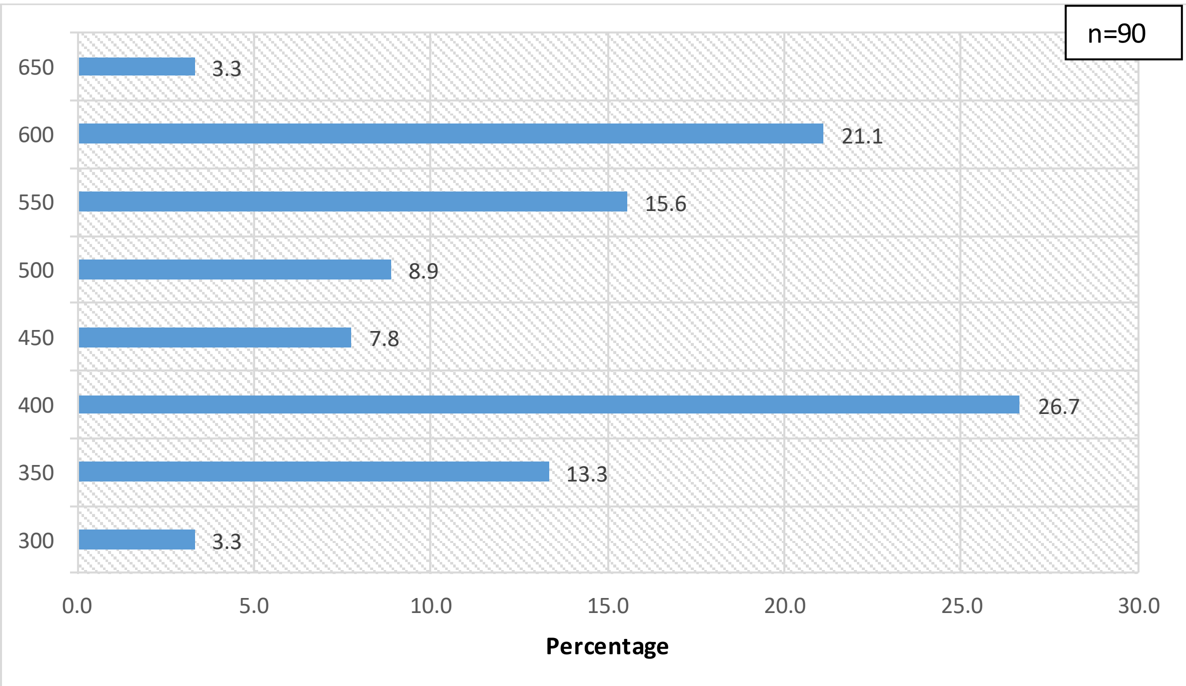

Figure 4.16 Price of ICs available within households' locality ***Source: (Fieldwork, 2017)***

From figure 4.16, there was price variation on the cost of ICS within the localities where this study was conducted as shown in the figure above. 27% of the households stated that it costs 400 KS; 21% said it cost 600 KS; another 16% stated 550 Ksh. The variation in the cost was attributed to the fact that there are various kinds of ICS. However, the average cost of the ICS in all the households' locality was 470 Ksh.

The FGD revelled that an ideal ICS that is good would cost about 3500 but the locals have no means to procure such ICS and thus go for the very cheap and locally made ICS. This confirmed Rogers (2003) study which found that in rural households, technology with cheaper start-ups and installations are more readily adopted than the effective model of same technology.

Price rating of ICS in households' locality

Majority of the households, 79% stated that the price is expensive; while 11% of the households indicated that the price is fair.

According to the FDGs, a majority of the discussants (60%) said that high cost of installing the stoves or rather purchase of stove made them unable to afford. It simply meant that the community or people are willing to buy but due to many other household demands, they tend to shift their income to other important things. As quoted by one of the discussants:

"Traditional stoves are cheap since it only requires you to get stones which are freely available. Selling to us expensive stoves especially to people like us who have low income is waste of time. We cannot afford since our priorities are not there. Therefore, we will not buy".

Also cited by the KI was that: *''everything has gone up. The price of fuel wood and ICS keep raising on daily basis making it difficult for a household with low income to purchase both since they are so expensive''*.

Cost of ICS used by household

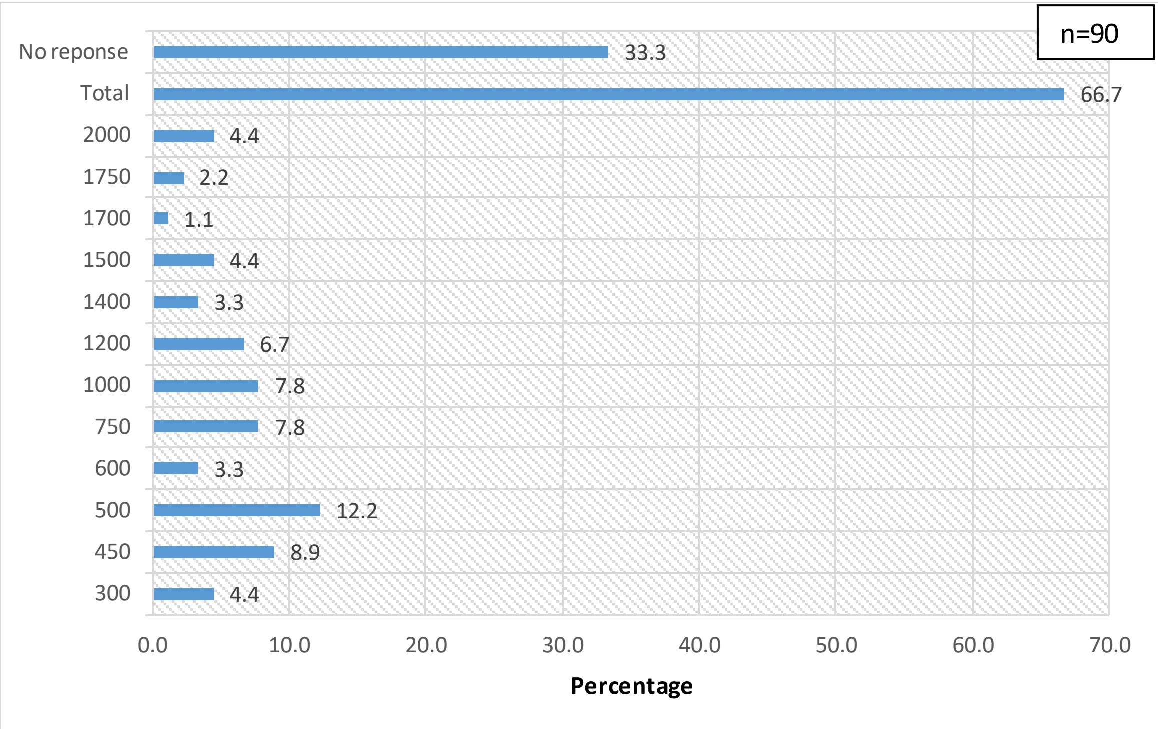

Figure 4.17 The cost of ICS used by households

Source: (Fieldwork, 2017)

Figure 4.17 shows, 67% of the households uses ICS in their households: 12% stated it costed them 500 Ksh while others stated varying amounts. The average mean of the ICS cost of ownership for those that own ICS was 668 KS. An interview with Juakali showed that ICS users consider the cost and durability before they purchase the stoves from the Juakali.

Rating of ICS cost owned by household

On the rating of the cost of ICS: 33% of those that do not own an ICS did not respond to the question; 64% stated that it is expensive; while 3% stated that the cost is fair.

4.4 Institutional Factors Influencing Households' Adoption of ICS

This section analysed institutional factors influencing ICS adoption and they include, regulations and standards; programs and policies; finance, tax and subsidies; and market development

4.4.1 Regulations and standards

Aawareness, quality control, and monitoring services

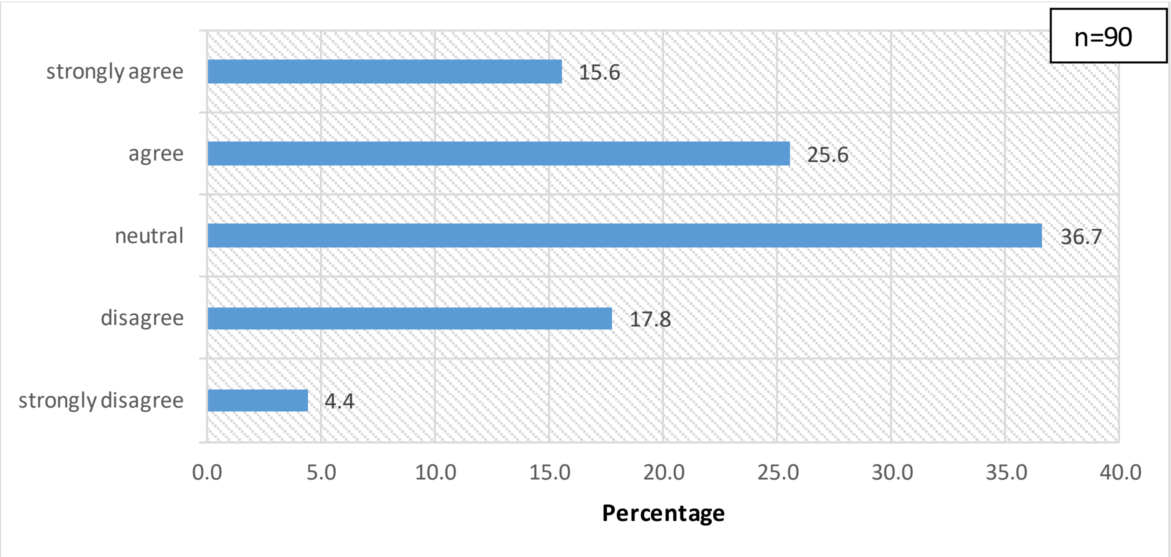

Figure 4.18 Providing services (e.g awareness creation, quality control, and monitoring) government institution affects rural household ICS adoption

Source: (Fieldwork, 2017)

From figure 4.18, most of the households, 41% accepted that provision of services like awareness, quality control, and monitoring by the government institutions can affect the rural household adoption of ICS. 37% of the households neither accepted nor rejected while 22% of the households rejected the statement.

Pearson correlations between ICS ownership and support to stove makers and distributors showed that the coefficient of correlation (r) is -0.242 at *P-value* 0.021. This meant that support to stove makers and distributors are negatively correlated to increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

The KII from the MoEP showed that they usually conduct field visits to the villages, attend Barrazas, shows within the county and also make visits to local community groups in order to create awareness on the adoption of ICS. However, the MoEP is challenged by finance and field human personnel to execute such task effectively. Additionally, lack of proper coordination and awareness sensitization to the community. (Author, personal communication with MoEP, 2017).

An FGD revealed that inadequate access to funding, finance and human personnel makes it so difficult for institutions to carry out some of its function like monitoring and quality control of the ICS. One of the discussants stated that

"We know of few people who have bought/ been bought for the stoves from NGOs. The stoves are very poor and expensive for no reason. They break down and these people don't even follow-up to know if you are using".

Another discussant stated that *"There are some NGOs that came and distribute stoves a year ago. They broke down 3-4 months after. They never followed up to see if they are still in use/ how to repair it for them. So how do you purchase stoves that are very expensive with inferior quality?"*

Product assessment before before distribution.

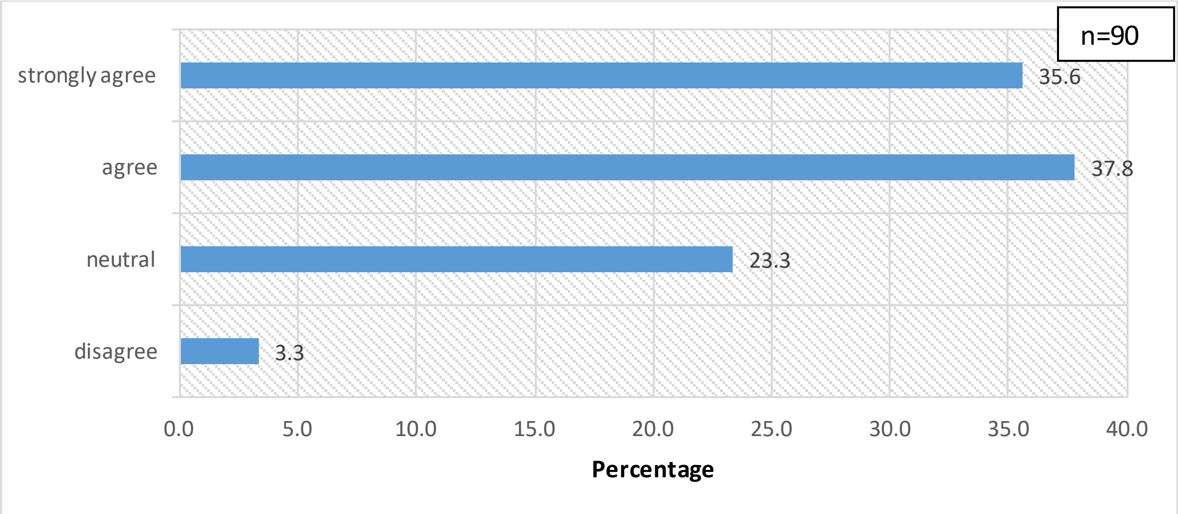

Figure 4.19 Institutional influence on the adoption of quality stoves by helping stove builders and distributors in assessing their produce before disposal.

Source: (Fieldwork, 2017)

The figure 4.19 shows that majority of the households, 77% accepted that the institution can influence the adoption of quality stoves by helping stove builders and distributors in product assessment. Only 3% of the household disagreed to this while 23% were neutral on the statement.

Pearson correlations between ICS ownership and product assessment showed that the coefficient of correlation (r) is -0.352 at *P-value* 0.001. This meant that product assessment is negatively correlated with increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

The MoEP partners with the ministry's local customers and few Juakali artisan who are trained within the ministry; and, local community women who are involved in the ministry's design-distribution process. (Author, personal communication with MoEP, 2017)

An interview with the Juakali artisans revealed that their ICS products are not certified by any relevant authority and no regulatory body has been put in place to monitor and regulate the Juakali ICS production. The MoREP personnel interviewed also stated that there is no regulatory framework to assess and certify ICS products aside from KEBS, who have not been active over years.

A study by Fiona and Jacqueline (2015) also suggested that government need to partner with ICS producers and distributors so as to enhance clean energy cook stoves through the stove quality.

4.4.2 Programs and policies

Government support to Community Development Organizations (CBOs)

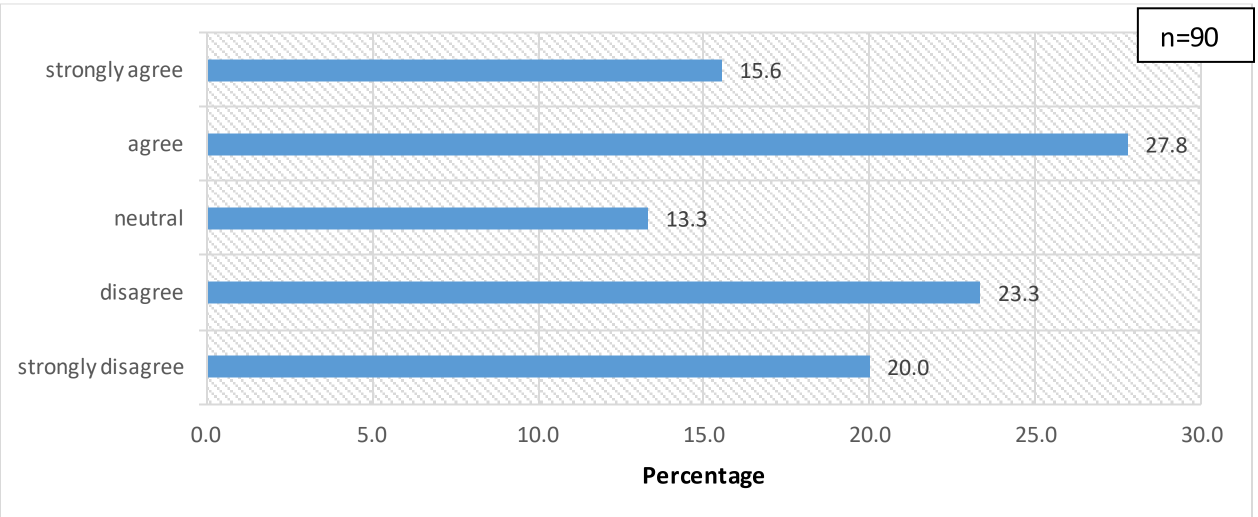

Figure 4.20 Government institution through development agents (CBOs) infulences households' adoption of ICS

Source: Fieldwork, 2017

From figure 4.20, almost equal number of the households 44% and 43%, support and rejects, respectively, the notion that government institutions though the community based organizations can influence the use of ICS. 13% of the households neither accepts nor rejects the statement. This study is consistent with the empirical works of Lim et al., (2013); Puzzolo et al., 2013 that CBOs play a critical role to stove adoption.

However, Pearson correlations between ICS ownership and government influence on CBOs showed that the coefficient of correlation (r) is -0.418 at *P-value* 0.000. This meant that government influence on CBOs are negatively correlated to increased adoption of ICS and statistically significant because the *P-value* less than 0.05.

Record from an FGD showed a likelihood of increased ICS adoption if there is availability of skilled ICS makers/installers. Furthermore, the discussants stated that most institutions act independently and do not engage the community to give their ideas on better ways to increase ICS adoption. One of the discussant quoted that *"you cannot promote a technology to people if you don't create public awareness…"*

4.4.3 Finance, tax and subsidies

Materials, technical and financial support

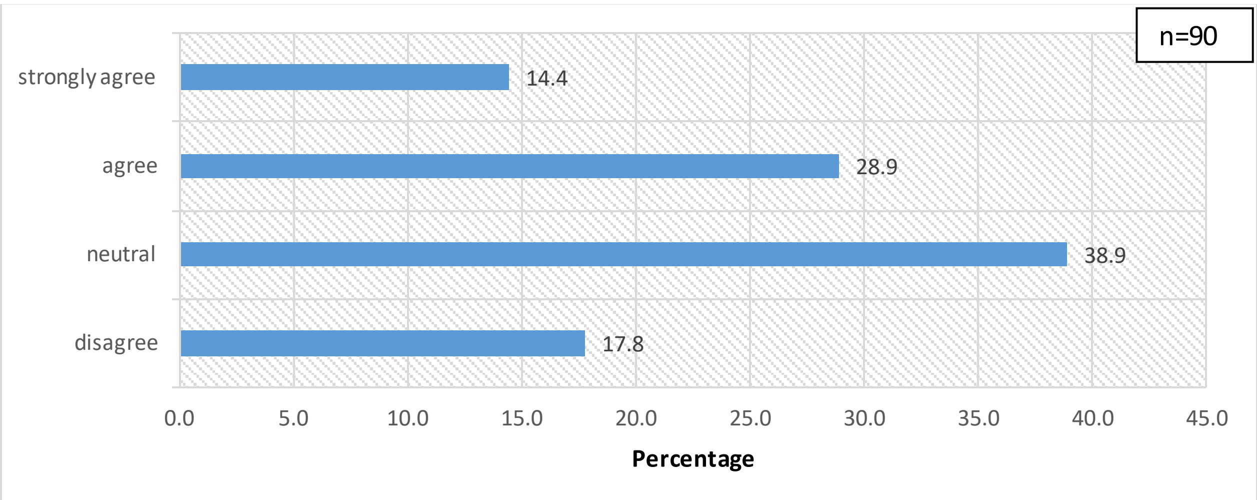

Figure 4.21 Providing supports (e.g materials, technical financial) institution affects households' adoption of ICS.

Source: Fieldwork, 2017

The figure 4.21 shows that statement on the provision of supports like material, technical and financial was accepted by 43% households; 18% rejected while 39% were neutral about the statement.

Pearson correlations between ICS ownership and provision of material, technical and financial support showed that the coefficient of correlation (r) is -0.242 at *P-value* 0.021. This meant that provision of material, technical and financial support are negatively correlated to increase adoption of ICS and statistically significant because the *P-value* less than 0.05.

An interview with the Juakalis revealed that access to capital makes it very difficult for them; and access to loan and finance to boost business growth and marketing. Most of the Juakali produce low-quality ICS because they have no access to credit. More often than not, guarantor or collateral is required to access credit thus creating more challenge for small business entrepreneurs (Author, personal communication with Juakali artisans, 2017).

4.4.4 Market development

Decentralizing ICS production site to users.

Majority of the households, 93% accepts that the decentralization of ICS production sites closer to users can affect the ICS purchasing decision by reducing costs such as transportation. Only 7% of the households stated that they neither accept nor reject the notion.

Pearson correlations between ICS ownership and decentralization of ICS production showed that the coefficient of correlation (r) is -0.383 at *P-value* 0.000. This meant that decentralization of ICS production is negatively correlated to increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

The MoEP locally produce wood fuel ICS within the ministries work premises thus making the ministry's production to be un-decentralised. The decentralised production currently in existence are by the juakali artisans and they produce inferior quality stoves because they lack the desired materials to produce quality ICS (Author, personal communication with MoEP, 2017),

An FGD revealed that there the highly skilled stove builders are out-sourced, causing them a high cost of installation to cover their transport cost.

Offering incentives like finance, subsidies to customers.

Majority of the households, 83% accepted that by an offering of incentives like finance and subsidy from ICS institutions to customers to increase the adoption of ICS. Only 17% of the households stated that they neither accept nor reject the notion.

Pearson correlations between ICS ownership and financial and subsidy incentives to customers showed that the coefficient of correlation (r) is -0.270 at *P-value* 0.010. This means that financial and subsidy incentives to customers are negatively correlated to increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

During the FGD, about 70% of the discussants revealed that ICSs are not sold at a subsidised price or even on credit basis. Additionally, stating that the provision of micro-finance to the community will act as a booster especially to the non-user in the study area.

Further discussion by the Key Informant, MoREP stated that due to the low income of the juakali artisans/stove producers and customers, given access to credit may help overcome liquidity constraints to produce and purchase quality stoves. This study was further supported by the findings of Rehfuess et al., (2014) on the positive effect of price subsidy on stoves, financial incentives for stove construction and maintenance, other promotional offers and consumer finance through microcredit loans.

Offering post-acquisition support.

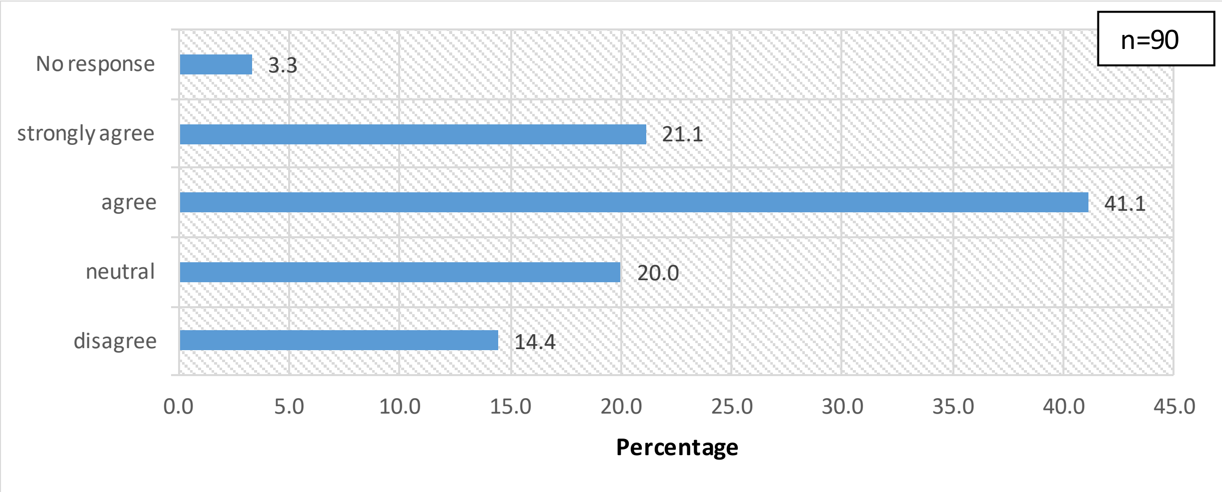

Figure 4.22 Offering post-acquisition support, Institutions influences households' adoption of ICS.

Source: (Fieldwork, 2017)

The figure 4.22 shows that majority of the households, 62% accepted that post-acquisition support from institutions to ICS customers can influence the adoption of ICS. 20% neither accepted nor rejected the notion while 14% rejected the notion.

Pearson correlations between ICS ownership and offering post-acquisition support showed that the coefficient of correlation (r) is -0.401 at *P-value* 0.000. This meant that offering post-acquisition support is negatively correlated to increased adoption of ICS and statistically significant because of the *P-value* less than 0.05.

Kenya Climate Innovation Centre [KCIC] indicated that while government and other institutions in Kenya have made a tremendous effort to create a mature ICS sector, the county governments which are the decentralised point are yet to fully explore the potential and increase ICS adoption. This institutional limitation influencing the adoption of ICS is significant as confirmed by this study (KCIC, 2016).

From the correlations conducted, I found that regulations and standards; programs and policies; finance, tax and subsidy; and market development institutional factors on ICS adoption to be statistically significant at P-value 0.05 and negatively correlated to increased adoption of ICS.

4.5 Hypothesis Test Using Binary Logistic Regression (BLR)

Binary logistic regression was used in this study to test the hypothesis. The regression tested the dependent variable against the independent variables to ascertain which of the independent variable is statistically significant. The previous sections 4.2 to 4.4 described the independent variables according to the data from the households, key informants and focus groups discussants. Such description was further put to test in order to validate the claims in the sections 4.2 to 4.4.

The hypothesis test involved two stages. The first stage referred to as “Step 0” is specifically testing the dependent variable and to determine which factors in the independent variable are statistically significant.

From the first stage, only statistically significant factors in respective independent variables in included into the next stage. The second stage referred to as “Step 1” tests the independent variable. Thus Step 1 for respective independent variables are captured in sections 4.5.1, 4.5.2 and 4.5.3 for the socioeconomic, stove related and institutional independent variables respectively.

Table 4.9 Summary of households in the BLR

Selected Cases	N	Percent
Included in Analysis	90	100.0
Missing Cases	0	.0
Total	90	100.0

Source: (Fieldwork, 2017)

Table 4.9 shows the summary of the number of households that were included in the binary logistic regression. The total households included were 90.

Table 4.10 Value of dependent variable

Dependent Variable Encoding	
Original Value	Internal Value
Yes	0
No	1

Source: Fieldwork, 2017

Table 4.10 show the values of the dependent variable which were encoded as 0 and 1 to represent yes or no. The dependent variable represented the households' ownership of ICS.

Table 4.11 BLR Classification Table

	Observed		Predicted		
			do you own an ICS		Percentage Correct
			yes	No	
Step 0	do you own an ICS	yes	60	0	100.0
		No	30	0	.0
	Overall Percentage				66.7

Source: (Fieldwork, 2017)

From table 4.11, the BLR classification table showed that 60 (67%) of the households own an ICS while 30 (33%) of them do not own an ICS. The table further shows that if everyone owns an ICS, then (67%) accuracy.

Table 4.12 Equation Variable

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-0.693	0.224	9.609	1	0.002	0.500

Source: (Fieldwork, 2017)

Table 4.12; show that Beta weight "B" is the intercept which is -0.693. The exponential Beta weight Exp (B) is 0.500 i.e. responses of "no" divided by the "yes" response (30/60). The

Exp (B) is mostly interpreted by subtracting the Exp (B) value which is 0.500 from 1. This gives 0.500. Thus, considering the factors influencing the adoption of ICS in the sense of there is 50% chance of being an ICS owner when studied in a larger population.

At standard error 0.224, the significance of the factors influencing the adoption of ICS is 0.002 i.e. there is 0.2% chance of getting a difference as large as the difference in this study given that the null hypothesis is true. From a statistically significant point of view, there is a 0.2% chance that the difference in the factors influencing the adoption of ICS is as different as observed in this study when studying a larger population.

Thus, the equation for the BLR model in this study is

$$\ln\left(\frac{p}{1-p}\right) = (-0.693) + B_1X_1 + B_2X_2 + B_3X_3$$

Where

$\ln\left(\frac{p}{1-p}\right)$ = the dependent variable Y* i.e. the Probability of adopting ICS

Bo = the intercept/constant of the dependent variable is (-0.693)

B_1 = the intercept or constant of independent variable socioeconomic factor

X_1 = independent variable socioeconomic factor

B_2 = the intercept or constant of independent variable stove related factor

X_2 = independent variable stove related factor

B_3 = the intercept or constant of independent variable institutional factor

X_3 = independent variable institutional factor

Table 4.13 Summary of Model

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	0.000	0.705	1.000

Source: (Fieldwork, 2017)

From the table 4.13 on a scale of 0 to 1.1, the Nagelkerke R Square vale is 1.0 i.e. 100% (out of 110%). This means that 100% out of 110% variability in the dependent variable is accounted for by the independent. However, this is qualified in the context that this is a pseudo R Square value as shown in Table 4.14.

Further analysis on the BLR included only the statistically significant variable in the hypothesis testing as outlined below from section 4.5.1 to 4.5.3 below.

4.5.1 First hypothesis testing for socioeconomic factor variables

Table 4.14 Dependent variable for Socio economic hypothesis

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 0	Constant	-0.693	0.224	9.609	1	0.002	0.500

Source: (Fieldwork, 2017)

The 1st H_1 (alternative hypothesis) which is socioeconomic factors significantly influence the adoption of ICS is accepted because the *P-value* is less than 0.05 as shown in table 4.14.

$$\ln\left(\frac{p}{1-p}\right) = (-0.693) + B_1X_1$$

Where,

B_1 is the constant for socioeconomic factor

X_1 are the respective socioeconomic variable

Table 4.15 Socioeconomic variables not in the Equation

Socioeconomic variables not in the Equation				
	Variables	Score	df	Sig.
Step 0	Composition of socio group	20.967	1	.000
	Membership of any socio organization	16.493	1	.000
	Main source of income	11.208	1	.001
	Influence of neighbours	7.868	1	.005
	Socio-information exchange	4.326	1	.038
	Cultural practice	1.938	1	.164
	Household living and feeding size	1.890	1	.169
	Age	1.513	1	.219
	Education attained	.480	1	.488
	Membership into different organizations	.120	1	.729

Source: (Fieldwork, 2017)

From the table 4.15, the first step analysis of the BLR showed the Composition of socio group; Membership of any socio organization; Main source of income; Influence of neighbours; and Socio-information exchange is the only statistically significant socio-economic factors.

Table 4.16 Socioeconomic Variables in the Equation

Socioeconomic Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Composition of socio group	20.470	5843.265	.000	1	.997	775873 977.181
	Membership of any socio organization	-40.658	11686.531	.000	1	.997	.000
	Main source of income	-3.477	1.117	9.684	1	.002	.031
	Influence of neighbours	.619	.491	1.591	1	.207	1.857
	Socio-information exchange	-.352	.428	.675	1	.411	.703
	Constant	-17.856	5843.266	.000	1	.998	.000

a. Variable(s) entered on step 1: Only statistically significant Socioeconomic variables from step 0.

Source: (Fieldwork, 2017)

Based on the hypothesis rule, at least one of the independent variable must be statistically significant to accept H_i. As shown in table 4.16, at least one of the socio-economic variable are statistically significant in *step 1,* thus H_1 for socioeconomic factor is accepted.

Since the constant for socioeconomic factor is -17.856, the BLR equation model for the socioeconomic factor is

$$\ln\left(\frac{p}{1-p}\right) = (-17.856) + (B_{1i}X_{1i})$$

Where,

B_{1i} is the constant for respective socioeconomic variables

X_{1i} are the respective socioeconomic variables.

4.5.2 Second hypothesis testing for stove related factor variables

Table 4.17 Dependent variable for stove related factor hypothesis

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 0	Constant	-.693	.224	9.609	1	.002	.500

Source: (Fieldwork, 2017)

The 1st H_1 (alternative hypothesis) which was socioeconomic factors significantly influence the adoption of ICS was accepted because the *P-value* is less than 0.05 as shown in table 4.17.

$$\ln\left(\frac{p}{1-p}\right) = (-0.693) + B_2X_2$$

Where,

B_2 is the constant for stove related factor

X_2 are the stove related variable

Table 4.18 Stove related Variables not in the Equation

Stove related Variables not in the Equation				
Step 0	Rating of ICS cost	79.699	1	.000
	Period of exposure to ICS usage	68.602	1	.000
	Repair of ICS	60.390	1	.000
	Combined features like cost, portability, quality, appearance and fuel consumption	55.021	1	.000
	ICS Size effect on cooking	47.066	1	.000
	Design to fit the surrounding	30.155	1	.000
	Replacement of ICS	27.488	1	.000
	Cook stove types in use	18.719	1	.000
	Type of repair	15.935	1	.000
	Replacement of ICS with same model	8.289	1	.004
	Main source of cooking fuel	1.239	1	.266

Source: (Fieldwork, 2017)

From the table 4.18, the first step analysis of the BLR shows that the statistically significant stove related factors include the Rating of ICS cost; Period of exposure to ICS usage; Repair of ICS; Combined features like cost, portability, quality, appearance and fuel consumption; ICS Size effect on cooking; Design to fit the surrounding; Replacement of ICS; Cook stove types in use; Type of repair; and Replacement of ICS with same model.

Table 4.19 Independent variables for Stove related hypothesis

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 1[a]	Main source of cooking fuel	3.875	9639.003	.000	1	1.000	48.205
	Cook stove types in use	-1.136	2547.869	.000	1	1.000	.321
	Combined features like cost, portability, quality,	8.290	9979.045	.000	1	.999	3982.969

	appearance and fuel consumption						
	Rating of ICS cost	-.037	39.650	3.486	1	.002	.013
	Type of repair	22.678	4785.573	.000	1	.996	7060462825.014
	Period of exposure to ICS usage	6.253	1528.424	.000	1	.997	519.820
	Repair of ICS	17.195	9842.355	.000	1	.999	29346006.351
	Replacement of ICS	18.688	11440.414	.000	1	.999	130690470.603
	Replacement of ICS with same model	1.992	12905.493	.000	1	1.000	7.328
	Design to fit the surrounding	.832	6220.248	.000	1	1.000	2.299
	ICS Size effect on cooking	-13.583	11010.712	.000	1	.999	.000
	Constant	-97.247	34178.238	.000	1	.998	.000
a. Variable(s) entered on step 1: Only significant stove related variables in *step 0*							

Source: (Fieldwork, 2017)

Based on the hypothesis rule, at least one of the independent variable must be statistically significant to accept H_i. As shown in table 4.19, at least one of the stove-related variable are statistically significant in *step 1,* thus H1 for stove related factor is accepted.

Since the constant for stove-related factor was -97.247, the BLR equation model for the stove related factor is

$$\ln(\frac{p}{1-p}) = (-97.247) + (B_{2i}X_{2i})$$

Where,

B_{2i} is the constant for respective stove related variables

X_{2i} are the respective stove related variables

4.5.3 Third hypothesis testing for institutional factor variables

Table 4.20 Dependent variables for institutional hypothesis

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 0	Constant	-.693	.224	9.609	1	.002	.500

Source: (Fieldwork, 2017)

The 3rd H_1 (alternative hypothesis) stating that institutional factors have significance on the adoption of ICS is accepted because the *P-value* is less than 0.05 as shown in table 4.20.

The model for this equation is

$$\ln(\frac{p}{1-p}) = (-0.693) + B_3 X_{3i}$$

Where,

B_3 is the constant for institutional factor

X_3 is the institutional variable

Table 4.21 Institutional Variables not in the Equation

Institutional Variables not in the Equation				
Variables		Score	df	Sig.
Step 0	Government through CBOs	15.752	1	.000
	Post ICS acquisition support	14.481	1	.000
	Decentralizing ICS production	13.196	1	.000
	Support to stove builders and distributors	11.155	1	.001
	Materials, technical financial supports	6.840	1	.009
	Finance and subsidy to customers	6.577	1	.010
	Awareness creation, quality control, and monitoring	5.292	1	.021
	Overall Statistics	90.000	29	.363

Source: (Fieldwork, 2017)

From the table 4.21, the first step analysis of the BLR shows that the institutional significant factors are Government support through CBOs; Post ICS acquisition support; Decentralizing ICS production; Support to stove builders and distributors; Materials, technical financial supports; Awareness creation, quality control, and monitoring

Table 4.22 Independent variables for Institutional factor hypothesis

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Government through CBOs	-.761	.351	4.704	1	.030	.467
	Awareness creation, quality control, and monitoring	.429	.354	1.466	1	.226	1.535
	Materials, technical financial supports	.279	.459	.371	1	.543	1.322
	Support to stove builders and distributors	-.218	.373	.340	1	.560	.804
	Decentralizing ICS production	-.321	.644	.249	1	.618	.725
	Finance and subsidy to customers	.247	.512	.233	1	.629	1.281
	Post ICS acquisition support	-.798	.358	4.952	1	.026	.450
	Constant	3.159	2.573	1.508	1	.220	23.537

a. Variable(s) entered on step 1: Only statistically significant Institutional variables from step 0.

Source: (Fieldwork, 2017)

Based on the hypothesis rule, at least one of the independent variable must be statistically significant to accept H_i. As shown in the table 4.22, at least two of the institutional variable are statistically significant in *step 1,* thus H1 for institutional factor is accepted.

Since the constant for institutional factor was 3.159, the BLR equation model for the institutional factor is

$$\ln\left(\frac{p}{1-p}\right) = (3.159) + (B_{3i}X_{3i})$$

Where,

B_{3i} is the constant for respective stove related variables

X_{3i} are the respective stove related variable

4.6 Chapter Summary

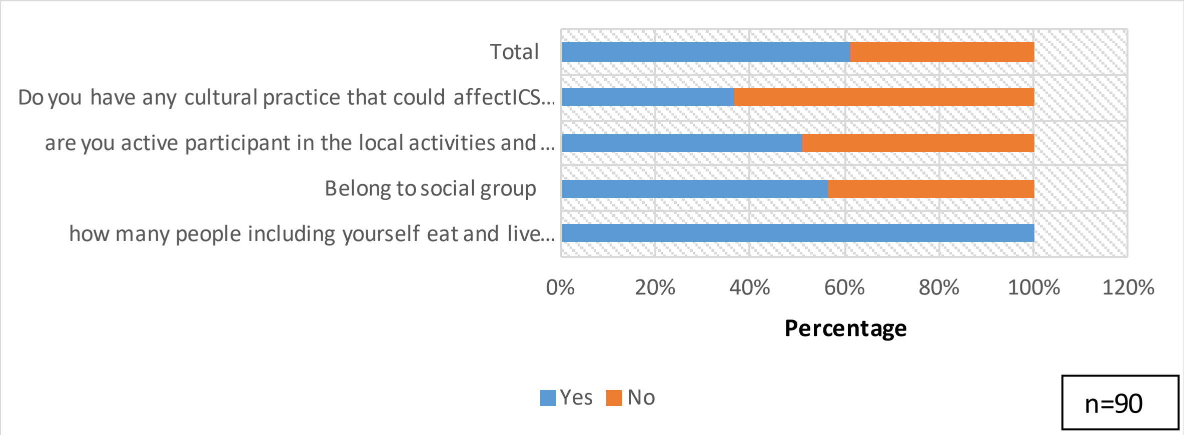

Figure 4.23 Socioeconomic factors outlining yes or no response

Source: (Fieldwork, 2017)

General yes or no responses on socio-economic factor like cultural, social group, social activeness, and household size showed that 61% of the households recognise socio-economic factor as a factor that influence the increase adoption of ICS as shown in figure 4.23.

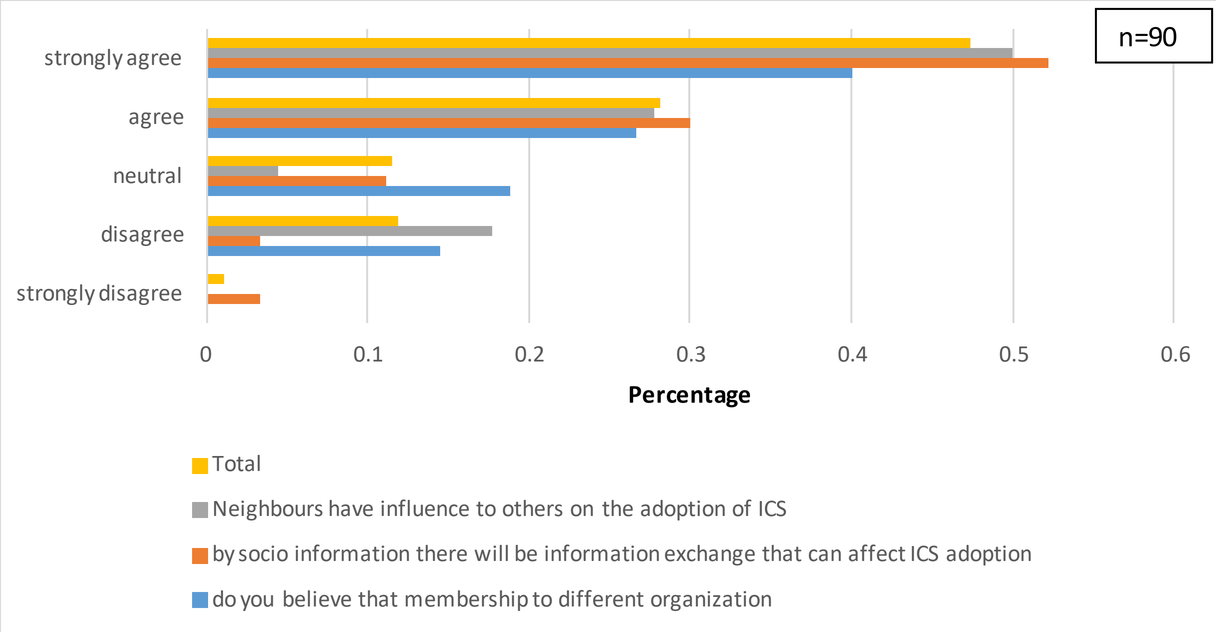

Figure 4.24 Socio-economic factors on scale response

Source: (Fieldwork, 2017)

From figure 4.24, scale-related responses on socio-economic factors 75% of the households accepted that socio-economic factors influenced increased ICS adoption. While 13% of the households rejected the idea and another 11% of them neither rejected nor accepted.

Correlational comparison between the dependent variable and independent variable at the significant P-value of 0.05 indicated that main source of income is negatively correlated (r = -0.460), membership in social group is positively correlated (r = 0.428), social information exchange is negatively correlated (r = -0.219), cultural belief is positively correlated (r = 0.174), membership in social group is positively correlated (r = 0.428), social information exchange is negatively correlated (r = -0.219), and neighbours influence is positively correlated (r = 0.296) to increased adoption of ICS. The BRL hypothesis test shows that socioeconomic factors influence the adoption of ICS.

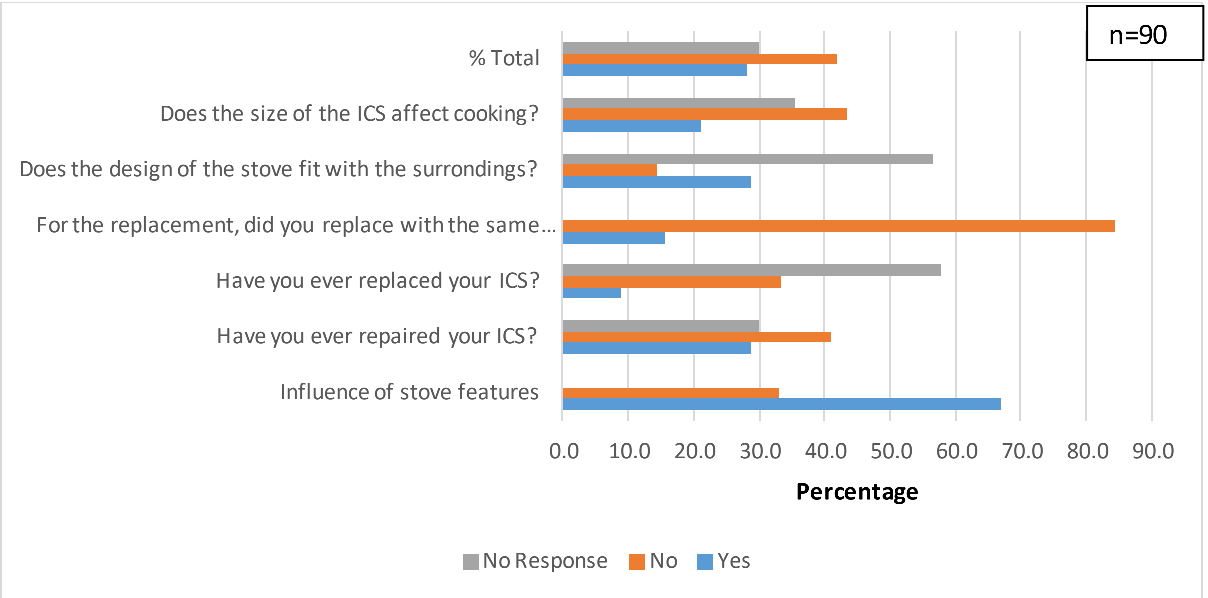

Figure 4.25 Stove related factor outlining yes or no response

Source: (Fieldwork, 2017)

From figure 4.25, the yes or no related responses showed that 42% of the households do not believe that stove related factor affects the increased adoption of ICS. Those that believed it affects were 28% of the households. While those that did not respond to the question were 30%. This meant that out of the 67% ICS owners, 28% were influenced by stove related factor while 39% were not.

Correlational comparison between the dependent variable and the independent variable at the significant P-value of 0.05 indicated that stove characteristics are positively correlated (r = 0.782) to increased adoption of ICS. The BRL hypothesis test shows that stove related factors influence the adoption of ICS.

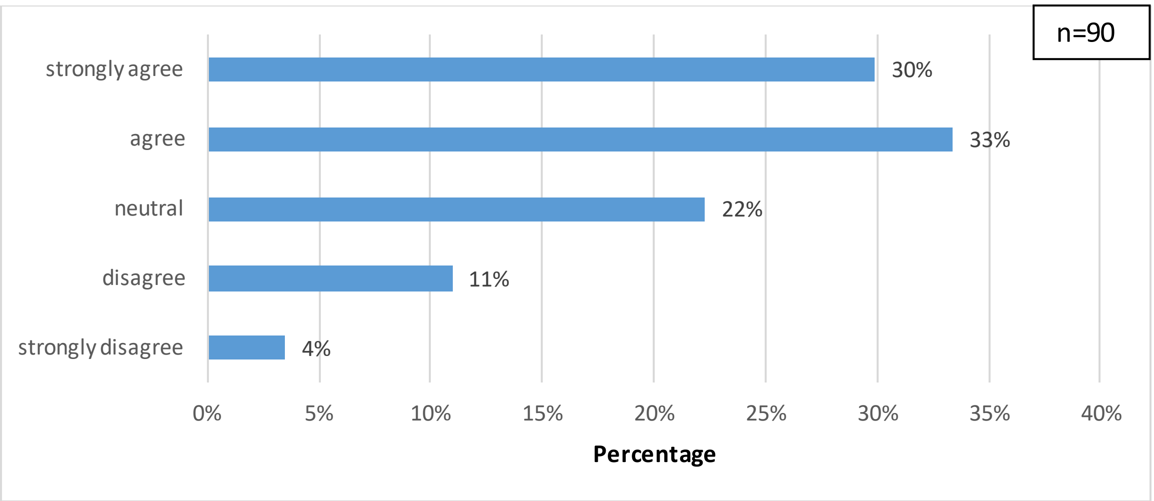

Figure 4.26 Percentage Total of Institutional Factors

Source: (Fieldwork, 2017)

The figure 4.26 indicates that 63% accepts that institutional factors affect the adoption of ICS.

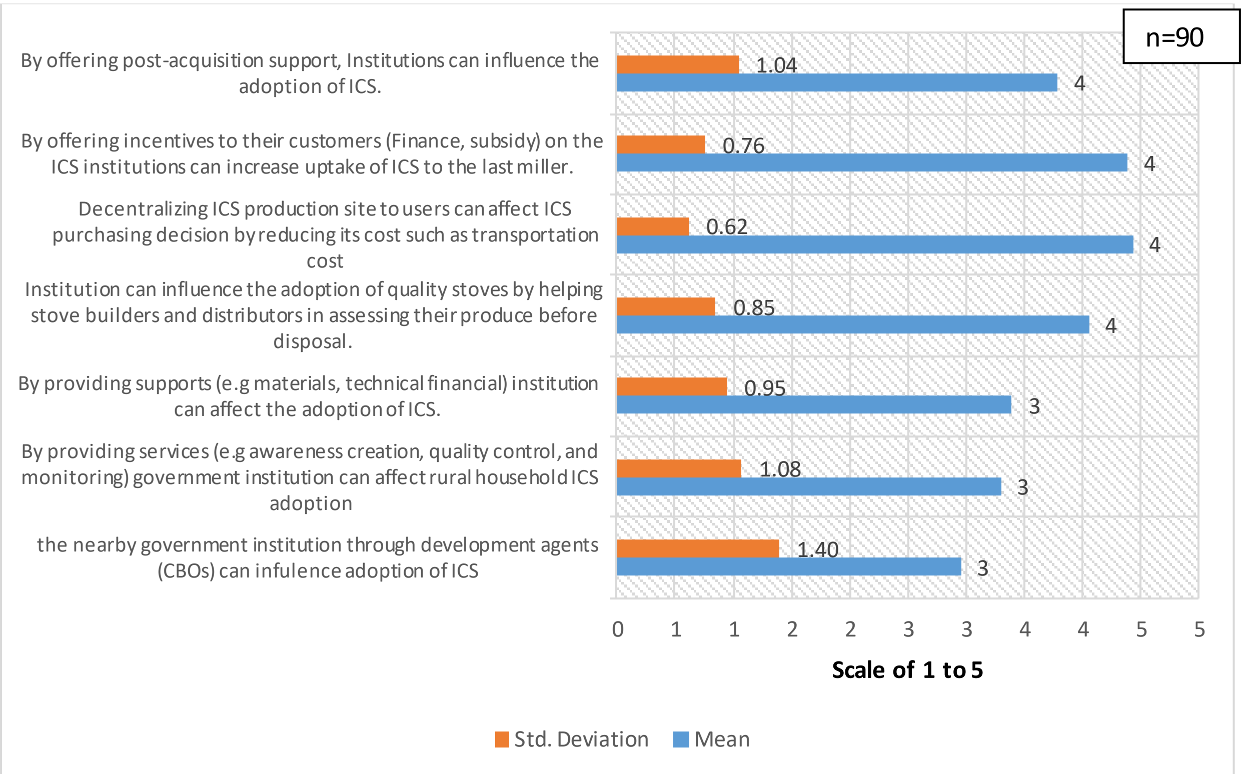

Figure 4.27 Descriptive Summary of Institutional Factors

Source: (Fieldwork, 2017)

As shown on the figure 4.27, on an estimation, the descriptive mean agreement for the institutional factors on a scale of 1 to 5 (closer to point 5 is to agree) was 3.57. Specific inquiry on the institutional factors showed that the households' agreed to post-acquisition support, the incentive to customers, production decentralization, and help to stove builders and distributors would increase the adoption of ICS. This study came up with similar findings from Makonese 2006 that found training, technology and information exchange and decentralization of ICS as institutional factors that influence high production, adoption and dissemination of quality ICS.

Correlational comparison between the dependent variable and independent variable at the significant P-value of 0.05 indicated that support to stove makers and distributors as negatively correlated (r = -0.242), product assessment as negatively correlated (r = -0.352), government influence on CBOs as negatively correlated (r = -0.418), provision of material, technical and financial support as negatively correlated (r = -0.242), decentralization of ICS production as negatively correlated (r = -0.383), financial and subsidy incentives to customers as negatively correlated (r = -0.270) and offering post-acquisition support as negatively correlated (r = -0.401) to increased adoption of ICS. The BRL hypothesis test shows that institutional factors influence the adoption of ICS.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

5.0 Introduction

This chapter presents the summary, conclusion and recommendation of the study on the Factors influencing adoption of ICS by the rural households' residents in Funyula Sub-County. This study was necessary because Busia County is ranked among the top poorest counties in Kenya with a large population largely relying on Biomass especially fuel wood for cooking, boiling and even lighting. As related to this study, the chapter also suggested further areas that should be studied.

5.1 Summary

With respect to socio-economic characteristics: the study found that the middle age category had a mean age of 40 years and are more adaptable to ICS technology. Also, most of the households that use ICS had attained at least primary school education and thus higher level of education was not necessarily a factor to increased ICS adoption. The study found that as household size increases, ICS adoption increases but decreases when household size increases above 6 persons. Belonging to the social group increases the chance of social information exchange, access to knowledge, loans and credit that will likely increase the adoption of ICS.

However, limiting factors like income and cultural beliefs, which include the taste of food that is cooked from the traditional stove and the capacity of traditional to accommodate large traditional household size were limiting factor to ICS adoption. The study found that the composition of socio group membership of any social organization, the main source of income, and influence of neighbours was significant at *P-value* less than 0.05.

On stove related factors, the study found that cost of the stove is expensive forcing most rural households whose income is below 5000 KS to use traditional stoves or adopt a cheap and substandard ICS. Those substandard ICS are locally made by the Juakali and uses firewood, frequently breakdown and often requires repairs. The ICS that are expensive uses charcoal which additionally acts as a limiting factor to usage because charcoal as cooking fuel is not readily available to most rural households. Access to information about the stoves' usage and quality; correlation of stove size to the cooking size and household size; quality of the stoves in relation to its durability; stove's efficiency; and stove's fuel consumption and fuel type availability are a range of factors that contribute to the adoption of ICS.

The study found that ICS cost, period of exposure to ICS usage, repair of ICS, combined features like cost, portability, quality, appearance and fuel consumption, ICS Size effect on cooking, design to fit the surrounding, replacement of ICS, cook stove types in use, type of repair, and replacement of ICS with same model was significant at *P-value* less than 0.05.

With respect to institutional factors: the study found that government institutions through the community based organizations can influence the use of ICS. The provision of services like awareness, quality control, and monitoring by the government institutions can affect the rural household adoption of ICS. However, inadequate access to funding, finance and human personnel makes it so difficult for institutions to carry out some of its product assessment function like monitoring and quality control of their ICS. Additionally, the ICS providing institutions is still challenged with the provision of supports like material, technical and financial to ICS producers especially the Juakali. There is a high volume of quality ICS that are not in circulation because of unsubsidized cost and lack of provision of micro-finance to the community.

The study found that statistically significant factors at *P-value* less than 0.05 include government support through CBOs, post ICS acquisition support, decentralizing ICS production, and support to stove builders and distributors, materials, technical financial supports.

5.2 Conclusion

This study found that 61% of the households recognised socio-economic as factors influencing increased adoption of ICS. Significantly on the empirical test: those socio-economic factors are composition of socio group; membership of any socio organization; main source of income; and influence of neighbours.

Out of the 67% households that have ICS, 28% were influenced by stove related factor for them to own an ICS while 39% were not. The statistically significant stove related factors at play included the rating of ICS cost; period of exposure to ICS usage; repair of ICS; combined features like cost, portability, quality, appearance and fuel consumption; ICS size effect on cooking; design to fit the surrounding; replacement of ICS; cook stove types in use; type of repair; and replacement of ICS with the same model.

The households' majority 63% accepted that institutional factors affect the adoption of ICS. Those institutional significant factors were government support through CBOs; post-ICS acquisition support; decentralizing ICS production and support to stove builders and distributors.

Therefore, socio-economic, stove-related, and institutional factors have a significant influence on adoption of improved cooking stoves among rural households in Funyula constituency as affirmed by the 0.002 significance level on the factors influencing adoption of ICS as found in this study.

5.3 Recommendation

Based on the study findings this study made a general, market and policy-based recommendations sectioned below to the government, institutions facilitating ICS and the public especially residents of Funyula Sub-County.

5.3.1 General recommendations

Majority of the households 64% believed something could be done to increase the adoption of ICS in their respective localities. Strategies that would increase the households' adoption of ICS included the reduction in the cost of ICS; awareness creation like radio advertisement on ICS product, benefits and usage; subsidizing of the cost of ICS; and teaching of locals on how to design ICS. As an incentive to quality ICS production, the Juakali needed an affordable and subsidized production cost; and standardisation of their products and cost.

Based on the significance test for this study, this study recommends the followings with respect to each objective observed in this study:

On socio-economic factors, the residents of Funyula rural areas should be facilitated to join social groups and considering that their motives to joining such group are to enhance their means of livelihood, there should be technical, knowledge and financial based assistance by the CBOs and other institutions. This in addition to other recommended poverty reduction programmes will enhance the means of livelihood which in turn increases the adoption of an effective ICS.

On stove related factors, ICS producers need to find means of reducing the cost of ICS to make them cheaper and affordable to the rural residents; other ICS features like design, durability, size, portability, quality, appearance and fuel consumption needs to be enhanced during ICS production. The firewood ICS fuel type was preferred by the households, however, to conserve the environment, the charcoal fuel type should be continually produced more while charcoal fuel sources should be made readily available and affordable for rural households.

On institutional recommendations, there should be technical, material, financial support to ICS producers/distributors/buyers; and decentralizing of ICS production. Increased access to funding, finance and human personnel should be made available to the local producers and institutionalised producers to ensure the production of quality ICS and enhance the monitoring and quality control of ICS. Lastly, the regulatory framework by KEBS should be effective as noted by MOREP to ensure all ICS products are certified before sold or distributed to the community/public. The Juakali recommended that their products be inspected by KEBS before selling or distributing them to the retailers/customers.

5.3.2 Multifactorial approach

While this study recommends actionable and implementable programmes independently of the factors identified in this study, this study also recommends an interconnected approach that collectively addressed the socioeconomic, stove related and institutional factors. Such all-encompassing approach should be addressed from a market and policy-based approach.

Market-based strategy

Institutionally, there is a need for partnership among private/ public organization with various brands of ICS to increase the community trust; and contributions to the efforts by various organizations such as credit union, credit cooperatives, self-help groups and microfinance. Institutions to help consumer afford a stove of desired design through instalments spread throughout the months. Awareness needs to be strategized in a way that informs the community about the ICS cost-benefit including health, environment and social to impact its adoption beyond looking at the cost (Author, personal communication with MoEP & Juakali artisans, 2017).

In enhancing local potentials, there should be community-market based approach to increase distribution in rural areas through direct demonstrations, dramas etc.; assess potential market and customer need through financial services according to their need and after sales support especially in rural areas; promote the in-county production, since in Busia there is none existence, to promote decentralised production of quality stoves that have been marked certified and recognized on social and health benefit by thoroughly training the Juakali artisans.

Policy-based strategy

Despite the continuing increase in the adoption of ICS in Funyula Sub-County there has been a deficit in ICS implemented programmes and policy gaps. In addressing these challenges: there is need to train the local Juakali artisans within the sub-county; community involvement to increase the involvement of the locals and end-users especially women in the design-distribution of ICS. Cultural factor like gender sensitivity is critical to the adoption of ICS (GACC, 2012) thus the need to significantly include women in the awareness, advocacy and implementation programs aimed at increasing ICS.

An enactment of policies like access to credit and loans will reduce the poverty level within the sub-county considering that all the households in this study indicated an income below 5000 KS. This is highly reflected by the FGD participants who stated that the provision of micro-finance to the community will act as a booster especially to the non-user in the Busia County.

5.4 Suggested Areas for Further Studies

Based on the findings from this study: the study recommended that research be conducted on: the effects of non-effective ICS on health and environment; economic implications of ICS on rural households; role of government and CBOs on the effective implementation of ICS in rural households; and the evaluation of Juakali artisans on the production and design of ICS for rural communities.

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APPENDICES

APPENDIX I

QUESTIONNAIRE FOR HOUSEHOLDS

INTRODUCTION
I am a student at the University of Nairobi pursuing Masters of Arts Degree in Environmental Planning and Management. I am carrying out a research on the Factors that Influence Adoption of Improved Cooking Stoves (ICS). A case study of Funyula Sub-county. The research is purely for academic purposes. Any information given to me will be treated with utmost confidentiality.

- **<u>Demographic data</u>**

1 Gender
Male …………1
Female……….2
2 Age
18-30) 31-55 ( ) 56-80 ( ) above 81
3 Marital status
Single
Married
Widow
Separated
4 Religious affliction
None
Catholic
Protestant
Other

- **<u>PART1: Socio-economic status</u>**

5 What is your level of education attained?
None
Primary education
Secondary education
Tertiary
University
6 How long have you lived in this village?
Less than 2 years 2-5 years 6-9 years more than 10 years
7 a) In your household, do you live with people?
Yes……..1
No………2
b) How many people including yourself who normally eat and live within your household?
8 a) Are you a member of any social organization group within your locality?
Yes……1
No……2
b) What is the composition of the members of the social organization group?
My neighbours……..1
My friends…………….2

My community members……3
Others…………………4

9 Are you an active participant in local associations and activities?
Yes……..1
No……..2
Please state your opinion for each of the given statement using the following scales:
1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

		Scale	Comment
11	Do you believe that membership to different social-organization can influence ICS adoption?		
12	By social organization, there will be information exchange that can affect ICS adoption?		
13	Neighbours have influence to others on the adoption of ICS.		

14 a) Do you have any cultural practice that could affect ICS ownership?
Yes……..1
No………2
b) Mention few of these cultural practices are?

15 What is your main source of income?
Farming………..1
Casual labourer……..2
Government employee…..3
Private formal……….4
Other…………………..5

16 What is your average income per-month does this household get?
Less than 5000…….1
5001-10000…………2
Above 10000……….3

- **PART 11: Stove-related factors influencing adoption of ICS**

17 What is the household main source of cooking fuel?
Solar………………1
Biogas……………2
Biomass residue……..3
Paraffin………..4
Electricity……..5
Gas/LPG……….6
Charcoal……….7
Collected firewood………8
Purchased firewood…….9

18 What types of cook stoves are used in your household?
Traditional three stone………1
Improved traditional stove……..2
Ordinary jiko…………………………..3
Kerosene stove………………………4
Improved jiko with liner…………..5
Kuni mbili stove………………………6
Multi-purpose stove……………….7
Jiko bora…………………………………8
Upesi jiko……………………………….9
Other (specify)………………………10

19 Do you own an ICS?
Yes….1
No…..2 (go to qsn 23)

20 What influenced your adoption?
Appearance………1
Fast cooking……..2
Little fuel usage…3
Portability…………4
Quality………………5
Cost…………………..6
Other…………………7

21 What could be the reason for not owning one?

22 For the ICS that you are using, what was its cost?

23 How would you rate the (cost)?
Cheap…..1
Fair……….2
Expensive….3

24 For how long have you been using the above mentioned ICS?

25 a) Have you ever replaced or repaired your ICS?
Yes……1
No…….2
b) What kind of repair did you do on it?
Repair of body cracks………1
Repair on door…………………2
Repair on pot rests…………..3
Other (specify)………………….4

26 a) for the replacement, did you replace it with the same model?
Yes……..1
No………2
b) If No, why?

27 a) Does the design of the stove fit to the surrounding's?
Yes……..1
No………2

28 What is your preferred/ideal stove design?

29 a) Does the size of ICS affect your cooking?
Yes……1
No…….2
b) How does it influence your cooking?

- **PART III: Institutional factors**

Please state your opinion for each of the given statement using the following scales:
1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	items	Scale	Comments
30	The nearby government institution(through development agents, CBOs) can influence improved cook stoves		
31	By providing services (e.g awareness creation, quality control, and monitoring) government institution can affect rural household ICS adoption.		
32	By providing supports (e.g materials, technical financial) institution can affect the adoption of ICS.		
33	Institution can influence the adoption of quality stoves by helping stove builders and distributors in assessing their produce before disposal.		
34	Decentralizing ICS production site to users can affect ICS purchasing decision by reducing its cost such as transportation cost.		
35	By offering incentives to their customers (Finance, subsidy) on the ICS institutions can increase uptake of ICS to the last miller.		
36	By offering post-acquisition support, Institutions can influence the adoption of ICS.		

- **PART IV: Strategies for increase ICS adoption**

37 Do you think that ICS uptake can increase within the households of this area?

Yes……..1

No……….2

38 Which strategies do you think can be used in ICS dissemination in the area?

Thank you for your cooperation

APPENDIX II

KEY INFORMANT INTERVIEW GUIDE

FOR

GOVERNMENT AND NGO OFFICIALS

The questionnaire is intended to determine the factors that influence the adoption of Improved Cook stoves in Funyula sub-county, Namboboto ward

The questionnaire is divided into two (2) parts. Part one contains general questions to be answered by all respondents. Part two is divided into two sections. Section A contains questions for stove builders and section B is for employees from the local NGOs and Government organizations.

Thank you in advance.

PART 1: GENERAL QUESTIONNAIRE TO DETERMINE THE FACTORS THAT INFLUENCE ADOPTION OF IMPROVED COOK STOVES IN BUSIA COUNTY, FUNYULA SUB COUNTY.

1. **RESPONDENT NAME GENDER**
2. **RESPONDENT ORGANISATIONAL CATEGORY**
3. **WHAT IS YOUR MANDATE IN THE ORGANIZATION?**
4. **RESPONDENT HIGHEST EDUCATION LEVEL**
5. **YEARS OF WORK EXPERIENCE IN THIS COUNTY**

SECTION A: **<u>SPECIFICALLY FOR STOVE DESIGNERS (JUAKALI),</u>**

1 What type and numbers of improved cook stoves do you manufacture per year?
2 a) Where do you source your raw materials for making ICS?
b) Are these sources sustainable?
c) Are the sources accessible?
3 What is the average sale price of the domestic improved cook stoves that you produce?
4 Give a breakdown of costs that inform the pricing of the stoves?
5 How best can these costs be reduced.
6 What were the average sale prices of the stoves 1-5 years ago?
7 How do you ensure quality of the stoves that you manufacture?
8 a) Have your stoves been tested for efficiency, emissions, durability, safety and Ease of use?
b) If yes, how are they rated?
C) If no, why have your stoves not been tested?
9 Do you give incentives to your clients to increase uptake of improved Cook stoves by last mile users? (e.g. credits, warrant, linkage to financing Sources etc)
10 a) Of the stoves you manufacture, which one do you produce least?
b)Explain
11 a) Of the stoves you manufacture, which one do you produce most?
b) Explain
12 a) Are there stoves (sizes/types) that your clients often ask for that you don't manufacture?

b) If yes, why don't you manufacture them

13 Which stoves do consumers normally ask for? (name at least 3 ICS)

14 What are the most common complaints amongst (potential) stove purchasers?

15 What do (potential) stove purchasers like most about the stoves?

16 What do (potential) stove purchasers consider first when purchasing your stoves (e.g cost, outlook, durability etc)

17 a) What are the sources of finances for your business?

b) Do you know of any alternative financing opportunities for improved cook stoves?

18 a) What are the conditions for accessing finances for improved cookstoves?

b) Are these conditions favorable?

c) If no, what recommendations do you give to address this challenge?

19 a) What are the challenges that are faced in ICS production?

b) What can be done to overcome the above challenges?

20 In your view, how can we increase uptake of ICS to the last mile consumer?

SECTION B: <u>LOCAL NGOS AND GOVERNMENT ORGANIZATION</u>

- **<u>MARKET DEVELOPMENT</u>**

1 What type of improved cook stoves do you deal in?

2 For how long has this organization been in business of ICS?

3 (If the institution does not manufacture improved cook stoves) Where do you source your improved cook stoves?

4 Who are the other main players where one can buy improved cook stoves?

5 a) How do you create awareness about the improved cook stoves your deal in to reach the last mile consumers?

b) What informs the choice of the method you use?

c) Who are the other main players involved in marketing and distribution of your improved cook stoves

6 Of the stoves you supply, which one do you sell least

Explain why.

7 Of the stoves you supply, which one do you sell most?

Explain why

8 a) Are there stoves (sizes/types) that people often ask for that you don't manufacture/deal in?

b) If yes, why don't you manufacture or deal in them?

9) What are the challenges faced with your distribution and marketing model?

10 What can be done to overcome the above challenges?

11 In your view, how can we increase uptake of ICS to the last mile consumer?

- **<u>PROGRAMS and POLICIES</u>**

12 Through what activities/programs are the policies of ICS being implemented by your organization?

13 What has been the impact of the policies on the adoption of ICS in Funyula Sub-county?

14 a) What policy gaps exist that you think are affecting the adoption of ICS?

b) How can the gaps be filled?

- **<u>REGULATIONS AND STARNDARDS</u>**

15 What strategies are in place for cook stove players to conform to the standards?

16 Are the standards being implemented?

If no, why?

17 What grading systems are used for cook stoves in Kenya?

18 What grading systems exist for cook stoves at international level?

b) How can these systems be tailored for Kenyan?

19 Are there local agencies that do help stove builders and distributors assess the quality of their stoves against the recommended standards?

20 Do these agencies have deliberate programs to sensitize stove builders/distributors on where and why to do the testing?

21 a) what challenges do the testing agencies face in assessing stove quality against standard
b) How can the challenges be addressed?

- **<u>FINANCE, SUBSIDY AND TAX</u>**

23 a) do you think by offering incentives to the ICS consumers, does it play a role in increasing its up-take?
b) if YES, explain how?
c) If NO, Explain Why

24 a) Does your organization offer any kind of incentives to your customers to increase stove purchase?
b) If yes, what kind of incentive?
d) If No, Explain why?

THANK YOU SO MUCH FOR YOUR COOPERATION.

APPENDIX III

FOCUS GROUP GUIDE

1. What is the status of improved cook stoves technology adoption in the area?
2. What are some of the challenges faced by households in adopting the ICS?
3. What are some of the constraints facing ics actors (NGOs, Government and other sectors in promoting ICS technology within this area?
4. What other key factors do you know that play a key role to stove adoption by the consumer?
5. In what ways can we overcome this challenge to increase the ICS upto the last consumer?

APPENDIX IV

RESPONDENT CONSENT

Title of the Study: "Factors Influencing Adoption of Improved Cooking Stoves: The Case Study Of Rural Households In Busia County, Funyula Sub-County, Kenya".

Institution: Department Of Geography & Environmental Studies, Faculty of Arts, College of Humanities and Social Sciences, University of Nairobi, P.O.BOX 30197-00400, Nairobi.

Investigator: SYLVIA ATIENO NYANDIE ODONGO, P.O.BOX 30197-00400, Nairobi.

Supervisors: PROF. E. H. O. AYIEMBA & Mr. JOHN WAKAJUMMAH, Department of Geography & Environmental Studies, Faculty of Arts, College of Humanities and Social Sciences, University of Nairobi, P.O.BOX 30197-00400, Nairobi.

Ethical Approval: National Council for Science and Technology / University of Nairobi Ethical and Research Committee.

Permission is requested from you to participate in this research study. With principles that You:

Voluntarily agreement to participate in this study is voluntary
May wish to withdraw from the study at any point you deem fit.
May seek clarity to understand the nature and importance of this study

Purpose of the study: To find out factors that influence the adoption of Improved Cooking Stoves among rural households in Funyula constituency, Busia County, Kenya

Procedures to be followed: With your cooperation, you will answer questions related to the objectives of this study. All information obtained will be handled with confidentiality.

Risks: There will be no risks involved in this study to you.

Benefits: There may be no direct benefits to you but the results of this study will be useful in understanding the factors that influence the adoption of Improved Cooking Stoves in Funyula constituency in order to further inform policies and practices that increase the ownership and increased adoption of effective ICS.

Assurance on confidentiality: All information obtained from you will be kept confidential and used for the purpose of this study only.

Contacts: you may wish to contact me with regards to issues concerning this study through any of the various addresses provided above.

I now request you to sign the consent form attached

CONSENT FORM

"Factors Influencing Adoption of Improved Cooking Stoves: The Case Study Of Rural Households In Busia County, Funyula Sub-County, Kenya".

I ________________________________ (respondent) give consent to the investigator to use the information that I will provide him as part of his study and that the nature of the study has been explained to me by the ………………………………...

Signature___________________________________ Date________________________

I (field agent/researcher) confirm that I have explained the nature and effect of the study.

Signature___________________________________ Date________________________