WOODFUEL ACCESSIBILITY IN THE RURAL AND URBAN AREAS OF TRANS-NZOIA AND WEST-POKOT COUNTIES, KENYA

BY:

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for a degree in any other University. No part of this thesis may be reproduced without the prior written permission of the author and/or University of Eldoret.

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Declaration by Supervisors

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

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DEDICATION

This study is dedicated to all mothers and children finding it difficult to obtain firewood and charcoal.

ABSTRACT

This study investigated woodfuel accessibility in the rural and urban areas of Trans-Nzoia and West-Pokot Counties, with the aim of providing scientific data for appropriate decision-making in ensuring sustainable accessibility. Across-sectional research design and multi-stage sampling techniques were applied. Kolongolo and Kacheliba were selected as rural areas of Trans-Nzoia and West-Pokot respectively, Kitale and Makutano were selected as urban areas. Questionnaires were administered to 365 households and 50 Small Scale Enterprises (SME) hotels, and 10 key informants interviewed. Field observations were made and captured using digital camera. Accessibility levels were categorized into very accessible, accessible, inaccessible and very inaccessible. Linear regression, Kruskal-Wallis test, and χ^2-test of association were used in data analysis. Results indicated that among households, firewood and charcoal were accessible in Kacheliba, but inaccessible in Kolongolo, Makutano and Kitale. Among SME hotels, charcoal was inaccessible both in Makutano and Kitale. In general, woodfuel was accessible in Kacheliba, and inaccessible in Kolongolo, Makutano and Kitale. In Kolongolo, 85.6% of households using firewood were practicing freehold land tenure. In Kitale, 79.1% of households using charcoal had adopted improved charcoal cook stove with a ceramic lining. In Kacheliba, 71.4% of households using charcoal were aware of government policies governing charcoal production, transportation and utilization. In Makutano, 71.4% of households using charcoal had a family size of between 4 and 6 members. Kruskal-Wallis test indicated a significant difference in woodfuel accessibility levels between the four study areas ($\chi^2_{(3,95)}$=46.526, N =405, P = <0.001). χ^2-test of association indicated that firewood and charcoal accessibility levels have insignificant association with existing government policies and regulations. This research concluded that in West-Pokot County, woodfuel is accessible in rural areas, but inaccessible in urban areas, while woodfuel is inaccessible in rural and urban areas of Trans-Nzoia County. Firewood and charcoal accessibility are not affected by existing government policies and regulations. It recommends efficient enforcement of existing policies that will reduce distance travelled, time taken, cost and budgetary allocation on firewood and charcoal among households and SME hotels.

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ABBREVIATIONS AND ACRONYMS

AGECC:	Advisory Group on Energy and Climate Change
ASALs:	Arid and Semi Arid Lands
DF:	Development Fund
FAO:	Food and Agricultural Organization
ICs:	Improved Cookstoves
IIRR:	International Institute of Rural Reconstruction
ITDG:	Intermediate Technology Development Group
KCJ:	Kenya Ceramic Jiko
KFS:	Kenya Forest Service
kg:	Kilogram
km:	Kilometre
Kshs:	Kenya Shillings
KVDA:	Kerio Valley Development Authority
LPG:	Liquid Petroleum Gas
M.C:	Moisture Content
NEMA:	National Environment Management Authority
PFE:	Pastoralist Forum Ethiopia
R:	Correlation coefficient
R^2:	Coefficient of determination
RETAP:	Rural Energy Technology Assistance Programme
SME:	Small Scale Enterprises
SPSS:	Statistical Package for the Social Sciences

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DEFINITION OF TERMS

Accessibility: is the ability to access and benefit from a particular entity, system or product.

Charcoal: a black substance consisting of carbon and ash obtained by removing water and volatile constituents from vegetation and animal substance.

Firewood: wood that is used as fuel

Woodfuel: a wood based energy product

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter provides the background information of the research problem based on the existing literature and explains the purpose of the research, hypotheses and justifications.

1.2 Background Information

Globally, every nation is concerned about ensuring energy security to enhance sustainable development (Aquil, Shadab, Shadman & Tiwari, 2014; Singh & Singh, 2014). Amongst various energy sources, biomass especially woodfuel is the main source of primary energy (Anjum, 2012: Aabeyir, Quaye-Ballard, Luise & Oduro, 2011). About 3 billion individuals globally depend on woodfuel as their primary source of energy (AGECC, 2010). Woodfuel contributes 7% and 76% of the energy consumed in the world and developing countries respectively (Aabeyir *et al.*, 2011; Anjum, 2012). Over 81% of primary energy used for cooking and heating in Sub-Saharan Africa is derived from woodfuel (Marjorie, 2011; Minang, van Noordwijk, Freeman, Mbow, de Leeuw & Catacutan, 2015). In Uganda, Rwanda, Tanzania and Ethiopia, about 90% of primary energy is derived from woodfuel (Egeru, Kateregga & Gilber, 2015; FAO, 2001; Saundry, 2009).

In Kenya, woodfuel constitute 70% and about 90 % of primary energy supply at national and rural household (Osiolo, 2009). In West-Pokot and Trans-Nzoia Counties, woodfuel meets over 90% of household energy demands especially for cooking and heating (County Government of West-Pokot, 2013; County Government of Trans-Nzoia, 2013). However, about 30% and 57.2% of woodfuel were supplied

unsustainably by 1980 and by 2000 respectively (O'Keefe, Raskin & Steve, 1984; Kamfor, 2002). Increasing unsustainable supply causes unsustainable accessibility that eventually results to inaccessibility (World Agroforestry Centre, 2014).

1.3 Statement of Problem

Though woodfuel is an important resource in West-Pokot and Trans-Nzoia, its accessibility has been declining as forest cover continues to deplete due to human activities and deforestation (County Government of West-Pokot, 2013). Woodfuel inaccessibility is leading to an increase in time spend in collecting firewood by about 6 hours per day, and increased monthly spending on woodfuel to about 35% of households' monthly income (Arayal, 2002; Ajao, 2011; Egeru *et al*., 2015). Inaccessibility has increased the distance covered for woodfuel collection especially in towns by between 20 and 50 km (Ngetich, Birech, Kyalo, Bett & Freyer, 2009). Escalation of charcoal prices from Kshs 700 to Kshs 1,300 per sack as from 2010 to 2012 has also been experienced in Eldoret (Mumo, 2011). Increased utilization of non-preferred wood species with high extractive contents that cause health problems, reduced quality of cooked food, and environmental degradation are other effects (Ngetich *et al*., 2009).

Marjorie (2011), and Githiomi, Mugendi and Kung'u (2012) blames inadequate attention on enacting and implementing sustainable woodfuel production and utilization policies, at local, national and international levels as the major reason for increasing woodfuel inaccessibility. Inadequate attention has been due to scarcity of scientific data on woodfuel accessibility to aid in decision making, leading to inefficient management of woodfuel sector (Marjorie, 2011).

1.4 Justification

The need to determine woodfuel accessibility in different counties in Kenya is important for stakeholders involved in ensuring energy access for all. As a result, the fundamental opportunity derived from this study was an indication of woodfuel accessibility levels and possible factors affecting woodfuel accessibility in West-Pokot and Trans-Nzoia counties. This helps in adding scientific information on woodfuel accessibility debates to enhance better decision-making to prevent unsustainable supply of woodfuel from reaching 33 million metric tonnes by 2020 as predicted by Kamfor (2002). Better decisions in woodfuel sector helps in improving people's socio-economic status by reducing distance covered, time and amount of money spend on woodfuel collection.

1.5 Research Objective

1.5.1 General objective

This study aimed at investigating woodfuel accessibility in the rural and urban areas of Tran-Nzoia and West-Pokot Counties in Kenya.

1.5.2 Specific objective

1). To determine woodfuel accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties.

2). To determine factors affecting woodfuel accessibility in the rural and urban areas of Trans-Nzoia and West-Pokot Counties.

1.6 Hypothesis

H_O: Woodfuel accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot counties are not significantly different.

H_O: There are no factors affecting woodfuel accessibility in rural and urban areas of Trans-Nzoia and West-Pokot Counties significantly.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature on the measures of woodfuel accessibility and factors that may influence woodfuel accessibility globally, regionally and nationally.

2.2 Measures of Woodfuel Accessibility

2.2.1 Physical measures

Reviewed literature indicated that distance, collection time, and trip pattern were the three major physical measures of woodfuel accessibility.

2.2.1.1 Distance

Distance is the simplest physical measure of woodfuel accessibility as it indicates proximity to the resource (Horst & Hovorka, 2009; Kishor & Mitchell, 2011; Ogwuche & Asobo, 2013). Since women and children collect all usable firewood that is within their reach based on convenience, the resource gets exhausted with time; forcing them to travel longer distances to collect woodfuel (Ogwuche *et al*., 2013). This is because people clear formerly vegetated lands for woodfuel and other activities like agricultural activities, and settlement (Hosier, 1985), leaving few vegetation for woodfuel.

A study in South Africa (Bembridge & Tarlton, 1990) using distance to measure the proximity of firewood indicated that women and children travel over 3 km to access firewood. This was due to high dependency on depleting natural vegetations for firewood (Aquil *et al*., 2014; Anjum, 2012). Arayal (2002) also used distance to determine the trend of woodfuel accessibility in Eritrea since 1961 to 2001, the results

showed a reducing accessibility as the average distance for woodfuel collection increased by 15 km and 10 km in urban and rural areas respectively. In urban areas, the increase was attributed to overdependence on charcoal and firewood from highland regions, while in rural areas was due to the declining natural resource productivity. In addition, the long distances in rural areas were determined by the availability of dry wood, which eases up collection as many people prefer walking long distance to obtain dried wood (Horst *et al*., 2009). World Energy Outlook (2006) and Egeru *et al.* (2015) also reported an increase in distances to firewood collection points in Tanzania and Eastern Uganda.

In Kenya, Kamfor (2002), and Ngetich *et al*. (2009) reported longer distances travelled to collect firewood and charcoal in Nairobi and Njoro respectively. This was due to inadequate tree cover/vegetation in the neighbourhood to supply adequate woodfuel products especially in urban areas. On this basis, Karekezi, Kimani and Onguru (2008) reported that charcoal consumed in urban areas are mostly produced in rural areas, implying that they are transported over a long distances.

On the contrary, Mutua, Ngui and Mwakubo (2010) reported that Kenyans cover an average distance of 0.59 km and 6.44 km looking for charcoal and firewood respectively in urban areas. However, such distances especially on charcoal were based on purchasers, other than the distance travelled by the supplier to obtain the product. Githiomi *et al*. (2012) found that the percentage of households in rural areas obtaining woodfuel from farm trees like woodlots, scattered trees on farms and trees on communal land was increasing, indicating a shift from natural vegetation and gazetted forests, hence reducing the average distance travelled for woodfuel collection. This was supported by Kamfor (2002) that 60% of woodfuels were being obtained from farms. This indicates a change in the role of on-farm biomass as

O'keefe (1989) found that though on-farm biomass is abundant in rural areas located in high potential areas, they still experience woodfuel shortages due to gender roles as women were not allowed to cut trees for firewood, but only use trimmings and wastes from other activities.

2.2.1.2 Time

Though the use of time as a measure of accessibility to woodfuel was disputed by Van't Veld, Narain, Gupta, Chopra and Singh (2006) that individuals change their collection strategy as they collect from private lands, while others start purchasing from vendors, Dewees (1989), O'keefe (1989), and Abebe, Koch and Mekonnen (2012) concurred that time spend in collecting woodfuel can measure its accessibility. This is because in the event of woodfuel scarcity, there is an increase in time of collection. Hosier (1985) and Dewees (1989) used additional time in firewood collection as a measure of difficulty in obtaining the resource. They concurred that, individuals having high levels of accessibility spend less time collecting large quantities of woodfuel, hence having low opportunity costs.

The study by Arayal (2002) indicated that the average time of collecting firewood increased from 1.2 hours to 6.6 hours between 1961 and 2001 in Eritrea. This increase was as a result of over reliance on natural vegetation for fuelwood, which were being replaced by woody biomass that is shaped by economic factors, apart from being cleared for agricultural purposes and settlement due to increased population. Malmberg (1994) also used time as a measure of access to firewood in Zambia; the results indicated that women spend about 3 hours 4 minutes collecting a head load of firewood weighing about 20 kg per day. This is because they travel a substantial distance to find firewood vegetation. This value was not far from Tanzanian case where firewood collectors spent 5 hours to collect 25 kg head load of

firewood (Fleuret & Fleuret, 1978). Contrary, individuals in urban areas spend less than 30 minutes to find their woodfuel, especially charcoal as they purchase them from the market (Horst *et al*., 2009). People buy woodfuel because it is not economical to travel longer distances and spend much time on collection. In Uganda, Egeru *et al.* (2015) reported an increase in firewood collection time as a result of firewood scarcity.

In Kenya and Uganda, Mutimba and Barasa (2005), and Egeru *et al.* (2015) found that people in arid and semi-arid lands (ASALs) spend more time collecting firewood not because of its unavailability, but because of preference to particular tree species. This implied that even if other species can be collected with ease, people continue spending more time searching for preferred species.

The reviewed literature indicates that woodfuel collectors in some areas spend more time collecting firewood as compared to others areas. However, none of the study has compared the time spent per kilogram of firewood collected in different areas. As a result, it is not clear on whether the additional time spent is as a result of additional kilogram of firewood collected.

2.2.1.3 Trip pattern

Malmberg (1994) used trip pattern to measure woodfuel accessibility in Zambia and Ghana. The results indicated that households with an average of 5 members in Zambia make 5 trips per week, while a household of 9 members in Ghana make 4 trips per week. The difference was attributed to variations in collection trips depending on favourable collection times. As an effect, Zambian data might have been overestimated by about 15% because the study was carried out during dry season, which favours firewood collection, with which some is stored for future use (Malmberg, 1994). However, during rainy season, household members concentrate on

agricultural activities, implying less firewood collection trips. In South Africa, Bembridge *et al*. (1990) found that distance to woodfuel collection source determines trip patterns per week. This was because only small quantities can be carried over long distances. However, having close proximity to woodfuel source implies that people will not mind collecting smaller quantities more often (Bembridge *et al*., 1990). Egeru *et al*. (2015) support that, the frequency of firewood collection decreases as the distance increases.

In Kakamega, long distances to collection sites reduced the frequency of collection from the same site as the focus shifts to the nearby sites (Sikei, Mburu & Lagat, 2009). Moreover, increased distance changes the transportation mechanism. When collection site becomes too far, people start transporting woodfuel using bicycles and animals carts, implying that they carry enough to sustain them for a long time. The higher the collection trips, the higher the rates of exploitation of the resource in the nearby hence increasing inaccessibility in future (Mugo & Gathui, 2010). Sikei *et al*. (2009) argues that families that face difficulties in finding enough woodfuel have higher collection frequencies.

In Kenya, 16% of the population buy charcoal on a daily basis, and 53% on a weekly basis (Mutimba *et al*., 2005). However, the frequency of collecting firewood varies depending on the season of the year. Sikei *et al.* (2009) found that woodfuel collection frequencies vary from 58%, 32% and 10% on a daily, weekly and monthly basis respectively. The frequencies are high during dry season as compared to rainy season where more labour is concentrated on agricultural activities while woodfuel collection receives less attention (Mutimba *et al*., 2005).

However, based on various controversies on various factors including season, means of transporting the product, and family size affecting trip patterns, this measure

was not used in this study. This is because it was perceived as not being a good measure of accessibility.

2.2.2 Economic measures

According to Kamfor (2002), households collect woodfuel by themselves, others purchase on a regular basis, while the rest supplement purchasing and free collection. As a result, Economic indicators like budgetary allocation on woodfuel, and total monthly woodfuel expenses incurred by the family are important for household fuel use decisions during scarcity (Abebe *et al*., 2012).

2.2.2.1 Budgetary allocation

Based on budgetary allocations, energy budgets differ from one location to the other and from one urban area to the other (Mutua *et al*., 2010). Heltberg (2003) found that budgetary allocation on firewood was lower in rural areas than urban areas because of the opportunity to supplement purchase with home-grown and self-collection. However, in cases budgetary allocations are calculated regardless of home-grown or self-collection, higher proportion in rural areas is attributed to minimum cash-earning opportunities (Horst *et al*., 2009). In Nigeria, (Ajao, 2011) found that some households were spending more than 12% and 5% of their annual income on charcoal and firewood respectively as a result of high charcoal prices.

In Njoro Kenya, woodfuel budgets accounts for a substantial percentage of household incomes and business costs (Ngetich *et al*., 2009). Though households have opportunities for increasing their on-farm woodfuel production through tree planting, this opportunity reduces land availability for food production leading to fuel and food crisis. On the same line, Karekezi *et al*. (2008) attributed higher budgetary allocations amongst poor urban dwellers to low income levels as compared to their richer counter-parts. In case of inefficient technologies like open fire cooking stove with less

than 10% efficiency, households can spend up to 35% of their monthly income on cooking fuel (Karekezi *et al*., 2008).

A typical boarding school spends between KShs 70,000 and KShs 105,000 per year on firewood, while others spend about 20-30% of their kitchen budgets on firewood (RETAP, 2009). Averagely, cottage industries including small kiosks and brick making industry among others incur between 20-30% of total operation costs on energy (Kamfor, 2002).

Literature indicated that studies on budgetary allocations have not compared budgetary allocation of firewood and charcoal in high potential areas and ASALs. In addition, the available information on cottage industry is very little in Kenya as only one article under my reach dealt with budgetary allocations in cottage industries.

2.2.2.2 Cost of woodfuel

Cost of woodfuel bought or collected is another measure of woodfuel accessibility. Higher costs indicate unavailability, while lower costs indicate availability. By 2010, an average price of one cord of woodfuel (3 m^3) was $145 (Brown, 2010). In Kenya, one sack of charcoal weighing 35 kg on average was costing KShs 336 in 2005 (Mutimba *et al*., 2005), and by 2011, a sack of charcoal was selling at KShs 1,800, KShs 1,300 and KShs 1,800 in Githunguri, Eldoret and Kisumu respectively (Mumo, 2011). In 2008, a sack of charcoal having an average weight of 36 kg was selling at USD 5 in urban areas, (Karekezi *et al*., 2008), and the costs were high as charcoal vendors were to travel long distances before getting the product. However, the cost of both charcoal and firewood vary among town and locations depending on the proximity to the source (Mwampamba, 2007).

The costs determined in literature are based on the market value, but not the amount of money spent by families per month on charcoal and/or firewood. This

implies that the total amount of money spend by households per month on firewood or charcoal is unknown, leaving a gap in knowledge on amount of money families spend on woodfuel per month in different areas.

2.3 Factors Affecting Woodfuel Accessibility

2.3.1 Household size

Household size is an important variable in determining type and quantity of food to be cooked (Ogwuche *et al*., 2013). In Northwest Pakistan, households with larger family sizes were experiencing higher collection trips per month, meaning that they were more susceptible to woodfuel shortages and daily price fluctuations as compared to their counterparts having small family sizes (Inayatullah, 2011). In addition, larger households in urban areas reduce charcoal and firewood accessibility as it increases family woodfuel budgetary allocation and monthly expenditure as larger quantities of woodfuel will be required for cooking and heating (Ogwuche *et al*., 2013; Inayatullah, 2011). However, Bembridge *et al*. (1990) contradicted that family size especially with more female members increase labour availability, implying a reduction in time for collecting and carrying firewood.

Mugo *et al*. (2010) emphasized that household size affects woodfuel accessibility indirectly. This is because the larger the household size, the higher the energy demand. This high demand calls for higher woodfuel collection or purchase frequencies, resulting to more waste of time and energy on firewood collection. In addition, Nyembe (2011) supports this argument that most households using firewood are poor, and they spend larger percentage of their income on woodfuel in case they buy.

Articles reviewed in this section have investigated the effects of family size on time taken to collect firewood, total cost of woodfuel product incurred by households and budgetary allocations. However, none of them has investigated the effects of family size on the distance travelled to access the product.

2.3.2 Land tenure systems

Land tenure is a contract that establishes people that can use a resource on a piece of land for a specified period of time under the stipulated conditions. This implies that land tenure determine peoples' security to manage trees and forests for woodfuel production and utilization (Waiganjo & Ngugi, 2001). In the absence of clear land and tree rights, the community lack the incentive of managing trees sustainably, but encourages exploitation of woodlands for short-term benefits (Marjorie, 2011).

In Ghana, though integration of trees into agricultural systems has been a roadmap for sustainable woodfuel supply, trees on communal lands are managed by chiefs that restrict the size of trees to be harvested and limit accessibility of woodlots in communal lands (Aabeyir *et al.*, 2011).

In Kenya, there are four major land tenure systems, namely; public, leasehold, freehold, and customary land tenures. Customary tenure systems is where those affiliated to the group have absolute right to the resource, but outsiders are restricted from accessing the resource by the political authorities (Waiganjo *et al.*, 2001). Under freehold tenure, the owner has absolute ownership for an indefinite period of time, as compared to leasehold system, where the land ownership rights are granted by freeholders for a specified period of time. Lastly, public land tenure involves all lands owned by the government for its own purposes.

The type of land tenure system practiced by a household determines the type and level of financial investments that a household can make (Mtimba *et al*., 2005). As a result, land tenure systems that guarantee long-term land rights motivates huge and long-term financial investment as compared to those that only guarantee short-term land rights. Mandila (2014) found that households with land title deeds are more likely to adopt agroforestry systems as compared to their counterparts without title deeds. This is because though agroforestry systems and practices require large sums of financial investments; their benefits are realized after a long time. As a result, those with land title deeds are sure of future land ownership and tree rights that motivates them to adopt agroforestry systems and practices. In relation to woodfuel accessibility, adopting agroforestry systems and practices, households with land title deeds are more accessible to woodfuel as compared to those with leasehold, public and customary land tenures. This is because the management of such trees is entrusted in the hands of households with 100% accessibility (Waiganjo *et al*., 2001). However, the species, quantity and sizes of trees to be harvested in private lands are controlled by household heads. These restrictions make accessibility much difficult for the immigrants and landless households. On the other hand, vegetation under public lands like gazetted forests in Kenya are entrusted in the hands of Kenya Forest Service (KFS), which has been limiting accessibility with the aim of ensuring sustainable supply. On the other hand, Minang *et al*. (2015) argues that land tenure system has no significant effect on woodfuel accessibility because accessibility to private plots is not completely exclusive to land owners as neighbours can collect firewood and graze.

The information in articles reviewed has only majored on explaining the management and controls of woodfuel trees in farmlands and government forests.

However, little is known about how a particular land tenure system will affect distance travelled and time taken to collect woodfuel, and households and cottage industry's costs incurred and budgetary allocation on woodfuel. This implies that further research is required to link land tenure systems with the four measures of woodfuel accessibility.

2.3.3 Technology advancement

Households using biomass energy conversion and utilization technologies with low efficiency between 5% and 10% require more energy per unit output, leading to overexploitation of available vegetation (Faaij, 2006). Efficient cookstoves with more than 15% efficiency on the other hand reduce woodfuel demand per household by around 50%; hence reducing the burden on trees and monthly budgetary allocations (Inayatullah, 2011). Vahlne and Ahlgren (2014) supports that the purpose of disseminating ICs is to help households cut on their total energy demand energy to save forests and spend less on cooking energy. This is in line with Rosa, Majorin, Boisson, Barstow, Johnson, Kirby *et al*. (2014), and Jeuland and Pattanayak (2012) that urban households adopt ICs to reduce their spending on cooking energy, while rural households adopt ICs to reduce the number of trips, and number of hours spent on firewood collection.

On the other hand, Nepal, Nepal, and Grimsrud (2010) and Jeuland *et al*. (2012) found that most of ICs on the market do not meet household cooking requirements, while some have poor quality to an extent that their effect on woodfuel demand is insignificant. In addition, frequent maintenance and operation of some ICs increases household's monthly budgetary allocation on cooking energy. Raman, Murali, Sakthivadivel and Vigneswaran (2013) adds that cookstoves without adequate

regulation of primary and secondary air supply leads to poor combustion that results to low efficiency due to poor combustion.

In Kenya, schools that use 3 Lories of wood every term will only need one lorry in case they use ICs other than using open fire stoves (Walubengo, 2002). This increases woodfuel accessibility as it reduces overexploitation of resources leading to sustainable harvesting. It also reduces the collection trips made by institutions and budgetary allocation, hence increasing their woodfuel accessibility (Inayatullah, 2011). However, traditional inefficient stoves are preferred because they require little investment capital, flexible in terms of size and shape, and easy to use (Bailis, 2009).

From the reviewed literature, it is clear that articles contradict on the effects of ICs on energy demand, costs and monthly budgetary allocation on woodfuel. As a result, further research is required to conclusively state the effects of ICs on woodfuel accessibility.

2.3.4 Land cover changes

Land cover changes resulting from increased population density, and subsequent economic activities affect woodfuel accessibility in many ways. Economic activities like shifting cultivation, charcoal business, and opening up land for road construction influence changes in land cover. During charcoal production, favoured tree species are cleared first, leading to the use of less favoured species, or increased distance before finding preferred species (Nduwamungu, Munishi, loesch, Hagedorn & Lulu, 2009). In Uganda, rapid expansion of cane farming led to difficulties in woodfuel accessibility (ITDG, 1999). This is because, after clearing vegetation for farming, local people were forced to travel further to collect woodfuel, apart from increasing the cost of woodfuel.

The Construction of Morogoro-Dar-es Salaam Highway in Tanzania increased commercialization of charcoal and timber extraction activities, leading to deforestation along the highway (Nduwamungu *et al*., 2009). In the short-run, infrastructure construction improved charcoal and firewood accessibility, but leads its extinction in the long-run.

Clearing trees for charcoal and firewood is made on different arrangements depending on the region in Kenya (Mugo *et al*., 2010). The cleared trees during land opening up for crop production are used for charcoal production or fuelwood. For instance, land was cleared in Narok for wheat farming, leading to availability of charcoal and firewood. The reason was, at the time of clearing, woodfuel was a by-product and was being obtained at low prices or for free. In Kitui, land was cleared for ranching and squatters were allowed to use such vegetation for charcoal and fuelwood. The presence of agricultural residues after harvesting also increases the accessibility to biomass energy resources as they provide alternative energy product (Mugo *et al*., 2010).

Literature review indicated that only one article under my reach has indicated the effects of land cover changes on firewood and charcoal accessibility in Kenya. As a result, further research is required to either approve or disapprove the article's content.

2.3.5 Pastoralism

Pastoral communities in Somali never cut trees because they serve as livestock browsers and edible fruits (PFE, IIRR & DF, 2010). In case tree cutting is inevitable, only branches are cut, leaving the tree to recover. This ensures sustainable supply of woodfuel products throughout the year. However, pastoralists' herds in other areas destroy the environment due to overgrazing, preventing the development of savannas

into scrubland for woodfuel (Nduwamungu *et al.,* 2009). Moreover, pastoral communities like the Turkana in Kenya use fire in making their ecosystem much suitable for their animals' food. This is mostly used in preventing the growth of woody plants (Moran, 2006).

Review of literature indicates that there is no conclusive evidence in the available literature about the effects of pastoralism on woodfuel accessibility. As a result, further research is needed to ascertain how pastoralism affects the accessibility to woodfuel.

2.3.6 Policies and regulatory framework

Most policies managing woodfuel acquisition and utilization in Sub-Saharan Africa are based on command and control, focusing on restrictions and enforcement; creating an environment that does not allow sustainable and responsible sector (Marjorie, 2011). This is because taxation on tree fell for woodfuel in most countries discourages extraction of firewood and production of charcoal from nearby trees (Marjorie, 2011). In Malawi, woodfuel policies through taxations discouraged its use because taxation made the product more expensive than alternative energy products (Zulu & Richardson, 2009).

In Kenya, there are various sectorial policies dealing with the development of woodfuel (Minang *et al*., 2015). Forest Act 2005 has been instrumental in seeking the improvement of tree and forest resource management by the community (Mbuthi, 2009). In addition, the energy Act 2006 develops woodfuel as an indigenous energy source with the aim of diversifying energy mix and self-sufficiency in the energy supply. The current Forest (Charcoal) Rules 2009 supports charcoal production on a sustainable basis, apart from improving systems of charcoal markets by increasing

efficiency and productivity, leading to improved livelihood and environmental conservation (Gathui *et al.*, 2012).

However, the chiefs Act Cap 128 of 1970 revised in 1988 affected woodfuel accessibility as fuelwood in private lands were being controlled by the chief. Production and transportation of charcoal was also controlled by the Chief. Forest Act 2005 and Agriculture Act 2010 encourage Private farmers to take part in tree planting. Though such policies exist, charcoal and firewood are still unaffordable as a result of corruption in the sector (Mutimba *et al.*, 2005). However, Minang *et al.* (2015) stated that the regulations in the charcoal sector are rarely enforced effectively, paving room for corruption. This is because their implementation is always in short-term as a result of high implementation costs, and lack of political will.

The articles in this section have mainly looked at the means through which government policies enhance sustainable forest and forest resource management in Kenya. However, they have not explained whether such policies make firewood and charcoal more accessible or inaccessible.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section explains study site, research design, sampling, data collection and analysis techniques.

3.2 Site Description

3.2.1 Description of West-Pokot and Trans-Nzoia Counties

3.2.1.1 West-Pokot

West-Pokot County (Figure 3.1) lies between latitude 10° $10^{'}$N and 30° $40^{'}$N and longitudes 34° $50^{'}$E and 35° $50^{'}$E. The County occupies an area of 9,169.4 km^2, receives an annual rainfall of about 400 mm and 1,200 mm in the lowland and highland areas respectively. Annual temperatures vary from 10°C to 30°C (Huho, 2012). Temperature and rainfall vary as a result of altitude variation ranging from 400 m to 1500 m above the sea level. The low altitude areas include Alale, Kacheliba, Kongelai, Masol and parts of Sigor. These areas are prone to soil erosion due to flash floods (County Government of West-Pokot, 2013).

The state of road network in the region is poor, with 151 km Bitumen surfaces, 349 km gravelled surface and 697 km earth surface. Tourism sector is not well developed despite the presence of various tourist attractions including Nasolot Game reserve, Kapenguria Museum, beautiful and good sceneries, and rich culture that remain untapped (County Government of West-Pokot, 2013).

West-pokot County has a population of 512,690, with a population density of 56 persons per km^2 and poverty level of 69.7%, with age dependency ratio of 100:122. Major resources in the region include wildlife, minerals, solar and wind

energy, and livestock. Nomadic Pastoralism, Commercial business and mining are the main economic activities; while agricultural products include livestock products and maize (County Government of West-Pokot, 2013).

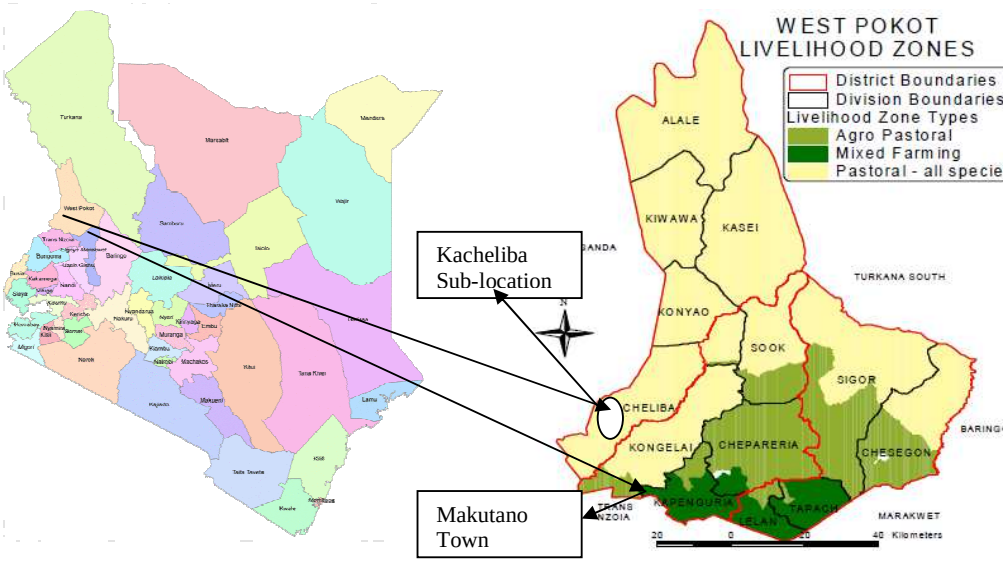

Figure 3.1: West-Pokot County Map

(Source: County Government of West-Pokot, 2013)

The state of education in the county is poor with only 318 primary and 34 secondary schools. Teacher to student ratio in public schools is at 1:27. In the health sector, Kapenguria District Hospital is the most notable health facility, while Doctor to population ratio is about 1:84,528 (County Government of West-Pokot, 2013).

The study was specifically carried out in Kacheliba sub-location and Makutano town. Kacheliba sub-location is located in arid regions of Pokot North District, Kacheliba division, Kacheliba constituency and Suam location. The sub-Location has a human population of 6,196 and population density of 11.38/km^2 (Kenya Bureau of statistics, 2010). Pastoralism is the main economic activity as the soils are infertile,

receives an average annual rainfall of about 100 mm, high temperatures of about 30°C, and altitudes of less than 400 mm above the sea level.

Makutano town is located in semi-arid regions of West-Pokot County, Pokot East district, Kapenguria division and Kapenguria constituency along the Kenyan Great North Road. The town is the main business centre in West-Pokot and has a human population of about 5,480 and density of 100.3/km^2. The town receives an annual rainfall of about 1,100 mm, and temperatures of between 15°C and 30°C. Trading is the main economic activity in the town (County Government of West-Pokot, 2013).

3.2.1.2 Trans-Nzoia County

Trans-Nzoia County (Figure 3.2) lies between latitudes 0° 38'N and 1° 18'N, and longitudes 34°38'E and 35° 23'E. It covers an area of 2,495.5 km^2, with temperatures ranging from 10^0C to 30^0C, and annual average rainfall of 1,296.1 mm (NEMA, 2009). It has 59.2 km, 135 km, and 306.5 km Bitumen, Gravel and Earth surface roads respectively. The county has a population of 818,757 people and a population density of 328 persons per km^2, with poverty level of 50.2%, and dependency ratio of 100:99 (Commission on Revenue Allocation, 2012).

Tourist attraction centres include Kitale Museum, Mount Elgon and Saiwa National Parks. Main economic activities in the region include large scale maize, beans and wheat farming. There are 471, and 120 primary and secondary schools respectively, with 1:52 teacher student ratio in public schools. The most notable health facilities in the region include Kitale County Hospital, Mount Elgon Hospital, and Cherangany Nursing Home. In public hospitals, doctor population ratio is 1:26,000, with Malaria and amoebic dysentery being the most prevalent diseases in the region (County Government of Trans-Nzoia, 2013).

The county has well drained, dark red loam to sandy loamy soils. However, there are some areas in the northern parts with low fertile soils. The fertile soils have encouraged agricultural practices in the region (NEMA, 2009).

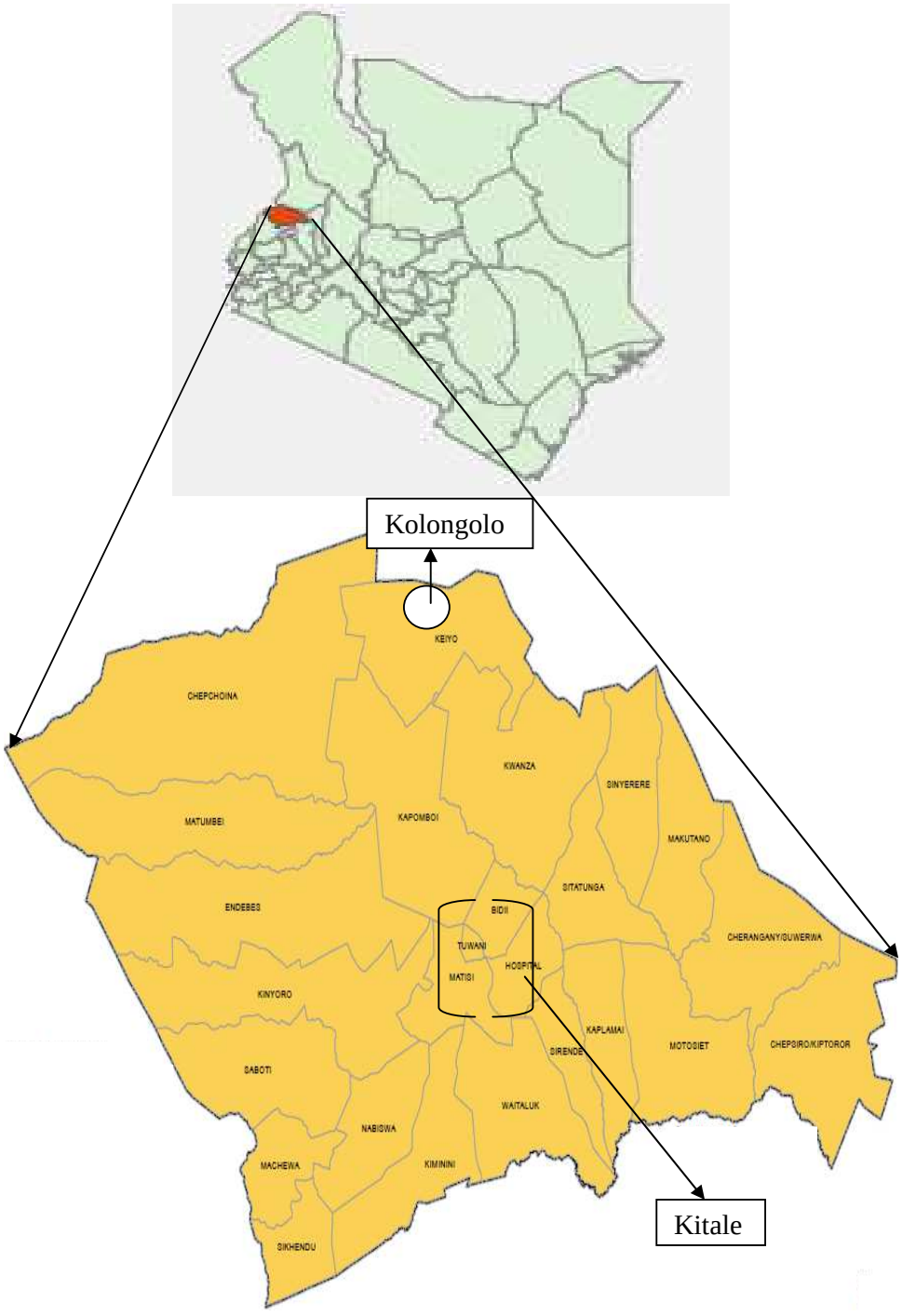

Figure 3.2: Trans-Nzoia County map

(Source: County Government of Trans-Nzoia, 2013)

Kolongolo sub-location and Kitale town were the specific research sites in Trans-Nzoia County. Kolongolo sub-Location is located in Kwanza district, Kolongolo location, Kwanza Constituency and Keiyo ward. The sub-location has a total population of 10,393, and population density of 98.3/km^2. Agricultural activities especially maize farming is the main economic activity (County Government of Trans-Nzoia, 2013).

Kitale town is made up of Matisi, Tuwani, Bidii and part of Hospital wards. The town is located at the boundary of three districts, namely Kwanza, Cherangany, and Saboti. The town is the largest urban centre in Trans-Nzoia and forms the County's headquarter. The total population is about 13,015, and population density of 200.1/km^2. Trading/business is the main economic activity (County Government of Trans-Nzoia, 2013).

Kitale town and Kolongolo sub-location receives an annual rainfall of about 1,200 mm, and temperatures of between 10°C and 30°C, and have well drained loamy soil that support agricultural activities (County Government of Trans-Nzoia, 2013).

3.3 Research Design

The study employed a cross-sectional research design that entailed collecting data from a representative subset at one specific point in time, without manipulating the study environment. The design best suits this study because it involved comparing different population groups at a single point in time.

The research also employed qualitative and quantitative research approaches. Quantitative research involved collection of numerical data on weight of firewood and charcoal using a spring balance machine, distance travelled, time taken to collect

firewood, budgetary allocation, and cost incurred on woodfuel purchase. Qualitative research approach on the other hand involved collection of data inform of texts like factors affecting accessibility levels.

3.4. Sampling and Sample Size

The study employed multistage sampling technique. Stratified random sampling technique was used to categorize the research population into urban and rural areas to ensure representation of both rural and urban population. Convenience sampling technique was used to select Kolongolo and Kacheliba sub-locations to represent Trans-Nzoia and West-Pokot rural areas respectively. In Urban areas Kitale and Makutano were selected based on purposeful sampling technique, based on the fact that the two provided needed information that represented urban areas. Kitale is the largest town, and headquarter of Trans-Nzoia County, while in West-Pokot Makutano is the largest town and has overtaken Kapanguria in terms of population and business activities (County Government of West-Pokot, 2013).

The sample size in the two sub-locations and towns was determined based on Israel (2012) sampling table (Appendix I). Sample sizes were selected at ±10% precision and 95% Confidence Level. Out of 2003 households in Kolongolo sub-location, and 935 in Kacheliba (Kenya Bureau of Statistics 2010), 95 and 91 households were selected respectively based on systematic sampling, where after selecting a starting point randomly; every other 10^{th} household was included in the sample. Out of 1325 households in Kitale town and 605 households in Makutano town, 91 and 88 households were selected respectively. The selection was based on the systematic random sampling just as in rural household survey. Simple random sampling was used in selecting 25 Small Scale Enterprises (SMEs) hotels in each

county. The SME hotels under consideration were those having a minimum of 10 and a maximum of 20 employees, and located in urban areas.

3.5 Data Collection

3.5.1 Questionnaires

Two sets of questionnaires namely household, and SME hotels questionnaires (Appendices II and III) were developed and administered to households and SME hotels respectively. These were used to gather information concerning the distance travelled to collect firewood, time taken to collect firewood, and monthly expenditure on charcoal and firewood. The questionnaires also gathered information about the factors associated with household's woodfuel accessibility levels.

Two enumerators with K.C.S.E certificate in each site (Kolongolo, Kitale, Kacheliba and Makutano) were selected with the help of the area assistant chief. They were trained on data collection and allocated routes to assist in data collection.

Questionnaires were selected because they were relatively cheap, quick and convenient in dealing with a large geographical area (Natasha, Woodsong, Macqueen, Guest & Namey, 2005). Questionnaires contained both open ended and closed ended questions. The open ended questions allowed participants to express their perceptions, while closed ended questions ensured easier coding and analysis.

3.5.2 Interviews

The researcher carried out face-to-face interviews on 10 key informants from Lake Victoria Basin Development Authority and Kerio Valley Development Authority, NEMA and KFS officials to supplement information obtained through questionnaires. Information collected included comments about distance travelled to collect woodfuel, time taken to collect woodfuel and the amount spent by individuals

in these two regions. Other information was their comments on factors affecting woodfuel accessibility.

Interview information was very essential in clarifying short answers given in questionnaires. The interviews were open-ended and semi-structured (Appendix IV) to allow participants express their concerns apart from giving satisfactory answers.

3.5.3 Field observation

The researcher carried out direct field observations to identify cooking technologies and types of woodfuel used in the study areas. This was carried out in some randomly selected households and small scale enterprises that the questionnaires were administered. Field observation data was collected inform of photographs taken by the digital camera. However, before taking photos, the field observer obtained permission from the household owner.

3.6 Dry Weight of Woodfuel

The dry weight of woodfuel consumed by a household per month was determined by subtracting the Moisture Content (M.C) of woodfuel from the wet weight (equation 1);

$$\mathrm{Dw} = (100\% - M.C\%) * Ww \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

Dw = Dry Weight of woodfuel collected

M.C = Moisture Content

Ww= Wet weight of woodfuel

The M.C of woodfuel was determined based on Laboratory Test in Wood Science Lab II at the University of Eldoret. The M.C was calculated based on wet-weight basis (equation 2).

$$M.C = (\frac{Ww-Dw}{Ww}) *100 \quad \text{..... (2)}$$

Where: initials were as defined in equation 1

3.7 Distance and Time per Kilogram of Firewood

The formula in equation 3 was used to calculate distance/kg of firewood collected by households.

Distance per kg of firewood collected $=(N \times H \times D) \div M$ ..... (3)

Where

N = number of trips per month

H = number of head-loads per trip

D = distance travelled to collect one head-load (km)

M = Dry weight of firewood collected per month (kg)

On the other hand, equation 4 was used to calculate time/kg of firewood collected by households.

Time (hours)/kg of firewood collected $=(N \times H \times T) \div M$ ..... (4)

Where

N = number of trips per month

H = number of head-loads per trip

T= time taken to collect one head-load of firewood

M = Dry weight of firewood collected per month (kg)

3.8 Unit Cost, Monthly Expenditure, and Budgetary Allocation

The average monthly expenditure, unit cost per and budgetary allocation on firewood were calculated based equation 5, 6 and 7.

$ac = N \times Hm \times c$ ..... (5)

Cost/kg $= (ac) \div M$ ..... (6)

Budgetary allocation $= ac \div i$ ..... (7)

Where

ac = average monthly expenditure on firewood

N = number of head-loads per month

Hm = number of head-loads based on the Market weight

c = average cost per market head-load based on the market value

M = Dry weight of firewood collected per month (kg)

i= household's head monthly income

The average monthly/daily expenditure, cost/kg and budgetary allocation on charcoal were calculated based on equation 8, 9 and 10 respectively;

$ac = N \times c$ ..... (8)

Cost/kg $= (ac) \div M$ ..... (9)

Budgetary allocation $= ac \div i$ ..... (10)

ac = average cost of charcoal incurred by the household per month/day

N = number of charcoal sacks consumed per month/day

c = average cost of charcoal per sack based on the market value

i= household's head monthly income/ SME hotel daily kitchen cost

3.9 Accessibility Levels

The accessibility levels of firewood and charcoal based on distance, time, monthly/daily expenditure/ cost/kg and budgetary allocation were determined based on the grading outlined in table 3.1.

Table 3.1: Accessibility Grading

Accessibility level	Grade	Cost of firewood in rural areas (KShs)	Cost of firewood in urban areas (KShs)	cost/kg of firewood (KShs)	Cost of charcoal (KShs)	cost/kg of charcoal (KShs)	km/kg	hrs/kg	Budgetary allocation (%)
Very accessible	1	<450	<500	<5	<1000	<7	<0.1	<0.1	<5
Accessible	2	450-900	500-1000	5-10	1000-2000	7-14	0.1-0.3	0.1-0.3	5-10
Inaccessible	3	900-1350	1000-1500	10-15	2000-3000	14-21	0.3-0.5	0.3-0.5	10-15
Very inaccessible	4	≥1350	≥1500	≥15	≥3000	≥21	≥0.5	≥0.5	≥15

Average accessibility levels were determined as indicated in equation 11

$C_{al} = (C_d + C_t + C_e + C_c + C_b)/n$..... (11)

Where:

Cal = average accessibility level

C_d = accessibility level based on distance (km/kg)

C_t = accessibility level based on time (hours/kg)

C_e = accessibility level based on monthly/daily expenditure on woodfuel

Cc = accessibility level based on cost/kg of woodfuel

C_b = accessibility level based on budgetary allocation

n = number of individual measures of accessibility used in determining average accessibility level.

After getting the average accessibility value, the final accessibility level was graded as indicated in Table 3.2.

Table 3.2: Final Accessibility Level Grading

Accessibility level	Average accessibility value	Accessibility grading
Very accessible	0-1.5	1
Accessible	1.5 - 2.5	2
Inaccessible	2.5-3.5	3
Very inaccessible	≥ 3.5	4

3.10 Data Analysis

3.10.1 Predictors of average woodfuel accessibility level

Multiple linear regression was used to model the relationship between accessibility level (dependant variable), and the distance/kg, Time/kg, monthly/daily expenditure on woodfuel, cost/kg and budgetary allocation on woodfuel (independent variables). This was to determine independent variables that significantly predict the accessibility level. It was hypothesised that:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0 \therefore C_{al} = \beta_0$

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0 \therefore C_{al} = \beta_0 + \beta_2 X_d + \beta_2 X_t + \beta_3 X_e + \beta_4 X_c + \beta_5 X_b$

Where:

C_{alj} is average accessibility level

β_0 = regression constant

$\beta_1, \beta 2, \beta_3, \beta_4, \beta_5,$ = regression coefficients of distance/kg, time/kg, monthly/daily expenditure, cost/kg and budgetary allocation on woodfuel respectively.

X_d, X_t, X_e, X_c, and X_b, are distance/kg, time/kg, monthly/daily expenditure, cost/kg and budgetary allocation on woodfuel respectively.

Multiple linear regressions were used in testing statistical significance of each independent variable. This determined whether the standardized or unstandardized coefficients are equal to zero. Variables with p-value above 0.05 at 95% confidence level were considered insignificant in predicting woodfuel accessibility.

3.10.2 Average woodfuel accessibility levels

It was hypothesized that:

H_0: $U_{Rt} = U_{Rw}=U_{Ut}=U_{uw}$

H_1: $U_{Rt} \neq U_{Rw} \neq U_{Ut} \neq U_{uw}$

Where:

U_{Rt} and U_{Ut}= the mean ranks of woodfuel accessibility levels in rural areas and urban areas of Trans-Nzoia respectively.

U_{Rw} and U_{uw} = the mean ranks of woodfuel accessibility levels in rural areas and urban areas of West-Pokot respectively.

Kruskal-Wallis test was used in determining the significant differences in accessibility levels among the rural and urban areas of Trans-Nzoia and West-Pokot. χ^2 values with P-values above 0.05 at 95% confidence level meant that the differences were insignificant.

In case of significant difference, pair-wise analyses were carried out using Mann-Whitney *U* test to determine the exact locations that experience significant difference in accessibility levels. The grouping variable was the location (Kolongolo, Kacheliba, Kitale and Makutano). The test variables were the accessibility levels.

3.10.3 Factors influencing accessibility levels In West-Pokot and Trans-Nzoia

Chi-square test of association was used to determine whether firewood and charcoal accessibility is associated with family size/number of customer, type of cookstove technology, land tenure system, and government policies. Chi-square test of association determines whether variables are dependant or independent. We fail to reject the null hypothesis in case chi-square significance is significant at a p value greater than 0.05.

CHAPTER FOUR

RESULTS

4.1 Introduction

This section presents quantitative and qualitative data collected through questionnaires, interviews and observations.

4.2 General Information

4.2.1 The demographic information

Table 4.1 indicate demographic information from the study sites.

Table 4.1: Demographic Information from the Study Areas

		Kacheliba	**Kolongolo**	**Makutano**	**Kitale**
Gender	Male	40.66%	40.00%	51.28%	49.45%
	Female	59.34%	60.00%	48.72%	50.55%
Economic activities	Crop Farming	25.27%	52.63%	12.82%	19.78%
	Pastoralism	45.05%	0.00%	0.00%	0.00%
	Trade	13.19%	12.63%	25.64%	21.98%
	Formerly employed	9.90%	22.21%	17.95%	18.68%
	Employed informally	6.59%	12.63%	37.18%	37.36%
	Others	0.00%	0.00%	6.41%	2.20%
Income Levels	<Kshs 5,000	40.66%	29.47%	29.49%	21.98%
	Kshs(5,000-10,000)	35.16%	26.47%	28.21%	29.67%
	Kshs(10,000-15,000)	14.28%	16.84%	19.23%	17.58%
	Kshs(15,000-20,000)	4.40%	15.79%	8.97%	14.29%
	Kshs(20,000-25,000)	2.20%	7.37%	5.13%	5.49%
	>Kshs 25,000	3.30%	4.21%	8.97%	10.99%

4.2.2 Types, cost and characteristics of woodfuel used

Table 4.2 indicates the types of woodfuel and other types, characteristics and average costs of fuels used by different households in the study areas.

Table 4.2: Types, Cost and Characteristics of Woodfuel Used

		Kacheliba	**Kolongolo**	**Makutano**	**Kitale**
Types of woodfuel	Charcoal	1.10%	6.32%	57.69%	68.13%
	Firewood	91.21%	71.58%	5.49%	5.13%
	Both	4.40%	15.79%	8.97%	14.29%
Mode of firewood Collection	Self-collection	91.21%	49.47%	5.13%	5.49%
	Purchase	2.20%	6.32%	75.64%	80.22%
	Both	6.50%	44.21%	19.23%	14.21%
Mode charcoal collection	Purchase	100%	100%	100%	100%
	Self-Collection	0%	0%	0%	0%
Other types of fuels used.	Agricultural residues	3.30%	90.53%	33.33%	61.54%
	Saw Dust	0.00%	23.16%	17.95%	9.89%
	Paraffin	0.00%	13.16%	69.23%	68.13%
	Gas	0.00%	3.16%	7.69%	9.89%
	Cow dung	0.00%	1.05%	0.00%	0.00%
	Solar	0.00%	2.11%	0.00%	0.00%
	None	96.70%	4.21%	12.82%	5.49%
M.C (wet basis)	Firewood	13.57%	18.44%	13.72%	14.65%
	charcoal	5.03%	4.78%	3.94%	3.96%
Average mass (kg)	Firewood based on market size	6 (kg)	8 (kg)	8.5 (kg)	10 (kg)
	Charcoal	50 (kg)	50 (kg)	50 (kg)	50 (kg)
Prices (KShs) based on market sizes	Firewood	30	50	50	70
Prices (KShs) based on market sizes	Charcoal	(350-600)	(650-1100)	(500-1000)	600-1200)
SME hotels' Average kitchen cost (KShs)	<5000			4%	8%
	5000-10000			20%	32%
	10000-15000			48%	44%
	≥15000			28%	16%

4.3 Firewood Accessibility Levels

4.3.1. Distance per kilogram of firewood collected

From Figure 4.1, firewood collectors in Kitale cover the longest distance of 0.39 km per kg of firewood collected. Firewood collectors in Kacheliba on the other hand cover the shortest distance of 0.29 km per kg of firewood collected.

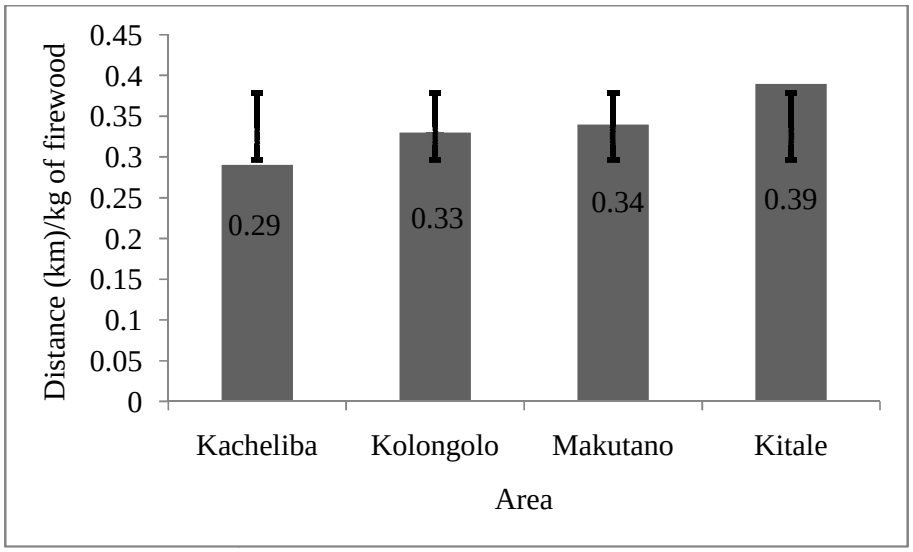

Figure 4.1: Distance/kg of Firewood Collected in Trans-Nzoia and West-Pokot

Interviewees and field observation indicated that intensive farming led to clearance of nearby vegetation for agricultural purposes in Trans-Nzoia. Some households in rural areas had established on-farm trees, where they undertake pruning and pollarding during the planting season and store the trimmings for firewood as indicated in plate 1. However, this was not enough to sustain the family for a year because only trimmings were used as the rest of the tree was left for other economical purposes. Households without on-farm trees claimed that the available land was inadequate to accommodate trees and food crops. As a result, the main sources of

firewood were along wetlands or rivers, while others were traveling to West-Pokot around Karenger and Kanyarkwat to obtain firewood from natural vegetation.

In Kitale, the town is surrounded by large tracks of private and government agricultural lands like Kitale prison farm, leaving no vegetation for firewood collection near the town. This makes people cover longer distances to Kitalale in KARI farm, and Kipsongo to collect firewood as compared to distances travelled in rural areas. Though KFS allowed people to collect firewood from Kitale forest, people prefer getting firewood for free at far distance from the town.

Plate 1: Firewood from Agroforestry Systems in Kolongolo
(Source: Author 2016)

In West-Pokot, Interview and observation results indicated that people in rural areas travel less than 7 km to collect a head load of firewood weighing about 15 kg. However, longer distances were attributed to preference of quality firewood in terms of species (acacia) and size. In this regard, though small twigs as indicated in plate 2 were available, people preferred walking longer distances in search of sizable firewood as indicated in plate 3. From personal observation, firewood collection in Kacheliba was being accompanied by other activities like herding especially during dry season. This was because at this time, young men move with large herds of cattle

in search of pasture, leaving women and children behind with only a few cattle. As a result, while herding, women and children collect firewood to a distance that they will herd.

Makutano town was surrounded by natural vegetation especially along Makutano-Kishaunet road. This reduced the distance travelled to collect firewood. However, just like in rural areas of West-Pokot, there were individuals that prefer walking long distances to Kishaunet or Kong'elai to obtain dried up, and sizable firewood; increasing the distance travelled for firewood collection.

Plate 2: Less Preferred Firewood in Kacheliba

(Source: Author 2016)

Plate 3: Preferred Firewood Quality in Kacheliba

(Source: Author 2016)

4.3.2 Time per kilogram of firewood

Figure 4.2 indicate that while firewood collectors in Makutano recorded the highest number of hours of 0.38 per kg of firewood collected, firewood collectors in Kacheliba recorded the lowest number of hours (0.27 hours) per kg of firewood collected.

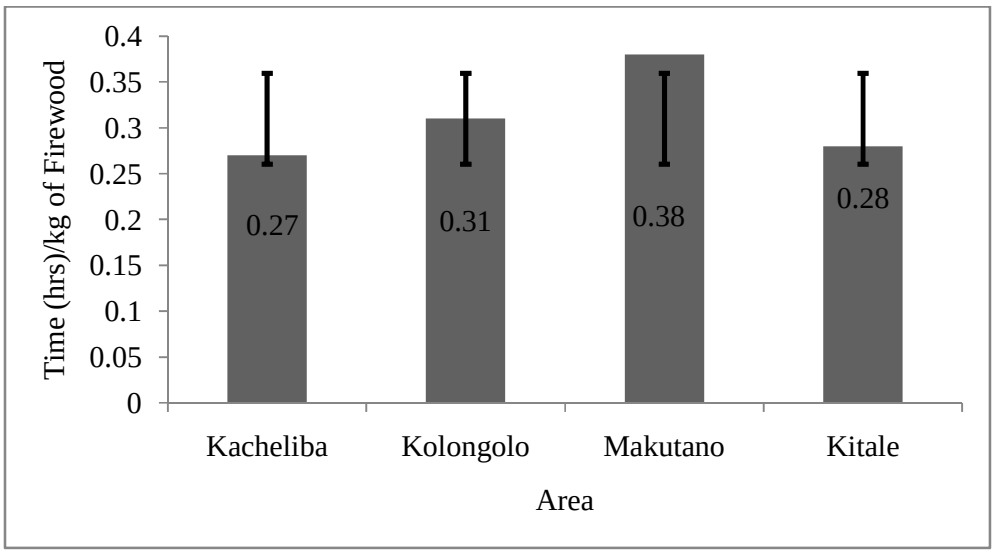

Figure 4.2: Time/kg of Firewood in Trans-Nzoia and West-Pokot

Interviewees and personal observation indicated that firewood collectors in the rural areas of Trans-Nzoia spent about 3 to 8 hours per day fetching firewood regardless of their quality in terms of species, moisture content and size because the resource is scarce. In addition, most of the time was wasted on the road walking or riding to firewood collection site in rural areas. However, due to very long distances, individuals in urban areas (Kitale) were using motorcycles and bicycles which eventually reduce the total time spent on the road.

In West-Pokot, time (hrs/kg) of firewood collected in Kacheliba was low because quality firewood was readily available as compared to Kolongolo, Kitale and Makutano. This was because most households in Kacheliba are pastoralists, and always engage in vegetation preservation for livestock feeds. As a result, though people in rural and urban areas of West-Pokot preferred getting quality firewood; it was readily available in the rural areas than in urban areas. As a result, more time was wasted traveling a considerable distance to and from the collection site in urban areas. However, those travelling shorter distances in urban areas were finding it difficult to obtain a head load of firewood, and spent more time at the collection site fetching quality firewood as compared to Kacheliba.

4.3.3 Household monthly expenditure on firewood

Figure 4.5 indicate that among the four study areas, the average household's monthly expenditure on firewood was comparatively high in Kitale (KShs 1577.5), and Low in Kacheliba (KShs 898.5).

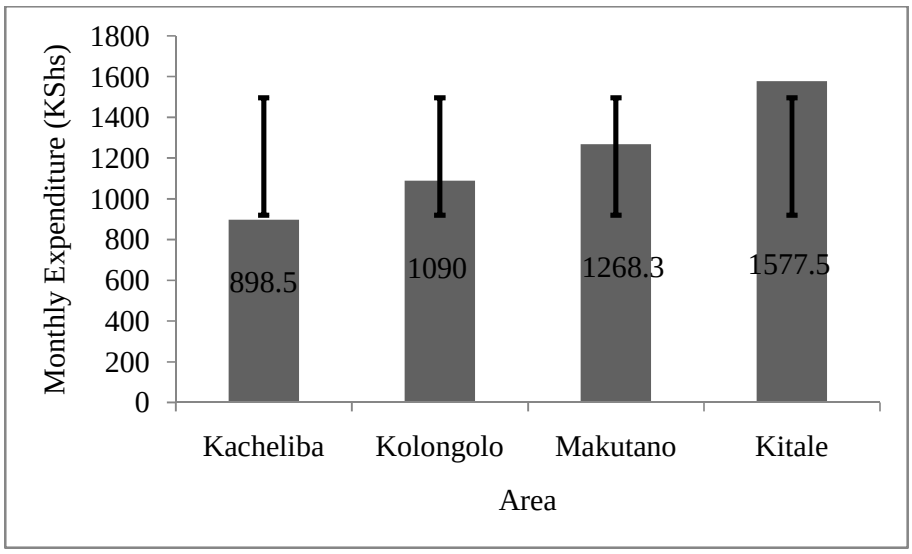

Figure 4.3: Households' Monthly Expenditure on Firewood

Interviewees indicated that total monthly expenditure on firewood in Trans-Nzoia was comparatively lower in rural than in Urban areas. This was because firewood in rural areas was readily available in form of trimmings from on-farm trees as compared to urban areas. In Kitale, higher monthly expenditure was attributed to higher prices of firewood (KShs 70) per bundle of firewood weighing 10 kg on average as compared to Kolongolo (KShs 50) per bundle of firewood weighing 8 kg. In addition, the distance to firewood collection site was shorter in rural areas than urban areas. Observation added that people in rural areas were using improved firewood cookstove (chepkube) in plate 4 than in urban areas. This implied that people in rural areas use less firewood than urban areas, translating to lower expenditure. However, the results contradicted some interviewees' results that, average family sizes in rural areas were larger than urban areas. This implied that the total amount of firewood consumed in rural households was higher than urban areas.

This could have translated to higher monthly expenditure on firewood in rural than urban areas.

Plate 4: Improved Firewood Cookstove

(Source: Author 2016)

In West-Pokot, the trend was attributed to the availability of firewood in rural areas than urban areas. This implied that the distance to firewood collection sites in Kacheliba is shorter than the distance in Makutano town. This resulted to differences in the prices of firewood as it was cheap in rural area (KShs 30 per 6 kg bundle) as compared to urban areas (KShs 50 per 8.5 kg bundle). However, the household's monthly expenditure on firewood in Kacheliba was not very low because many households use open fire cookstove and have larger family sizes that consume more firewood, translating to higher costs.

4.3.4 Cost per kilogram of firewood collected

Figure 4.4 indicate that the cost per kg of firewood collected was relatively low in Kacheliba (KShs 5.79), and high in Kitale (KShs 8.2).

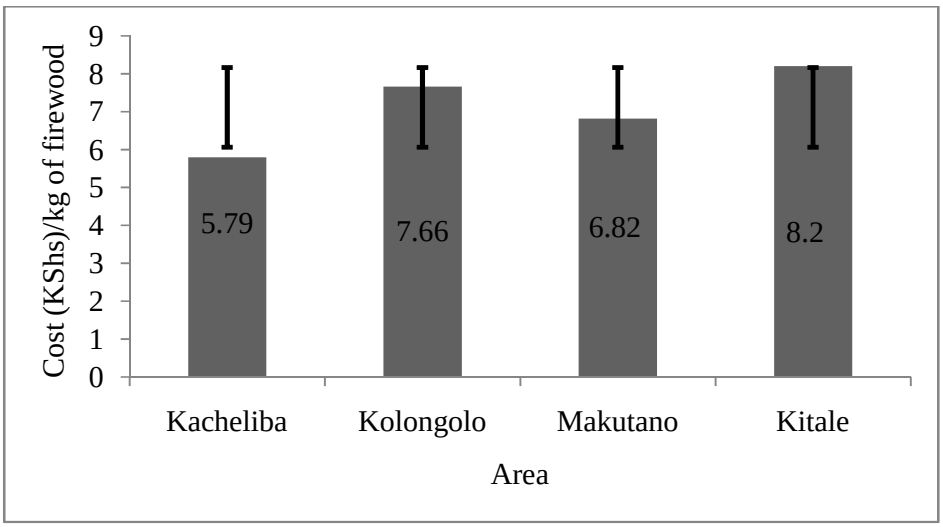

Figure 4.4: Cost/kg of Firewood in Trans-Nzoia and West-Pokot

This trend was attributed to higher cost of firewood in Kitale, and Lower cost of firewood in Kacheliba. This was as a result of longer distances to firewood collection sites in Kitale than Kacheliba. Interviewees added that the cost of firewood was higher in the rural and urban areas of Trans-Nzoia than West-Pokot because firewood was readily available in West-Pokot than Trans-Nzoia.

4.3.5 Household's budgetary allocation on firewood

From Figure 4.5, monthly budgetary allocation on firewood based on household's head monthly income was high in Kacheliba (32%), and low in Makutano (15.9%).

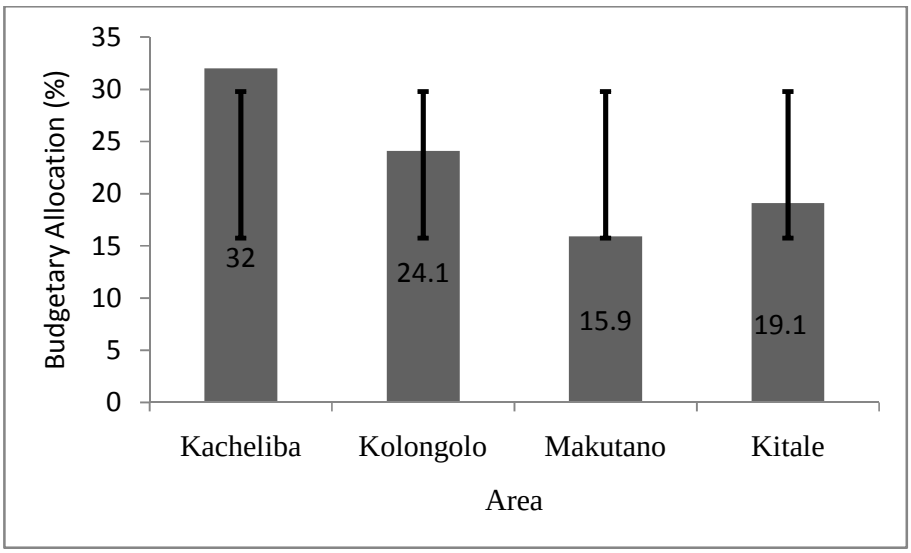

Figure 4.5: Household's Monthly Budgetary Allocation on Firewood

In Trans-Nzoia, interviewees reported that budgetary allocation on firewood in urban areas was higher than rural areas because of low cost of firewood in rural areas. However, the results contradicted some interview results that expected higher budgetary allocation in rural areas than urban areas because of low income levels in rural areas.

In West-Pokot, budgetary allocation was high in rural areas (Kacheliba) than urban areas because of lower levels of income in rural areas as compared to urban areas. As indicated in Table 4.2, 40.7% of respondents in Kacheliba earn <Kshs 5,000 per month, as compared to 29.5% in Makutano.

4.3.6 Firewood accessibility levels in Trans-Nzoia and West-Pokot

Table 4.3 indicate the average firewood accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties based on distance/kg, time/kg, monthly household expenditure, cost/kg and monthly budgetary allocation. The grading was based on the information in Table 3.1 and Table 3.2.

Table 4.3: Firewood Accessibility Grading in Trans-Nzoia and West-Pokot

Study site	Accessibility levels based on the individual variables					Average accessibility value	Accessibility Grade	Accessibility Level
	Distance/kg	Time/kg	Monthly expenditure	Cost /kg	Budget allocation			
Kacheliba	2	2	2	2	4	2.4	2	Accessible
Kolongolo	3	3	3	2	4	3	3	Inaccessible
Makutano	3	3	3	2	4	3	3	Inaccessible
Kitale	3	2	3	2	4	2.8	3	Inaccessible

Table 4.3 indicates that firewood is accessible in Kacheliba (Grade 2), and inaccessible in Kolongolo, Makutano, and Kitale (Grade 3).

Kruskal-Wallis test indicated that the mean ranks of firewood accessibility levels between Kacheliba, Kolongolo, Makutano and Kitale were statistically significant [$\chi^2_{(3,95)}$=36.625, N =249, P = <0.001). Therefore, reject the null hypothesis that firewood accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties are not significantly different.

Table 4.4 indicates Pair-wise analysis results based on Mann-Whitney *U* test.

Table 4.4: Pair-Wise Analysis of Firewood Accessibility Levels

Area	Kolongolo	Makutano	Kitale
Kacheliba	Mann-Whitney $U_{(1,95)}$= 6633.00, N=181, p=<.001	Mann-Whitney $U_{(1,95)}$= 875.000, N=127, p=<.001	Mann-Whitney $U_{(1,95)}$=762.500, N=123, p=<.001
Kolongolo		Mann-Whitney $_{(1,95)}$= 1378.500, N=126, p=.189	Mann-Whitney $U_{(1,95)}$=1205.500, N=122, p=.164
Makutano			Mann-Whitney $U_{(1,95)}$=564.500, N=68, p=.885

From Table 4.4, firewood was more accessible in Kacheliba than Kolongolo, Makutano, and Kitale. This was because the average accessibility levels of firewood for Kacheliba sub-location from Table 4.3 are significantly lower than the average accessibility levels of firewood in Kolongolo, Makutano and Kitale. The lower accessibility grade in Kacheliba was attributed to shorter distances/kg of firewood collected, shorter time (hours)/kg of firewood collected and low monthly expenditure on firewood as compared to other areas.

4.3.7 Predictors of firewood accessibility levels

4.3.7.1 Predictors of firewood accessibility levels in Kacheliba

The model summary information indicated that the regression model fits the available data well. The multiple correlation coefficient (R) = 0.804, showed that the model is good in predicting firewood accessibility level (dependant variable). Coefficient of determination (R^2) = 0.647, indicated that the independent variables explain about 64.7% of dependant variable variability. The regression ANOVA indicated that firewood accessibility level in Kacheliba can be predicted by distance/kg, time/kg, monthly expenditure, cost/kg, and budgetary allocation [$F_{(5,95)}$ = 31.141, P = <0.001]. Table 4.5 indicates that cost/kg is an insignificant predictor of firewood accessibility levels in Kacheliba.

Table 4.5: Coefficients Table for Firewood Predictors in Kacheliba

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.791	13.827		.636	.527
	Distance/kg of firewood	.960	.174	.476	5.511	.<001
	Time/kg of firewood	.566	.184	.262	3.083	.003
	Monthly expenditure	.000	.000	.253	3.850	.<001
	Cost/kg of firewood	-1.197	2.387	-.033	-.501	.617
	Budgetary allocation	.005	.001	.341	5.171	.<001

Therefore, Table 4.6 indicates the constants and coefficients after listwise elimination of cost/kg of firewood from the variable list. The resultant R and R^2 values are .804 and .646 respectively, while $F_{(4,95)}$=39.204, P=<.001.

Table 4.6: Significant Predictors of Firewood Accessibility Levels in Kacheliba

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
2	(Constant)	1.860	.068		27.187	.<001
	Distance/kg of firewood	.976	.171	.484	5.715	.<001
	Time (hrs)/kg of firewood	.561	.183	.259	3.074	.003
	monthly Expenditure	.000	.000	.254	3.876	.<001
	Budgetary allocation	.005	.001	.340	5.176	.<001
a. Dependent Variable: average accessibility level on firewood						

Based on the regression constant and coefficients in Table 4.6, equation 9 can predict household's firewood accessibility level in Kacheliba.

$$\mathbf{C_{alKa} = 1.860 + 0.976X_d + 0.561X_t + 0.000X_e + 0.005X_b \ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)}$$

Where:

C_{alKa} = firewood accessibility level in kacheliba

$X_{d,}$ X_t, X_e, and X_b, = distance/kg, time/kg, monthly expenditure, and budgetary allocation on firewood in Kacheliba respectively.

4.3.7.2 Predictors of firewood accessibility levels in Kolongolo

The regression model statistics indicated R value of 0.856 indicating that the model provides a good level of prediction, and R^2= 0.733 indicated that the independent variables explain about 73.3% of variability in dependant variable.

The regression F-ratio indicate that the predictor variables significantly predict the firewood accessibility levels in Kolongolo [$F_{(5,95)}$ = 57.603, P = <0.001]. However, distance/kg of firewood collected, and cost/kg of firewood are insignificant predictors of firewood accessibility in Kolongolo (Table 4.7).

Table 4.7: Coefficients Table for Firewood Predictors in Kolongolo

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.646	.071		23.097	.<001
	Distance/kg of firewood	.460	.261	.240	1.766	.081
	Time/kg of firewood	.866	.285	.411	3.037	.003
	Monthly cost of Firewood	.000	.000	.362	5.898	.<001
	Budgetary allocation	.004	.001	.257	4.223	.<001
a. Dependent Variable: average accessibility level on firewood						

Therefore, Table 4.8 indicates the constants and coefficients after listwise elimination of distance/Kg and cost/kg of firewood from the variable list. The resultant R and R^2 values are .850 and .723 respectively, while $F_{(3,95)}$=73.921, P=<.001

Table 4.8: Significant Predictors of Firewood Accessibility Levels in Kolongolo

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	1.643	.072		22.784	.<001
	Time/kg of firewood	1.321	.124	.626	10.651	.<001
	Monthly expenditure	.000	.000	.370	5.963	.<001
	Budgetary allocation	.004	.001	.239	3.934	.<001

From Table 4.8, the general form of equation to predict household's firewood accessibility level can be written as indicated in equation 10.

$$\mathbf{C_{alKo} = 1.646 + 1.321X_t + 0.000X_e + 0.004X_b \ldots\ldots\ldots\ldots (10)}$$

Where:

C_{alKo} = firewood accessibility level in kolongolo

X_t, X_e, and X_b, = time/kg, monthly expenditure, and budgetary allocation on firewood in Kolongolo respectively.

4.3.7.3 Predictors of firewood accessibility levels in Makutano

From the regression model summary information, R = .668, and R^2 = .446. R value implied that the developed model of firewood accessibility level in Makutano was of high quality. R^2 value indicated that the independent variables explained about 44.6% of variability in dependant variable.

The regression F-ratio indicate that the distance/kg, time/kg, monthly expenditure, cost/kg and budgetary allocation are best predictors of firewood accessibility levels in Makutano [$F_{(5,95)}$ =22.899, P = <0.001]. However, time/kg and monthly expenditure are insignificant predictors of firewood accessibility in Kolongolo (Table 4.9).

Table 4.9: Coefficients Table for Firewood Predictors in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.684	.147		11.461	.<001
	Distance/kg Kg of firewood	1.244	.355	.400	3.508	.003
	Time/kg of firewood	.468	.284	.196	1.650	.121
	Monthly cost of Firewood	9.914E-5	.000	.150	.942	.362
	Budgetary allocation	.010	.004	.466	2.613	.020
a. Dependent Variable: average accessibility level on firewood						

Table 4.10 indicates the constants and coefficients after listwise elimination of time/kg and monthly expenditure from the variable list. The resultant R and R^2 values are .916 and .839 respectively, while $F_{(2,95)}$=41.837, P=<.001

Table 4.10: Significant Predictors of Firewood Accessibility Levels in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	1.834	.107		17.139	.<001
	Distance/kg of firewood	1.373	.341	.441	4.024	.<001
	Budgetary allocation	.014	.002	.643	5.866	.<001
a. Dependent Variable: average accessibility level on firewood						

From Table 4.10, the general form of equation to predict household's firewood accessibility level in Makutano can be written as indicated in equation 11.

C_{alma} = 1.843 + 1.373X_d + 0.014X_b ……………………...(11)

Where:

C_{alma} = firewood accessibility level in Makutano

$X_{d,}$ and X_b, = distance/kg, and budgetary allocation on firewood in Makutano respectively.

4.3.7.4 Predictors of firewood accessibility levels in Kitale

Regression model statistics indicated R-value of .728, and R^2 -value of .530. R value indicated that firewood accessibility level model in Kitale was of good quality. R^2 value indicated that the independent variables explained about 53.0% of variability in dependant variable.

Regression ANOVA indicate that distance/kg, time/kg, monthly expenditure, cost/kg, and budgetary allocation are good predictors of firewood accessibility level in Kitale [$F_{(4,95)}$=3.671, P = 0.033]. However, distance/kg, cost/kg, monthly expenditure

and budgetary allocation are not significant predictors of firewood accessibility level in Kitale (Table 4.11).

Table 4.11: Coefficients Table for Firewood Predictors in Kitale

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.236	.252		8.866	.000
	Distance/kg of firewood	-1.291	.808	-.608	-1.598	.134
	Time/kg of firewood	2.829	1.177	.913	2.404	.032
	Monthly expenditure	.000	.000	.178	.869	.400
	Budgetary allocation	.004	.002	.428	2.098	.056
a. Dependent Variable: average accessibility level on firewood						

Table 4.12 indicates that eliminating distance/kg, cost/kg, monthly expenditure and budgetary allocation listwise from the list of variables, time/kg of firewood also becomes an insignificant predictor of firewood accessibility in Kitale. The resultant R and R^2 values are .441 and .195 respectively, while $F_{(1,95)}$=3.868, P=.067.

Table 4.12: Time/kg as a Predictor of Firewood Accessibility Levels in Kitale

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	2.487	.207		12.004	.000
	Time/kg of firewood	1.368	.695	.441	1.967	.067
a. Dependent Variable: average accessibility level on firewood						

Time/kg of firewood is an insignificant predictor of firewood accessibility in Kitale because is significantly correlated with distance/kg of firewood (Table 4.13).

Table 4.13: Correlation Analysis in Kitale

		Time/kg	Monthly expenditure	Cost/kg	Budgetary allocation
Distance/kg	Pearson Correlation	.866**	.142	.[a]	.098
	Sig. (2-tailed)	<.001	.574	.	.698
	N	18	18	18	18
Time/kg	Pearson Correlation	1	.127	.[a]	.076
	Sig. (2-tailed)		.615	.	.765
	N	18	18	18	18
Monthly expenditure	Pearson Correlation	.127	1	.[a]	.221
	Sig. (2-tailed)	.615		.	.224
	N	18	33	32	32
Cost/kg	Pearson Correlation	.[a]	.[a]	.[a]	.[a]
	Sig. (2-tailed)	.	.		.
	N	18	32	32	32
**. Correlation is significant at the 0.01 level (2-tailed).					
a. Cannot be computed because at least one of the variables is constant.					

4.4. Charcoal Accessibility Levels in Trans-Nzoia and West-Pokot Counties

4.4.1 Household monthly expenditure on charcoal

Figure 4.6 indicate that charcoal expenditure in the four study areas were in the order of Kitale > Kolongolo > Makutano > Kacheliba.

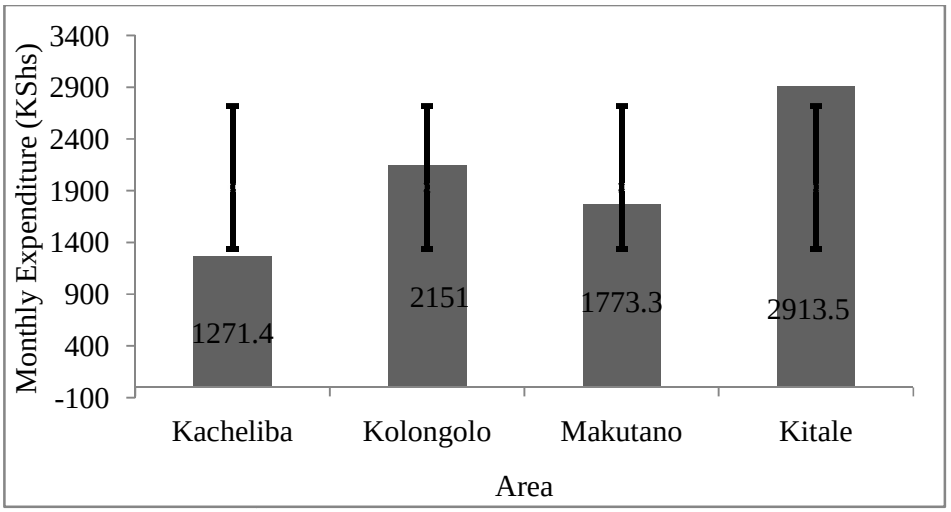

Figure 4.6: Household's Monthly Expenditure on Charcoal

Interviewees stated that charcoal was more expensive in urban areas as compared to rural areas of Trans-Nzoia. This was because charcoal distributed in urban areas is either transported from the rural areas of Trans-Nzoia, or imported from other Counties including West-Pokot, Marakwet and Turkana Counties. However, interviewees added that the prices in different household differed based on the quantity of charcoal purchased by the household. This was because households that purchase charcoal in tins costing between KShs (35 and 60) both in rural and urban areas of Trans-Nzoia incurred higher costs as compared to those buying charcoal in sacks.

Interview results indicated that monthly expenditure on charcoal in rural and urban areas is almost the same. This was because though the cost of charcoal in rural areas was cheap, the consumption of charcoal was high as a result of low efficient charcoal stoves, and large family sizes as compared to urban areas. In addition, most charcoal in rural areas is purchased in terms of tins costing between KShs (25 and 45), which were more expensive as compared to purchasing in sacks as in most urban households.

4.4.2 Cost per kilogram of charcoal

Figure 4.7 indicate that cost (KShs)/kg of charcoal was in the order of Kitale > kolongolo > Makutano > Kacheliba.

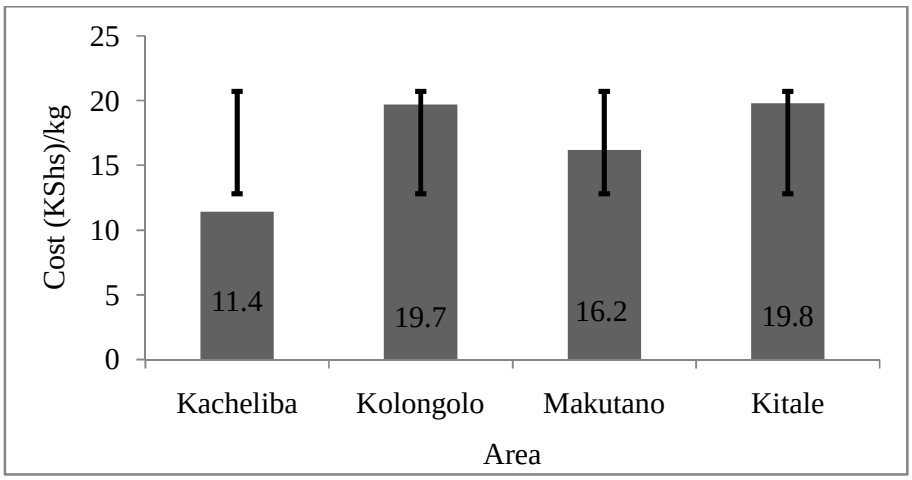

Figure 4.7: Cost per kg of Charcoal among Households

In Trans-Nzoia, Table 4.2 indicates that the price of charcoal was between KShs (650 and 1100) and KShs (600 and 1200) per sack in Kolongolo and Kitale respectively. In West-Pokot, charcoal was between KShs (350 and 600) and KShs (500 and 1000) per sack in Kacheliba and Makutano respectively. Interviewees attributed higher cost of charcoal in the urban areas of Trans-Nzoia to longer distances that charcoal is transported.

4.4.3 Household's budgetary allocation on charcoal

Figure 4.7 indicate that based on household's head monthly income, monthly budgetary allocation on charcoal was in the order of Kacheliba < Kolongolo < Kitale < Makutano.

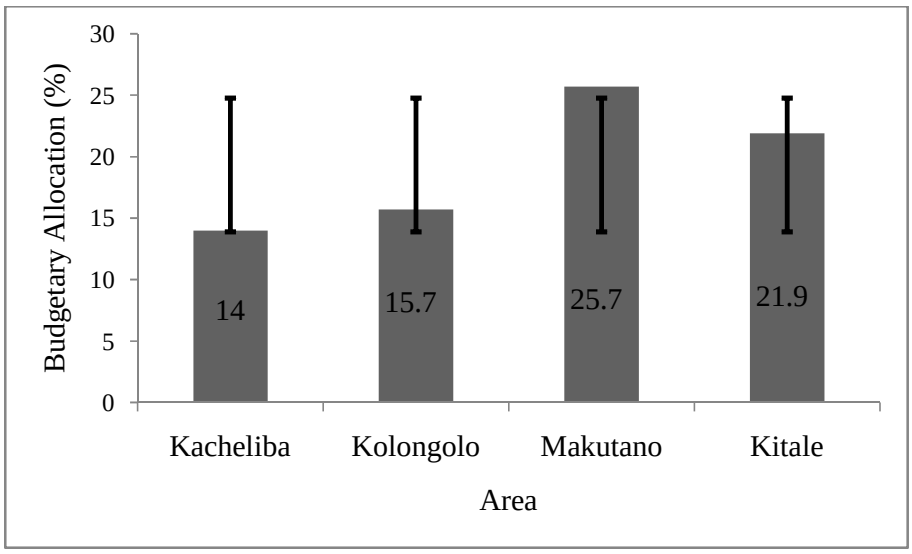

Figure 4.8: Household's Budgetary Allocation on Charcoal

Interviewess stated that budgetarry allocation on charcoal is low in the rural areas of Trans-Nzoia and West-Pokot than urban areas. This is because charcoal was considered as fuel for the rich, implying that only rich individuals with high income levels use charcoal in rural areas. This was evidenced in Table 4.2 that 1.1%, 6.3%, 57.7%, and 68.1% of households in Kacheliba, Kolongolo, Makutano and Kitale respectively use only charcoal. This contradicted interviewee results that though charcoal is cheap in rural areas, budgetary allocation may be the same because of low income levels in rural areas. In addition, ineficient charcoal cookstove technologies in rural areas leads to higher consumption of charcoal, raising monthly expenditure on charcoal and eventually raising budgetary allocation.

However, budgetary allocation on charcoal was high (25.7%) in Makutano as compared to Kitale (21.9%) because of differences in income levels. Table 4.2 indicate that the highest percentage of household heads (29.5%) in Makutano were

earning < KShs 5,000, as compared to 29.7% of household heads that were earning between KShs 5,000 and KShs 10,000 per month in Kitale.

4.4.4 Household's charcoal accessibility levels

Table 4.14 indicate the average charcoal accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties based on monthly household expenditure, cost/kg, and monthly budgetary allocation. The grading was based on the information in Table 3.1 and Table 3.2.

Table 4.14: Charcoal Accessibility Grading in Trans-Nzoia and West-Pokot

Study site	Accessibility levels based on the individual variables			Average accessibility value	Accessibility Grade	Accessibility Level
	Monthly expenditure	Cost/kg	Budgetary allocation			
Kacheliba	2	2	3	2.3	2	Accessible
Kolongolo	2	3	4	3	3	Inaccessible
Makutano	2	3	4	3	3	Inaccessible
Kitale	3	3	4	3.3	3	Inaccessible

Table 4.14 indicates that charcoal was accessible in Kacheliba (Grade 2), and inaccessible in Kolongolo, Makutano, and Kitale (Grade 3).

Kruskal-Wallis test indicated that the mean ranks of charcoal accessibility levels between Kacheliba, Kolongolo, Makutano and Kitale were statistically significant [$\chi^2_{(3,95)}$=13.023, N =190, P = 0.004). We therefore reject the null hypothesis that charcoal accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot are significantly different.

The results of pair-wise analysis to identify the exact locations that exhibit significant differences in accessibility levels based on Mann-Whitney *U* test are as indicated in Table 4.15.

Table 4.15: Pair-Wise Analysis of Charcoal Accessibility Levels

Area	**Kolongolo**	**Makutano**	**Kitale**
Kacheliba	Mann-Whitney $U_{(1,95)}$ =34.500, N=31, p=.017	Mann-Whitney $U_{(1,95)}$ =1120.500, N=80, p=.009	Mann-Whitney $U_{(1,95)}$=119.000, N=93, p=.002
Kolongolo		Mann-Whitney $U_{(1,95)}$=723.000, N=97, p=.147	Mann-Whitney $U_{(1,95)}$=929.500, N=110, p=.404
Makutano			Mann-Whitney $U_{(1,95)}$=2856.000, N=159, p=.210

From Table 4.15, charcoal is more accessible in Kacheliba than Kolongolo, Makutano, and Kitale. This was because the average accessibility grades as indicated in Table 4.14 are significantly lower in Kacheliba than in Kolongolo, Makutano and Kitale. This was attributed to low monthly expenditure, cost/kg of charcoal and low budgetary allocation in Kacheliba.

4.4.5 Predictors of charcoal accessibility levels

4.4.5.1 Predictors of charcoal accessibility levels in Kacheliba

The regression model statistics indicated a well fit regression model based on the available data, with R= 0.954 and R^2= 0.911. The resultant R showed that charcoal accessibility can adequately be predicted by the model, while R^2 indicated that about 91.1% of variations in the dependant variable can be explained by independent variables.

Regression F-ratio indicated that charcoal accessibility level in Kacheliba can significantly be predicted by monthly expenditure, cost/kg, and Budgetary allocation as [$F_{(3,95)}$= 10.217, P = 0.044]. However, cost/kg of charcoal was an insignificant predictor of charcoal accessibility level in Kacheliba (Table 4.16).

Table 4.16: Coefficients Table for Charcoal Predictors in Kacheliba

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.957	.804		3.676	.035
	Monthly expenditure	.001	.000	.628	3.513	.039
	Cost/kg of charcoal	-.171	.064	-.523	-2.671	.076
	Budgetary allocation	.021	.006	.728	3.808	.032

Table 4.17 indicates the constants and coefficients after listwise elimination of cost/kg from the variable list. The resultant R and R^2 values are .836 and .699 respectively, while $F_{(2,95)}$=4.641, P=.041

Table 4.17: Significant Predictors of Charcoal Accessibility Levels in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	.953	.462		2.065	.108
	Monthly expenditure	.001	.020	.734	2.648	.007
	Budgetary allocation	.015	.008	.517	1.867	.013
a. Dependent Variable: average accessibility level on Charcoal						

From Table 4.17, charcoal accessibility in Kacheliba can be predicted by equation 12.

$C_{alka} = 0.953 + 0.01X_e + 0.015X_b$ …….. (12)

Where:

Ca_{lka} = charcoal accessibility level in Kacheliba

X_e, and X_b, = monthly expenditure and budgetary allocation on charcoal in Kacheliba respectively.

4.4.5.2 Predictors of charcoal accessibility levels in Kolongolo

The regression model summary indicates that the regression model fits the data well. R = 0.888 indicating that the model provides a good level of prediction, and R^2 = 0.788 indicating that the independent variables explain about 78.8% of variability in the dependant variable.

Regression F-ratio indicate that the predictor variables significantly predict the charcoal accessibility levels in Kolongolo [$F_{(3,95)}$= 24.773, P = <.001]. However, cost/kg of charcoal was an insignificant predictor of charcoal accessibility level in Kacheliba (Table 4.18).

Table 4.18: Coefficients Table for Charcoal Predictors in Kolongolo

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.134	.603		1.882	.075
	Monthly expenditure	.000	.000	.632	4.596	.000
	Cost per kg of charcoal	.031	.035	.111	.871	.394
	Budgetary allocation	.019	.008	.300	2.552	.019
a. Dependent Variable: average accessibility level on Charcoal						

Table 4.19 indicates the constants and coefficients after listwise elimination of cost/kg from the variable list. The resultant R and R^2 values are .883 and .780 respectively, while $F_{(2,95)}$=37.207, P=<.001

Table 4.19: Significant Predictors of Firewood Accessibility Levels in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	1.637	.172		9.503	<.001
	Monthly expenditure	.000	.000	.695	5.959	<.001
	Budgetary allocation	.020	.008	.306	2.629	.016
a. Dependent Variable: average accessibility level on Charcoal						

From Table 19, household charcoal accessibility in Kolongolo can be predicted by equation 13.

C_{alKo} = 1.637+ 0.00X_e + .020X_b …….. (13)

Where:

C_{alKo} = charcoal accessibility level in kolongolo

$X_{e,}$ and X_b, = monthly expenditure and budgetary allocation on charcoal in Kolongolo respectively.

4.4.5.3 Predictors of charcoal accessibility levels in Makutano

Regression statistics in the model summary indicated that R = .862, and R^2 =.732. R indicates that the developed model of firewood accessibility level in Makutano was good. R^2 value indicates that the independent variables explain about 74.3% of variability in dependant variable.

Regression F-ratio indicated that monthly expenditure, cost/kg, and Budgetary allocation can significantly predict charcoal accessibility level in Makutano [$F_{(3,95)}$= 66.585, P = <0.001]. As a result, based on the regression constant and coefficients in Table 4.20, the prediction equation for charcoal accessibility can be written as indicated in equation 14.

Table 4.20: Coefficients Table for Charcoal Predictors in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.874	.213		4.108	<.001
	Monthly expenditure	.002	.000	.621	9.321	<.001
	Cost/kg of charcoal	.061	.013	.313	4.587	<.001
	Budgetary allocation	.010	.002	.396	6.324	<.001

$C_{alma} = .874 + .002X_e + 0.061X_c + 0.010X_b$ …….... (14)

Where:

C_{alma} = charcoal accessibility level in Makutano

X_e, Xc and X_b, = monthly expenditure, cost/kg and budgetary allocation on charcoal in Makutano respectively.

4.4.5.4 Predictors of charcoal accessibility levels in Kitale

From the regression model summary, R = .791, and R^2 = .626. The R value Indicated that the model fits the available data well, and 62.6% of variations in the dependant variable are explained by independent variables.

The regression F-ratio indicated that the model with independent variables is significantly different from the model without independent variables [$F_{(3,95)}$=45.214, P = <.001]. With coefficients from Table 4.20, equation 15 can predict charcoal accessibility in Kitale.

Table 4.21: Coefficients Table for Charcoal Predictors in Kitale

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.266	.248		5.097	<.001
	Monthly expenditure	.001	.000	.487	6.932	<.001
	Cost/kg	.046	.012	.255	3.716	<.001
	Budgetary allocation	.012	.002	.448	6.429	<.001

$C_{alki} = 1.266 + 0.001X_e + 0.046X_c + 0.012X_b$ …… (15)

Where:

C_{alki} = charcoal accessibility level in Kitale

X_e, X_c, and X_b, = monthly expenditure, cost/kg and budgetary allocation on charcoal in Kitale respectively.

4.5 Charcoal Accessibility Levels among Small Scale Enterprise Hotels

4.5.1 Daily expenditure and cost/kg of charcoal among SME hotels

Figure 4.9 indicate that SME hotels in Makutano incur low daily expenditure on charcoal than SME hotels in Kitale.

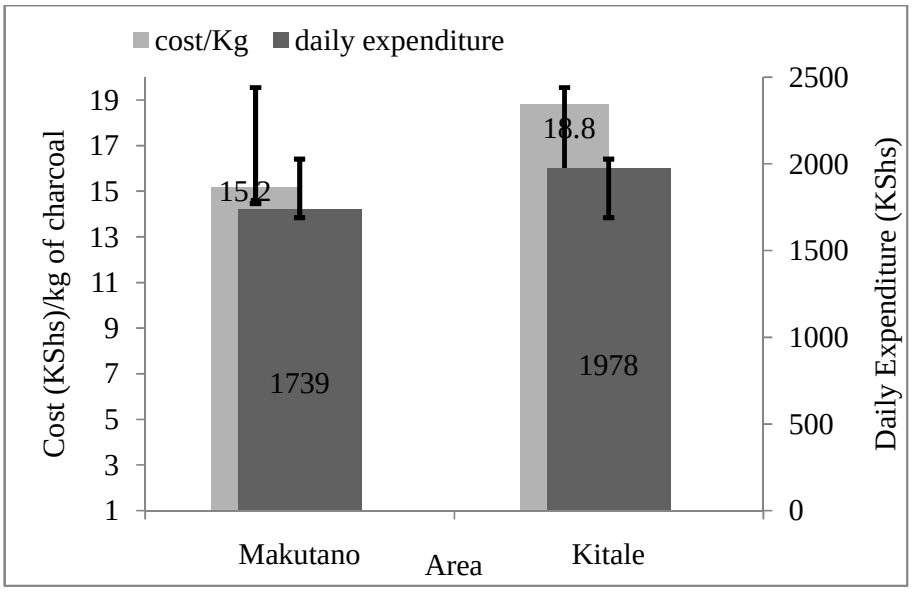

Figure 4.9: Daily Expenditure by SME Hotels on Charcoal

Interviewees indicated that daily expenditure on charcoal is high in Trans-Nzoia (Kitale) because the cost of charcoal was high as compared to West-Pokot (Makutano). In addition, the human population of Kitale was higher than Makutano, implying that the expected number of customers in Kitale was higher as compared to Makutano. This meant that SME hotels in Kitale buy more charcoal per day, translating to higher daily expenditure as compared to SME hotels in Makutano. Interview results indicated that SME hotels in West-Pokot and Trans-Nzoia obtain

their charcoal from vendors that ussually give discounts, meaning they both buy at lower prices of between KShs (400 and 800) as compared to the market price.

4.5.2 Daily budgetary allocation

Figure 4.10 indicate that the cost/kg of charcoal incurred by SME hotels, and the daily budgetary allocation on charcoal by SME hotels in Makutano were lower than Kitale.

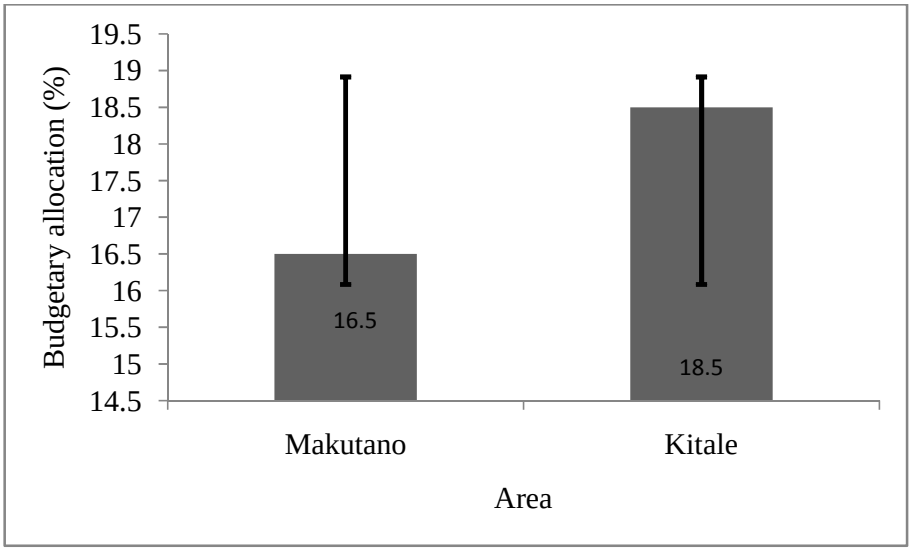

Figure 4.10: Budgetary allocation among SME Hotels

On budgetary allocation, the trend was explained by the higher daily expenditure on charcoal by SME hotels in Kitale, and high cost/kg of charcoal in Kitale as compared to Makutano.

4.5.3 SME hotels' charcoal accessibility levels in Trans-Nzoia and West-Pokot

Table 4.22 indicate the average charcoal accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties based on daily SME hotels' expenditure, cost/kg, and daily budgetary allocation. The grading was based on the information in Table 3.1 and Table 3.2.

Table 4.22: Charcoal Accessibility Grading among SME hotels

Study site	Accessibility levels based on the individual variables			Average accessibility value	Accessibility Grade	Accessibility Level
	Daily expenditure	Cost/kg	Budgetary allocation			
Makutano	2	3	4	3	3	Inaccessible
Kitale	2	3	4	3	3	Inaccessible

Table 4.22 indicates that charcoal was inaccessible among the SME hotels in Makutano, and Kitale (Grade 3).

Mann-Whitney U test indicate that the mean ranks of charcoal accessibility levels between SME hotels in Makutano and Kitale are statistically insignificant [Mann-Whitney U =278.000, N =50, P = 0.431). We therefore fail to reject the null hypothesis that charcoal accessibility levels among SME hotels in Makutano and Kitale are not significantly different. This is attributed to equal accessibility grades as indicated in Table 4.15 based on daily expenditure, and budgetary allocation on charcoal by SME hotels in the two areas.

4.5.4 Predictors of charcoal accessibility levels among SME Hotels

4.5.4.1 Predictors of charcoal accessibility among SME hotels in Makutano

Model Summary among SMEs' in Makutano indicate a well fit regression model based on the available data with R =0.862 and R^2 = 0.742. R showed that the model was of high quality in predicting charcoal accessibility among SME hotels in Makutano while R^2 indicated that the independent variables explain about 74.2% of variability in dependant variable.

Regression F-ratio indicate that the difference between the model with independent variables and the model without independent variables was statistically significant [$F_{(3,95)}$ =19.202, P = <.001]. However cost/kg of charcoal is an insignificant predictor of charcoal accessibility among SME hotels in Makutano (Table 4.23).

Table 4.23: Charcoal Predictor Coefficients among SME Hotels in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.167	.766		2.831	.010
	Daily expenditure	.001	.000	.763	5.817	<.001
	Cost/kg of Charcoal	-.021	.050	-.051	-.415	.682
	Budgetary allocation	.019	.014	.190	1.368	.187
a. Dependent Variable: Average level of Accessibility						

Table 4.24 indicates the constants and coefficients after listwise elimination of cost/kg from the variable list. The resultant R and R^2 values are .860 and .740 respectively, while $F_{(2,95)}$=29.895, P=<.001. However, budgetary allocation is not a significant predictor of charcoal accessibility levels among SME hotels in Makutano, West-Pokot County.

Table 4.24: Charcoal Predictors among SME Hotels in Makutano

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	1.860	.193		9.624	<.001
	Daily expenditure	.001	.000	.762	5.930	<.001
	Budgetary allocation	.017	.013	.171	1.331	.198
a. Dependent Variable: Average level of Accessibility						

Table 4.25 indicates that daily expenditure is a significant predictor of charcoal accessibility among SME hotels in Makutano. The resultant R and R^2 values are .874 and .718 respectively, while $F_{(1,95)}$=56.056, P=<.001.

Table 25: Significant Predictors of Charcoal Accessibility in Makutano (SMEs)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
3	(Constant)	2.008	.161		12.508	<.001
	Daily expenditure	.001	.000	.847	7.487	<.001
a. Dependent Variable: Average level of Accessibility						

Based on the constant and coefficients in Table 4.25, equation 16 predicts charcoal accessibility levels among SME hotels.

$C_{alki} = 2.008 + 0.001X_e$ ……. (16)

Where:

C_{alki} = charcoal accessibility level among SME hotels in Makutano

X_e =daily expenditure on charcoal.

4.5.4.2 Predictors of charcoal accessibility among SME hotels in Kitale

The model summary information indicated that the regression model fits the data well. R of 0.871 indicated that the model provides a good level of prediction, and R^2 of 0.758 indicate that the independent variables explain about 75.8% of variability of dependant variable.

The regression F-ratio indicated that the difference between model with independent variables and the model without independent variables was statistically significant [$F_{(3,95)}$=21.980, P = <.001]. However, cost/kg of charcoal is an insignificant predictor of charcoal accessibility among SME hotels in Kitale (Table 26).

Table 4.26: Charcoal Predictors' Coefficients among SME Hotels in Kitale

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.244	.248		5.014	<.001
	Daily expenditure	.001	.000	.618	5.239	<.001
	budgetary allocation	.040	.012	.392	3.324	.003
a. Dependent Variable: Average level of Accessibility						

Table 27 indicates variables that are significant predictors of charcoal accessibility among SME hotels in Kitale. The resultant R and R^2 values are .870 and .756 respectively, while $F_{(1,95)}$=34.127, P=<.001.

Table 4.27: Charcoal Predictors' Coefficients among SME Hotels in Kitale

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.244	.248		5.014	<.001
	Daily expenditure	.001	.000	.618	5.239	<.001
	Budgetary allocation	.040	.012	.392	3.324	.003
a. Dependent Variable: Average level of Accessibility						

From Table 4.27, equation 17 predicts charcoal accessibility levels among SME hotels in Kitale.

$$\mathbf{C_{alki} = 1.244 + 0.001X_e + 0.040X_b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)}$$

Where:

C_{alki} = charcoal accessibility level among SME hotels in Kitale

X_e and X_b =daily expenditure, and budgetary allocation on charcoal respectively.

4.6 Woodfuel Accessibility Levels

Table 4.28 indicate the average woodfuel accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot Counties. The grading was based on the information in Tables 3.2.

Table 4.28: Woodfuel Accessibility Grading in Trans-Nzoia and West-Pokot

Area	Firewood (Households)	Charcoal (Households)	Charcoal (SMEs)	Average Accessibility Value	Accessibility grading	Accessibility Level
Kacheliba	2.4	2.3	-	2.35	2	Accessible
Kolongolo	3	3	-	3.00	3	Inaccessible
Makutano	3	3	3	3.00	3	Inaccessible
Kitale	2.8	3.3	3	3.03	3	Inaccessible

From Table 4.28, woodfuel is accessible in Kacheliba, but inaccessible in Kolongolo, Makutano and Kitale.

Kruskal-Wallis test indicated that the mean ranks of woodfuel accessibility levels between Kacheliba, Kolongolo, Makutano and Kitale were statistically significant ($\chi^2_{(3,95)}$=46.526, N =405, P = <0.001). We therefore reject the null hypothesis that woodfuel accessibility levels in the rural and urban areas of Trans-Nzoia and West-Pokot are not significantly different.

The results of pair-wise analysis to identify the exact locations that exhibit significant differences in accessibility levels based on Mann-Whitney *U* test are as indicated in Table 4.29.

Table 4.29: Pair-Wise Analysis for Woodfuel Accessibility Levels

Area	**Kolongolo**	**Makutano**	**Kitale**
Kacheliba	Mann-Whitney $U_{(1,95)}$=2425, N= 186,p=<.001	Mann-Whitney $U_{(1,95)}$=2812.000, N=194, p=<.001	Mann-Whitney $U_{(1,95)}$=2827.500=207, p=<.001
Kolongolo		Mann-Whitney $U_{(1,95)}$=4853.500, N=198, p=921	Mann-Whitney $U_{(1,95)}$=5062.500, N=211, p=.288
Makutano			Mann-Whitney $U_{(1,95)}$= 35479.500, N=219, p=.234

From Table 4.29, woodfuel is more accessible in Kacheliba than Kolongolo, Makutano, and Kitale. This is because the average accessibility levels of woodfuel for Kacheliba sub-location from Table 4.28 are significantly lower than the average accessibility levels of woodfuel in Kolongolo, Makutano and Kitale.

4.6 Factors Affecting Woodfuel Accessibility

4.6.1 Factors affecting firewood and charcoal accessibility in Kolongolo

Table 4.30 indicate information about response percentages on different factors affecting firewood and charcoal accessibility in Kolongolo.

Table 4.30: Factors Affecting Firewood and Charcoal Accessibility in Kolongolo

Factor		Response (%)	
		Firewood	Charcoal
Land Tenure	Customary	0.0	0.0
	Freehold	85.6	60.7
	Leasehold	14.4	39.3
	Public	0.0	0.0
Government Policies	Yes	17.8	92.9
	No	82.2	7.1
Cookstove Technology	Open-Fire	53.3	0.0
	Improved firewood	46.7	0.0
	Ordinary metallic	0.0	39.1
	Improved metallic	0.0	4.3
	Improved with inner lining	0.0	56.5
Number of people eating the meal	(1-3) members	23.3	35.7
	(4-6)members	53.3	42.9
	7-9)members	17.8	14.3
	≥9members	5.6	

4.6.1.1 Firewood

Chi-square test of association indicated significant association between monthly expenditure on firewood with family size (χ^2 = 64.272, N= 90, P = <.001), and land tenure system (χ^2 = 16.113 N= 90, P = 0.002) (Appendix V). Significant association was also evidenced between monthly budgetary allocation and land tenure system (χ^2 = 8.533, N= 90, P = .034). This was because an increase in family size increases monthly expenditure on firewood in rural areas because of large quantities of firewood required to cook large quantities of food. However, the analysis contradicted interview results that distance travelled and time taken is influenced by family size in terms of providing enough labour for firewood collection.

Land tenure influenced monthly expenditure and budgetary allocation because individuals with privately owned land have adopted on-farm tree, and more income

generating avenues due to various investments in their farms; hence spent less on firewood and had higher income levels.

On the other hand, government regulation and cookstove technology had no significant association with any measure of firewood accessibility. This was attributed to the fact that government policies were rarely experienced in rural areas because of small scale collection and transportation of firewood. As a result, government regulations like Agricultural Act 2010 were yet to be felt in realizing firewood accessibility.

Insignificant association between cookstove and any measure of firewood accessibility was against interviewees' opinions that ICs adopted to reduce household expenditure on firewood, reduce distance and time to collect firewood.

4.6.1.2 Charcoal

Chi-square test of association indicate a significant association between monthly expenditure on charcoal and family size (χ^2 = 13.350, N= 24, P = .029) (Appendix VI).This was because the larger the family size, the higher the consumption rate of charcoal; translating to higher monthly expenditure.

Land tenure had no significant association because none of the respondent produces his/her charcoal as 100% of charcoal users in Kolongolo purchase the product. Interviewees indicated that most regulations including Energy Act 2006 and Charcoal Rules 2009 were not affecting charcoal at consumption, but at production and supply level.

Insignificant association between charcoal accessibility and cookstove technology was due to poor workmanships in manufacturing and usage. For instance, observation indicated that users were inexperienced with issues like closing the primary air inlet, and when to add charcoal.

4.6.2 Factors affecting firewood and charcoal accessibility in Kitale

Table 4.31 indicate information about response percentages on different factors affecting firewood and charcoal accessibility in Kitale**.**

Table 4.31: Factors Affecting Firewood and Charcoal Accessibility in Kitale

Factor		Response (%)	
		Firewood	Charcoal
Land Tenure	Customary	0.0	0
	Freehold	35.5	33.7
	Leasehold	64.5	61.6
	Public	0.0	4.7
Government Policies	Yes	35.2	67.0
	No	64.8	23.0
Cookstove Technology	Open-Fire	60.0	0.0
	Improved firewood	20.0	0.0
	Ordinary metallic	20.0	20.9
	Improved metallic	0.0	0.0
	Improved with inner lining	0.0	79.1
Family Size	(1-3) members	22.6	47.7
	(4-6)members	67.7	47.7
	>6members	9.7	4.7

4.6.2.1Firewood

Chi-square test of association showed that land tenure, government regulations, cookstove technology and family size had no significant association with distance, time, monthly costs and budgetary allocation on firewood in Kitale. This was because people were buying firewood at similar prices; implying similar budgetary allocation depending on their monthly income, and walk similar distance as there were no firewood plantations in private farms. However, those with few trees on their farms harvest inadequate firewood to sustain the family for a long time.

There were also no policies governing transportation of firewood in small scale, which most households do. This implied that Forest Act 2005 that aimed at increasing the usability of forest products to the local community is insignificantly contributing to firewood accessibility.

In addition, the effects of family size were insignificant to firewood accessibility. This was because households with smaller families use firewood when cooking hard to cook foods like a mixture of beans and maize, while larger families always use firewood regardless of type of food being cooked. In addition, the quantity of firewood consumed depends on the number of meals cooked per day, rather than family size. This was because some families cook once, while others more than thrice. Larger family sizes were also complimenting self-collection and purchase, resulting in lower expenditure on firewood than smaller families that depend on the purchase.

4.6.2.2 Charcoal

Household's charcoal accessibility based on the monthly expenditure on charcoal was significantly related to the family size (χ^2 = 44.752, N=86, p= <.001), and Land tenure (χ^2 = 17.578, N=86= 0.007). This was because of higher energy demand among larger families. The association between land tenure and monthly expenditure can be attributed to family sizes. This was because individuals either in private lands in towns were rich and had larger family size inform of house helps, relatives and children.

Insignificant association of cookstove technology with charcoal accessibility was as a result of poor workmanship and inadequate skills. As a result, though 79.1% of respondents were using ICs, their monthly expenditure was almost equal to those having ordinary stoves. Government rules and regulations were also not affecting charcoal accessibility at a household level, but at production and supply level.

4.6.3 Factors affecting firewood and charcoal in Kacheliba

Table 4.32 indicated information about response percentages on different factors affecting firewood and charcoal accessibility in Kacheliba.

Table 4.32: Factors Affecting Firewood and Charcoal Accessibility in Kacheliba

Factor		Response (%)	
		Firewood	Charcoal
Land Tenure	Customary	79.1	16.7
	Freehold	17.6	50.0
	Leasehold	3.3	33.3
	Public	0.0	0.0
Government Policies	Yes	71.4	71.4
	No	28.6	28.6
Cookstove Technology	Open-Fire	73.6	0.0
	Improved firewood	26.4	0.0
	Ordinary metallic	0.0	33.3
	Improved metallic	0.0	16.7
	Improved with inner lining	0.0	50.0
Family Size	(1-3) members	5.5	16.7
	(4-6)members	46.2	66.7
	7-9)members	36.3	16.7
	≥9members	12.1	

4.6.3.1 Firewood

Chi-square test of association indicated significant associated between monthly expenditure on firewood and family size (χ^2 = 17.717, N= 91, P = 0.037) and land tenure system (χ^2 = 41.017, N= 91, P = 0.001). On the other hand, household's monthly budgetary allocation was related to cookstove technology (χ^2 = 9.406, N= 91, P = 0.023).These results concurred with interviewees that an increase in family size increases energy demand.

Firewood collection in rural areas of West-Pokot was not restricted by land tenure as people can collect firewood beyond clans' land. This ensured that the cost of firewood was low as compared to areas with private lands where individuals were restricted from collecting in other people's lands unless authorized.

In Kacheliba, people use ICs not because they want to save money, reduce distance or time for firewood collection. Instead, they aim at reducing the cooking time so that they can engage in other income generating activities. This was because the cookstoves adopted in Kacheliba indicated in plate 4 can keep food warm for long; hence reducing the time needed to warm food in case needed.

Analysis contradicted interviewees' results that larger families collect and exhaust firewood from their farms faster, forcing them to move far and spent more time collecting enough firewood. In addition, government regulations had no significant association with household's accessibility to firewood because the management of vegetation in most rural areas was under clan elders, but not governments.

Plate 5: Improved Firewood Cookstove

(Source: Author 2016)

4.6.3.2 Charcoal

Chi-square test of association indicated that land tenure, cookstove technology, government rules and regulations and family size had no significant association with monthly household expenditure and budgetary allocation on charcoal in Kacheliba. This was because land tenure was not an issue with charcoal because almost everyone using charcoal buys from vendors. However, communal land ownership in general led to lower cost of charcoal because due to lower cost of production resulting from availability of trees in communal lands.

Most of the cookstoves were poorly used because charcoal was still cheap and available. In addition, family size may not affect the cost and budgetary allocation on firewood because larger families were rarely using charcoal due to higher costs.

4.6.4 Factors affecting firewood and charcoal accessibility in Makutano

Table 4.33 indicate information about response percentages on different factors affecting firewood and charcoal accessibility in Makutano.

Table 4.33: Factors Affecting Firewood and Charcoal Accessibility in Makutano

Factor		Response (%)	
		Firewood	Charcoal
Land Tenure	Customary	0.0	0.0
	Freehold	37.1	28.4
	Leasehold	62.9	71.6
	Public	0.0	0.0
Government Policies	Yes	20.5	83.3
	No	79.5	16.7
Cookstove Technology	Open-Fire	60.0	0.0
	Improved firewood	76.5	0.0
	Ordinary metallic	20.6	18.7
	Improved metallic	2.9	0.0
	Improved with inner lining	0.0	81.3
Family Size	(1-3) members	22.9	54.1
	(4-6)members	71.4	41.8
	>6members	5.7	4.1

4.6.4.1 Firewood

Chi-square test of association showed insignificant association between household firewood accessibility and land tenure, cookstove technology, government rules and regulations and family size. This was because regardless of land ownership system, individuals buy firewood at similar prices; implying similar budgetary allocation depending on their monthly income, and walk similar distance and time to collect firewood. Insignificant association between firewood accessibility and cookstove technology was attributed to poor workmanship and experienced usage.

4.6.4.2 Charcoal

Chi-square test of association indicated that monthly expenditure on charcoal was significantly associated with family size (χ^2 =35.584, N =73, P= <.001). This was because an increase in family size increases energy demand. However, this increase was non-linear because households with more than 5 members opt to buy charcoal in

sacks, implying lower cost as compared to those buying in tins, leading to lower expenditure per month.

There were no significant association between land tenure and household's charcoal accessibility level. This was because 100% of charcoal users were buying charcoal. Insignificant association between charcoal cookstove and charcoal accessibility level was due to poor standards, and inadequate technological knowhow among users to enable them gain advantages of improved cookstoves.

Government policies and regulations were also not related to household's charcoal accessibility levels, despite Table 4.33 indicating that 83.3% of respondents were at least restricted from charcoal production, transportation or utilization. This was because charcoal regulations like Charcoal Rules 2009 and water quality Act only controls charcoal production, an activity not engaged by many charcoal users as 100% of charcoal users buy charcoal. In addition, movement permits and certificate of origin among other movement requirements are only applied on large transportation of charcoal, implying that it restricts charcoal suppliers not consumers at household levels. However, Energy Act 2006 encourages adoption of ICs at household level on a voluntary basis.

4.6.5 Factors affecting charcoal accessibility among SMEs in Trans-Nzoia

Table 4.34 indicate information about response percentages on different factors affecting firewood and charcoal accessibility among the SME hotels in Trans-Nzoia and West-Pokot.

Table 4.34: Factors Affecting Charcoal Accessibility among SMEs

Factor		Response (%)	
		Trans-Nzoia	West-pokot
Cookstove	Ordinary metallic	40	84
	Improved stoves	60	16
Number of customers	≤60	56.0	32.0
	61-120	32.0	40.0
	>120	12.0	28.0

Chi-square test of association indicated a significant association between daily expenditure on charcoal and budgetary allocation with number of customers and cookstove technologies among the SME hotels in Trans-Nzoia and West-Pokot as summarized in Table 4.35.

Table 4.35: Chi-square analysis on Factors Affecting charcoal accessibility

	Pearson Chi-Square	N	df	Exact Sig. (2-sided)
Cost and cookstove technology in T.N	1.218	25	3	.000
Cost and number of customers in T.N	17.151	25	3	.000
Budget and number of customers in T.N	2.238	25	2	.002
Budget and cookstove technology in T.N	4.954	25	2	.000
Cost and cookstove technology in W.P	3.256	24	3	002
Cost and number of customers in W.P	5.151[a]	24	3	.000
Budget and number of customers in W.P	2.438[a]	24	2	.002
Budget and cookstove technology in W.P	2.054[a]	24	2	.000

T.N = Trans-Nzoia

W.P = West-Pokot

Significant association between the number of customers with daily expenditure and budgetary allocation was because the larger the number of customers mean larger quantities and that increases energy demand. Higher energy demand meant large higher daily expenditure.

However, whether the number of customers increase budgetary allocation of charcoal based on total kitchen costs remained unclear. This was because on one hand, some respondents argued that an increase in customer number implies higher total kitchen expenditure per day as a result of increased quantity and variety of food and charcoal to be purchased, implying that the rate of increase in charcoal expenditure is proportional to the increase in total kitchen expenditure. On the other hand, it was argued that cooking a variety of foods means some take long to cook than others, and some of those foods are just cooked in small quantities, implying that when carefully evaluated, the rate of increase in charcoal expenditure is higher than the rate of increase in total kitchen costs. The later augment means the higher the number of customers' increases budgetary allocation on charcoal, while the former argument means an increase in the number of customers has no effect on budgetary allocation on charcoal.

A significant association between cookstove technologies with daily expenditure and budgetary allocation on charcoal implied that SME hotels that were using ICs were likely to be very accessible to firewood. Interviewees interpreted that SME hotels using ICs use less charcoal because such stoves are standardized and meet the required standards. In addition, users have knowledge on using them as they know when to open and close primary air entrance.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This section interprets the research findings and relates them with the findings of other studies in woodfuel as reviewed in literature.

5.2 Woodfuel Accessibility Levels

5.2.1 Firewood accessibility levels

Firewood was accessible in Kacheliba, and inaccessible in Kolongolo, Makutano, and Kitale. This was due to relatively low distance/kg, time (hours)/kg, monthly expenditure (KShs), and Cost (KShs)/kg as compared to Kolongolo, Makutano, and Kitale. However, household's monthly budgetary allocation was high.

Shorter distances and time per kg of firewood collected in Kacheliba were attributed to availability of firewood from natural vegetation. This was because most natural vegetations were preserved for livestock feeds. PFE *et al*. (2010) noted that pastoralism discourage cutting down of trees because they serve as livestock browsers and edible fruits, and in case cutting is inevitable, only branches are cut, leaving the tree to recover. However, Nduwamungu *et al.* (2009) and Moran (2006) stated that pastoralism involves destruction of natural vegetations through overgrazing and burning.

However, the distances and time were not very short because people preferred walking considerable distances, and spending time fetching quality firewood in terms of size, moisture content and species. Since quality firewood is not readily available in Makutano as compared to Kacheliba, people in Makutano walk longer distances, spent more time travelling and fetching quality firewood. This concurred with

Bembridge *et al*. (1990), Arayal (2002), Horst *et al*. (2009), and Egeru *et al*. (2015) that women and children walk longer distance and spend more time fetching firewood because of overdependence on the dwindling natural vegetation and in search of quality firewood.

In Trans-Nzoia, people walk considerable distances and spend more time on the road, and at firewood collection site due to firewood scarcity. This was as a result of intensive agricultural activities that have led to the clearance of natural vegetations that are preferred for firewood. Hosier (1985), Nduwamungu *et al*. (2009), ITDG (1999), and Mugo *et al*. (2010) also noted that clearance of formerly vegetated lands for agricultural, infrastructure, and settlement purposes lengthen firewood collection distance and time.

Though some farmers in the rural areas have adopted on-farm tree planting, inadequate land to accommodate trees and food crops has hindered many from adopting the practice. These concurred with Githiomi *et al*. (2012), Kamfor (2002), O'keefe (1989) and Egeru *et al*. (2015) that some households obtain firewood from on-farm trees in form of trimmings. In addition, inadequate supply of firewood from on-farm trees due to food crop plantation preference concurred with Ngetich *et al.* (2009).

In Kitale, there were no firewood collection vegetations except beautification trees that are not meant for firewood. This was also noted by Kamfor (2002), Ngetich *et al*. (2009) and Malmberg (1994) that urban areas experience inadequate tree cover for firewood, leading to a prolonged distance and collection time. However, time/kg of firewood collected was an insignificant predictor of firewood accessibility in Kitale due to large variations resulting from different means of transport involved. This was in line with Ngetich *et al*. (2009) and Sikie *et al*. (2009) that an increase in distance

causes a change in the transportation means as people use bicycles and motorcycles to reduce the total time taken for firewood collection. The findings that time is not the best predictor of firewood accessibility concurred with Van‘t Veld *et al.* (2006) that individuals change their collection strategy in case of an increase in time required for firewood collection.

Monthly expenditure on firewood and cost/kg of firewood was low in Kacheliba because firewood was readily available. However, larger family sizes increases energy demand leading to higher household’s monthly expenditure. High cost/kg and monthly expenditure on firewood in Kolongolo, Makutano and Kitale were as a result of high firewood prices due to the scarcity of the product. The differences in firewood prices in the four study areas concurred with Mwampamba (2007) that the cost of firewood differ from locations depending on the proximity to the source. In addition, higher monthly expenditure as a result of larger family sizes especially in rural areas was also noted by Vahlne *et al.* (2014), Inayatullah (2011), and Ogwuche *et al*. (2013).

Budgetary allocation on firewood based on household’s head income was high in Kacheliba as compared to Kolongolo, Makutano and Kitale. This was explained by low levels of income in Kacheliba as compared to other areas. Low income levels in Kacheliba are as a result of low education level, inadequate technical skills along with limited job opportunities (County Government of West-Pokot, 2013). High Budgetary allocation on firewood in Kacheliba disagreed with Heltberg (2003) that budgetary allocation on firewood was low in rural than urban areas due to lower cost of firewood. However, attribution of higher budgetary allocations on low-income levels was supported by Horst *et al*. (2009), Nyembe (2011), and Karekezi *et al.* (2009). Variations in budgetary allocation on firewood in West-Pokot and Trans-Nzoia

counties are in line with Mwampamba (2007), Mutua *et al.* (2010), and Ajao (2011) that budgetary allocation on firewood varies between and among urban and rural.

5.2.2 Charcoal accessibility levels

Charcoal was accessible in Kacheliba, and inaccessible in Kolongolo, Makutano, and Kitale. This was because of low monthly expenditure on charcoal, Cost (KShs)/kg on charcoal consumed, and monthly budgetary allocation among households as compared to Kolongolo, Makutano, and Kitale.

Monthly expenditure on charcoal and cost/kg of charcoal in Kacheliba and Makutano were low than in Kitale and Kolongolo because of low charcoal prices. This was in line with Mumo (2011) that charcoal prices in high potential areas are high than in ASALS due to availability of firewood in ASALs. In addition, it agreed with Mwampamba (2007) that the costs of charcoal vary from one region to the other.

Monthly expenditure on charcoal and cost/kg of charcoal were high in Trans-Nzoia especially in urban areas because most of the charcoal consumed were imported from neighbouring counties like Pokot, Turkana and Marakwet. This implied that the prices of charcoal in Trans-Nzoia were high because of longer distances that vendors travel. This concurred with Karekezi *et al*. (2008) that costs of charcoal were high in areas where vendors travel longer distances before getting the product.

Budgetary allocation was low in rural than urban areas because only high income earning households were using charcoal. This contradicted Horst *et al*. (2009) that budgetary allocation should be higher in rural areas as compared to urban areas due to low income levels in rural areas. In Kitale, high budgetary allocation on charcoal was due to high charcoal prices, in Makutano budgetary allocation were due to low income levels. The variations in budgetary allocation in different regions was

also noted and explained by Mutua *et al*. (2010) levels of income vary from region to region, leading to variations in household energy budgets. In Makutano, the results concurred with Kamfor (2002), Karekezi *et al*. (2008), and Nyembe (2011) in Kenya and Ajao (2011) in Nigeria that many households spent larger proportions of their income in charcoal because they have lower income levels. In Kitale, budgetary allocation on firewood was high due to high charcoal prices. This was in agreement with Karekezi *et al*. (2008) that the higher the charcoal prices the higher the proportions of budgetary allocation.

Among the SME hotels, daily expenditure, cost/kg of charcoal, and daily budgetary allocation on charcoal was high in Kitale than Makutano. This was due to high cost of charcoal and larger number of expected customers in Kitale. These concurred with Ogwuche *et al*. (2013), Inayatullah (2011), and Mugo *et al*. (2010) that larger number of people expected to eat the meal increases energy demand, translating to higher household expenditure on charcoal.

5.3 Factors Affecting Woodfuel Accessibility

5.3.1 Family size/number of customers

Family size had no influence on the distance/kg and time/kg of firewood collected in the rural and urban areas of Trans-Nzoia and West-Pokot, but influenced household monthly expenditure on firewood in Kacheliba and Kolongolo. This was because an increase in family size increases household energy demand, translating to higher expenditures on firewood per month. However, this was contradicted by the results in urban areas of Trans-Nzoia that households' monthly expenditure was not influenced by family size. This was because the quantity of firewood used depends on the number of times the family cook, the type of food cooked, and ability of lager

families to supplement self-collection and purchase of firewood due to availability of labour to fetch firewood.

On the other hand, family size/number of customers dictates the household and SME hotel's expenditure on charcoal Kolongolo, Makutano and Kitale. This was because the increase in family size/number of customers increases energy demand, resulting in higher consumption per day as a result of increased quantity and variety of food cooked. This was not in line with the results in Kacheliba where monthly expenditure on charcoal was not related to family size. This was attributed to the fact that larger family sizes rarely use charcoal because it was expensive as compared to firewood.

The results that monthly and daily expenditure on firewood and charcoal increases with an increase in family size/number of customers were in line with Ogwuche *et al*. (2013), Inayatullah (2011), and Mugo *et al*. (2010). On the other hand, the results in the urban areas of Trans-Nzoia that an increase in family size increases the availability of labour to collect firewood concurred with Bembridge *et al*. (1990).

Family size in rural and urban areas of Trans-Nzoia and West-Pokot had no influence on the budgetary allocation on firewood and charcoal. This was because though the family size may be large, the average household's income may be higher resulting to low budgetary allocation and vice versa. The results are in disagreement with Nyembe (2011) that family size influences household budgetary allocation on firewood because family sizes increase daily expenditure on firewood. On the other hand, the number of customers influenced SME hotels' budgetary allocation on charcoal in Trans-Nzoia and West-Pokot. This was because an increase in the number of customers increases daily expenditure on charcoal, resulting to an increase in budgetary allocation on charcoal, and the reverse is true.

5.3.2 Land tenure

Land tenure in the study areas was not influencing the distance and time per kg of firewood collected. However, it was influencing household's expenditure on firewood in the rural areas of Trans-Nzoia and West-Pokot. In the rural areas of Trans-Nzoia, freehold land tenure system was encouraging adoption of agroforestry systems due to tree rights as explained by Mandila (2014), enabling families to supplement on-farm collected firewood and purchased firewood; hence reducing monthly expenditure on firewood. This also concurred with Mutimba *et al*. (2005) that the type of investment made on a particular piece of land was dictated by the land tenure system.

In Kacheliba, communal land tenure system was allowing people to collect firewood beyond clan land boundaries, resulting in lower expenditure on firewood per month because people can collect firewood for free. Individuals under freehold tenure were not allowed to collect firewood in other people's land for free in case they don't have enough in their lands; hence increasing monthly expenditure on firewood. This concurred with Aabeyir *et al.* (2011) that land tenure systems dictates the person that will access the resource in a particular piece of land. The results in Kacheliba concurred with Minang *et al*. (2015) that land tenure has no effect because neighbours enter each other's plots to obtain natural resources.

Land tenure influences household's monthly expenditure on charcoal in Kitale, but not in Kolongolo, Kacheliba and Makutano. Monthly expenditure on charcoal was influenced by land tenure system in Kitale because individuals practicing freehold tenure system were believed to be rich and live with relatives and house helps. This concurred with Mugo *et al*. (2010) and Inayatullah (2011) that an

increase in monthly expenditure on charcoal is as a result of increased energy demand.

On budgetary allocation, land tenure system influenced household's budgetary allocation on firewood in the rural areas of Trans-Nzoia only. This was because in Kolongolo, individuals with freehold land tenure systems diversify their sources of income because of land rights as explained by Waiganjo *et al*. (2001); hence increasing their income base and lowering budgetary allocation.

5.3.3 Cookstove technology

The adopted cookstove technology was not influencing distance, time, and household's expenditure on firewood and charcoal in the rural and urban areas of Trans-Nzoia and West-Pokot. This was in disagreement with Vahlne *et al*. (2014), Rosa *et al*. (2014), and Jeuland *et al.* (2012) that ICs are disseminated and adopted with the aim of reducing energy demand; hence cutting down household's expenditure on firewood and charcoal. In this regard, the results concurred with Nepal *et al*. (2010), that most ICs on the market are constructed without putting in place appropriate measures to reduce households' energy demand. In addition, there is inadequate knowledge on their users, like when to open the primary air entrance and the quantity of charcoal and firewood required per unit time (Raman *et al*., 2013).

The results indicated that cookstove technologies among the SME hotels were influencing daily expenditure on charcoal. This implied that SME hotels that were using ICs spent less on charcoal per day as compared to their counterparts. This concurred with Walubengo (2002) that adopting ICs help cottage industries to reduce expenditure on the cooking energy.

5.3.4 Government policies and regulations

Existing government policies and regulations were not influencing firewood and charcoal accessibility at a household level. This was because charcoal and firewood transportation permits are only issued in case of transportation of larger quantities of firewood and charcoal, but not small scale transportation as many households engage. This contradicted Marjorie (2011), and Zulu *et al.* (2009) that most regulations and policies encourage taxation on firewood and charcoal production, making the product more expensive. In addition, the policies like Charcoal Rules 2009, Agricultural Act 2010, and Forest Act 2005 as explained by Mbuthi (2009), and Gathui *et al.* (2012) that are instrumental in ensuring sustainable accessibility of firewood through sustainable harvesting, are yet to be felt in rural and urban areas of Trans-Nzoia and West-Pokot. However, the results concurred with Minang *et al.* (2015) that most policies are not applied effectively because they are not enforced for a long time after their enactment.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Woodfuel accessibility

In West-Pokot County, woodfuel is accessible in rural areas, and inaccessible in urban areas. In Trans-Nzoia County, woodfuel is inaccessible both in rural and urban areas.

6.1.2 Factors affecting firewood and charcoal accessibility among households

Distance and time per kg of firewood collected in the rural and urban areas of Trans-Nzoia and West-pokot are neither influenced by land tenure system, family size, cookstove technologies, nor government policies and regulations.

Family size and land tenure systems influences household expenditure on firewood in rural areas of Trans-Nzoia and West-Pokot. Budgetary allocation on firewood in rural areas of Trans-Nzoia is influenced by land tenure system, while budgetary allocations in rural areas of West-Pokot are influenced by cookstove technology.

Monthly expenditure on charcoal is influenced by family size in the rural and urban areas of Trans-Nzoia and urban areas of West-Pokot. Land tenure on the other hand influences household monthly expenditure on charcoal in the urban areas of Trans-Nzoia. Government policies have no influence on any measure of charcoal and firewood accessibility among households.

Among SME hotels, daily expenditure and budgetary allocation on charcoal in Trans-Nzoia and West-Pokot are influenced by the type of cookstove technology adopted, and the average number of customers per day.

6.2 Recommendations

1. Agriculture and forest extension officers should educate people in Trans-Nzoia on agroforestry practices and technologies to improve woodfuel accessibility by reducing distance, time, monthly expenditure and budgetary allocation on woodfuel.
2. Law enforcers should put more effort in enforcing current government policies and regulations like Charcoal Act 2009, Forest Act 2006, Agricultural Act 2010, and energy Act 2006 to ensure that their effective effects are felt by firewood and charcoal users.
3. Energy Regulatory Commission should formulate better standards of ICs, and eliminate poorly constructed ICs.
4. Energy and environmental conservation experts need to educate people on how to use ICs to ensure appropriate usage.

6. 3 Areas of Further Research

This study found no conclusive evidence on whether the number of customers expected by SME hotel per day lower or raises charcoal accessibility level. This was because some respondents argued that increasing the amount and variety of food to be cooked increases the amount of charcoal required to cook, hence increasing the amount of cash spent by the hotel translating to higher expenditure on charcoal per day. However, other respondents argued that increasing the amount and variety of foods increases SME hotels' total kitchen costs, implying that budgetary allocation will remain the same. As a result, further research is recommended to clear out this confusion.

In determining factors affecting accessibility levels of firewood and charcoal in households and SME hotels located in West-Pokot and Trans-Nzoia, this research concentrated only on four factors, namely family size or number of expected customers, land tenure systems, cookstove technologies and government policies and regulations. As a result, further research is recommended to assess the effects of other factors including availability of substitutes, and land size among others.

REFERENCES

Aabeyir, R., Quaye-Ballard, J., Luise. M. & Oduro, W. (2011). Analysis of factors affecting sustainable commercial fuelwood collection in Dawadawa and Kunsu in Kintampo North District of Ghana. *The IIOAB Journal*, 2(2):44-54. Retrieved 20 October, 2012, from IIOAB database.

Abebe, D., Koch, F. & Mekonnen, A. (2012). *Coping with fuelwood scarcity: Household responses in rural Ethiopia*. Discussion Paper Series EfD DP 12-01. Retrieved 24 February, 2013, from www.rff.org/files/sharepoint/.../EfD-DP-12-01.pdf.

AGECC. (2010). *Energy for a sustainable future*: Summary report and recommendations 28 April 2010, New York.

Ajao, A. (2011). Econometric analysis of urban charcoal demand in Ogbomoso Metropolis. *Report and Opinion*. 3(9):22-29. Retrieved 12 January, 2012, from http://www.sciencepub.net/report

Anjum, A. (2012). Biomass: Energy and environmental concerns in developing country. *International Research Journal of Environmental Science,* 1(1): 54-57. Retrieved 20 November 2013, from ISCA database.

Aquil, A., Shadab, K., Shadman, H. & Tiwari, G. (2014). The contemporary scenario of Indian renewable energy sector. *International Research Journal of Environmental Science*, 3(11), 82-89. Retrieved 17, November 2015, from ISCA database.

Arayal, E. (2002). *Review of the existing studies related to fuelwood and/or charcoal in Eritrea*. Retrieved 25 March 2013, from: ftp://ftp.fao.org/docrep/fao/004/X6788E/X6788E00.pdf.

Bailis, R. (2009). Modeling climate change mitigation from alternative methods of charcoal production in Kenya. *Biomass and Bioenergy*, 33:1491–1502. Retrieved 13 October 2011, from Nature Kenya database.

Bembridge, T. & Tarlton, J. (1990). Woodfuel in Ciskei: A headload study. *South African Forestry Journal*, 154: 88-99. Retrieved 11 February 2012, from http://www.tandfonline.com/doi/abs/10.1080/00382167.1990.9629058?journalCode=tsfs17#preview

Brown, G. (2010). *The average price for a cord of firewood*. Retrieved 24th February 2013, from http://www.ehow.com/facts_7163217_average-price-cord-firewood.html

Commission on Revenue Allocation. (2012). *Kenya county fact sheet*. Retrieved 3 January 2013, from opendata.go.ke/download/zn6m-25cf/application/pdf

County Government of Trans-Nzoia. (2013). *Trans Nzoia County Integrated Development Plan, 2013-2017*. Retrieved 12 January, 2012, from cog.go.ke/images/stories/CIDPs/TransNzoia.pdf

County Government of West-Pokot. (2013). *First County Integrated Development Plan 2013 – 2017*. County Government of West Pokot. Retrieved September 12 2014, from cog.go.ke/images/stories/CIDPs/WestPokot.pdf

Dewees, P. (1989). The woodfuel crisis reconsidered: Observations on the dynamics of abundance and scarcity. *World Development*, 17(8):1159-1172. Retrieved 27 January 2012, from *https://canvas.instructure.com/courses/851452/files/27921647/download?*

Egeru, A., Kateregga, E. & Gilber, J. (2015). Coping with firewood scarcity in soroti district of eastern Uganda. *Open Journal of Forestry*, 4(1):70-74.

Retrieved 21 August 2015, from *file.scirp.org/pdf/OJF_2014012714354925.pdf*

Faaij, A. (2006). Modern biomass conversion technologies. *Mitigation and Adaptation Strategies for Global Change,* 11(2):335-367. Retrieved 2 March 2012, springer.com/.../10.1007%2Fs11027-005-9004

FAO. (2001). *Plantations and wood energy*. Forest plantations thematic papers. Retrieved 2 March 2012, from FAO database

Fleuret. C. & Fleuret, K. (1978). Fuelwood use in a peasant community: Tanzanian case study. *Journal of Developing Areas,* 123:315-322. Retrieved 2 March 2012, from http://www.jstor.org/stable/4190582

Gathui, T., Mugo, F., Ngugi, W., Wanjiru, H. & Kamau, S. (2012). *Current regulations for a sustainable charcoal sector.* The Kenya charcoal policy handbook. Retrieved 7 December 2012, from http://r4d.dfid.gov.uk/PDF/Outputs/PISCES/Kenya-Charcoal-Pocketbook_lowres_0.pdf

Githiomi, J., Mugendi, D. & Kung'u, B. (2012). Analysis of household energy sources and woodfuel utilisation technologies in Kiambu, Thika and Maragwa districts of central Kenya. *Journal of Horticulture and Forestry*, 4(2):43-48. Retrieved 7 December 2012, from http://www.academicjournals.org/JHF

Heltberg, R, (2003). *Household fuel and energy use in developing countries- A multicountry study: Draft for discussion.* Retrieved 7 December 2012, from http://siteresources.worldbank.org/INTPSIA/Resources/490023-dy_05.pdf

Horst, G. & Hovorka, A. (2009). Fuelwood: The ‘‘other’’ renewable energy source for Africa? *Biomass and Bioenergy*, 33:1605–1616. Retrieved 7 December 2012, from http://www.sciencedirect.com/science/journal/09619

Hosier, R. (1985). *Energy, environment and development in Africa: Energy use in rural Kenya: Household demand and rural transformation*. Beijer Institute and the Scandinavian Institute of African Studies.

Huho, M. (2012). Conflict resolution among pastoral communities in West Pokot County, Kenya: A missing link. *Academic Research International*, 3(3):458-468. Retrieved 7 December 2012, from https://www.researchgate.net/.../238191173_CONFLICT_RESOLUTION.

Inayatullah, J. (2011). *What makes people adopt improved cook stoves? Empirical evidence from rural northwest Pakistan*. The Governance of Clean Development Working Paper 012–January 2011. Retrieved 7 December 2012, from cleancookstoves.org/.../what-makes-people-ado

Israel, D. (2012). *Determining sample size*. Florida cooperative extension service. Retrieved 7 December 2012, from https://edis.ifas.ufl.edu/pd006

ITDG, (1999). *Household energy and the environment*. Retrieved 28 March 2013, from http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0fnl2.2--00-0----0-10-0---0---

Jeuland, M. & Pattanayak, S. (2012). Benefits and costs of improved cookstoves: Assessing the implications of variability in health, forest and climate impacts. *PLoS One*, 7(2):1-15. Retrieved 9 December 2012, from https://cleancookstoves.org/binary.../376-1.pdf

Kamfor. (2002). *Study on Kenya's Energy Demand, Supply and Policy Strategy for Households, Small Scale Industries and Service Establishments.* Final Report to Ministry of Energy Nairobi Kenya.

Karekezi, S., Kimani, J. & Onguru, O. (2008). *Energy access among the urban and peri-urban poor in Kenya*. Energy environment and development network for Africa (AFREPREN/FWD). Retrieved 2 June 2012, www.gnesd.org/-/.../**Urban**%20**Peri-Urban**%20Theme/.../AFREPEN%20final.ashx?la=

Kenya Bureau of statistics. (2010). 2009 *Population by district*. Retrieved 2 October 2012, from http://www.google.co.ke/search?q=2009_Population_By_District.xls&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-a

Kishor, S. & Mitchell, P. (2011). Household level domestic fuel consumption and forest resource in relation to agroforestry adoption: Evidence against need-based approach. *Biomass and Bioenergy*, 35:337-345.

Malmberg, C. (1994). *Case study on the role of women in rural transport: access of women to domestic facilities.*SSATP Working Paper NO 11

Mandila, B. N. (2014). *Factors influencing adoption and profitability of agroforestry technologies and practices in semi-arid regions of West-Pokot County, Kenya*. Unpublished Masters Thesis, University of Kabianga.

Marjorie, K. (Ed). (2011). *Wood-based biomass energy development for Sub-Saharan Africa issues and approaches*. Africa Renewable Energy Access Program (AFREA). Retrieved 3 October 2012, from siteresources.worldbank.org/EXTAFRREGTOPENERGY

Mbuthi, P, (2009). *Integrated Woodfuel development strategy for Kenya 2008-2012*. Final report. Retrieved 7 October 2012, from

kerea.org/wp.../Integrated-Woodfuel-Development-Strategy-Final-23-April-09.pdf

Minang, P. A., van Noordwijk, M., Freeman, O. E., Mbow, C., de Leeuw, J. & Catacutan, D. (Eds.) (2015). *Climate-smart landscapes: Multifunctionality in practice*. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Moran, F. (2006). *People and nature: An introduction to human ecological relations.* Malden, Massachusetts: Blackwell Publishing.

Mugo, F. & Gathui, T. (2010) *Biomass energy use in Kenya.* A background paper prepared for the International Institute for Environment and Development (IIED) for an international ESPA workshop on biomass energy, 19-21 October 2010.

Mumo, M. (2011). *Kenya: Charcoal prices burn a hole in local household budgets.* Retrieved 7 October 2012, from allafrica.com/stories/201112200191.html

Mutimba, S. & Barasa, M. (2005). *National charcoal survey of Kenya: Summery report.* Nairobi: Energy for Sustainable Development Africa.

Mutua, J., Ngui, D. & Mwakubo, S. (2010). *A Comprehensive study and analysis on energy consumption patterns in Kenya.* A synopsis of the draft final report. Retrieved 10 October 2012, from www.cofek.co.ke/ERCStudy_ExecSummary_02082010.pdf

Mwampamba, T. (2007). Has the woodfuel crisis returned? Urban charcoal consumption in Tanzania and its implications to present and future forest availability. *Energy Policy*, 35(2007):4221–4234. Retrieved 10 October 2012, from Elsevier database.

Natasha, M., Woodsong, C., Macqueen, K, Guest, G. & Namey, E. (2005). *Qualitative research methods: A data collector's field guide*. North Carolina: Health International.

Nduwamungu, J., Munishi, P., Bloesch, U., Hagedorn, F. & Lulu, K. (2009). Recent land covers and uses changes in miombo woodlands of eastern Tanzania. *Tanzania Journal of Forestry and Nature Conservation*, 78:50-59. Retrieved 18 October 2012, from www.adansonia-consulting.ch/.../Article.Jean.Land_cover_use_changes_in_miombo

NEMA. (2009). *Trans-Nzoia district environment action plan 2009-2013*. Retrieved 12 April 2013, from http://www.nema.go.ke/index.php?option=com_phocadownload&view=category&download=373:trans-nzoiapdf&id=94:neap-reports&Itemid=567&start=20

Nepal, M., Nepal, A. & Grimsrud, K. (2010). *Unbelievable but improved cookstoves are not helpful in reducing firewood demand in Nepal*. Retrieved 23 September 2012, from http://www.bupedu.com/lms/admin/uploded_journal/Unbelievable%20but%20improved.pdf.

Ngetich, K., Birech, R., Kyalo, D., Bett, E. & Freyer, B. (2009). Caught between energy demands and food needs: Dilemmas of smallholder farmers in Njoro, Kenya. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 110(1):23–28. Retrieved 10 October 2012, from Elsevier database

Nyembe, M. (2011). *An Econometric analysis of factors determining charcoal consumption by urban households: The case of Zambia*. Unpublished Masters Thesis, Swedish University of Agricultural Sciences.

O'Keefe, P., Raskin, P. & Steve, B. (1984). *Energy and development in Kenya: Opportunities and constraints*. Beijer Institute and the Scandinavian Institute of African Studies, Stockholm and Uppsala.

Ogwuche, J. & Asobo, V. (2013). Assessment of socio-economic factors affecting household charcoal use in Makurdi urban area of Benue State, Nigeria. *Journal of Environmental Research and Management*, 3(7):0180-0188.

O'Keefe, P. (1989). Wood Energy in Eastern and Southern Africa. *Annu. Rev. Energy*. 14:445-448.

Osiolo, H. (2009). *Enhancing household fuel choice and substitution in Kenya*. DP No. 102.

PFE. IIRR. & DF. (2010). *Pastoralism and Land: Land Tenure, Administration and Use in Pastoral Areas of Ethiopia*. Retrieved 24 August 2012, from http://www.pfe-ethiopia.org/pub_files/pastoralism%20&%20Land%20full%20Book.pdf.

Raman, P., Murali, J., Sakthivadivel, D. & Vigneswaran, S. (2013). Evaluation of domestic cookstove technologies implemented across the world to identify possible options for clean and efficient cooking solutions. *Journal of Energy and Chemical Engineering*, 1(1):15-26. Retrieved 29 August 2014, from www.bowenpublishing.com/DownLoadPaper.aspx?PaperID=14357

RETAP. (2009). *Success factors*. Retrieved 17 February 2013, from http://www.retap-africa.org/index.php/about-us

Rosa, G., Majorin, F., Boisson, S., Barstow, C., Johnson, M., Kirby, M., Ngabo, F., Thomas, E. & Clasen ,T. (2014). Assessing the impact of water filters and improved cook stoves on drinking water quality and household air pollution: A randomized controlled trial in Rwanda. *PLoS One*, 9(3). Retrieved 17 February 2015, from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3948730/

Saundry, P. (2008). Energy profile of Uganda. *Research Journal of Applied Sciences,* 3(4):264-275. Retrieved 17 February 2015, from www.eoearth.org/view/article/51cbedb77896bb431f693654/

Sikei, G., Mburu, J. & Lagat, J. (2009). *Rural households' response to fuelwood scarcity around Kakamega forest, Western Kenya.* Retrieved 23 October 2012, from http://www.esee2009.si/papers/Sikei-Rural_households-response.pdf

Singh, M. & Singh, P. (2014). A review of wind energy scenario in India. *International Research Journal of Environmental Science,* 3(4):87-92. Retrieved 23 January 2015, from ISCA database

Vahlne, N. & Ahlgren, O. (2014). Policy implications for improved cook stove programs—a case study of the importance of village fuel use variations. *Energy Policy*, 66(2014):484–495. Retrieved 23 January 2015, from http://www.sciencedirect.com/science/article/pii/S030142151301149X

Van 't Veld, K., Narain, U., Gupta, S., Chopra, N. & Singh, S. (2006). *India's firewood crisis re-examined*. Washington: RFF.

Waiganjo, C. & Ngugi, E. (2001). *The effects of existing land tenure systems on land use in Kenya today*. International Conference on Spatial Information for Sustainable Development Nairobi, Kenya. 2–5 October 2001.

Walubengo, D. (2002). *Biomass use in Kenya policy considerations. Ppt.* Retrieved 29 December 2012, from http://www.google.co.ke/url?sa=t&rct=j&q=biomass%20use%20in%20kenyapolicy%20considerations%20dr.%20dominic%20walubengo&source=web&cd=1&cad=rja&ved=0CDcQFjAA&url=http%3A%2F%2Fstoves.bioenergylists.org%2Fstovesdoc%2FKenya%2FBiomass_use_Kenya.ppt&ei=UaveUNe-D5CRhQe8gYHACw&usg=AFQjCNF1BAILcU8KId0493jOssONMG5vMQ&bvm=bv.1355534169,d.ZG4.

World Agroforestry Centre. (2014). *Sustainable firewood access and utilization; Achieving cross-sectoral integration in Kenya*. Technical brief. Retrieved 24 December 2014, from www.worldagroforestry.org

World Energy Outlook. (2006). *Energy for cooking in developing countries*. Retrieved on 9 December 2012, from http://www.iea.org/publications/freepublications/publication/cooking.pdf.

Zulu, L. & Richardson, R. (2012). Charcoal, livelihoods, and poverty reduction: Evidence from Sub-Saharan Africa. *Energy for Sustainable Development*, 30:1-11. Retrieved 9 December 2012, from ELSEVIER database

APPENDICES

Appendix I: Sample Size Determination

Sample Size for ±3%, ±5%, ±7%, and ±10% Precision Levels where Confidence Level is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	A	222	145	83
600	A	240	152	86
700	A	255	158	88
800	A	267	163	89
900	A	277	166	90
1,000	A	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

Source: Israel (2012).

Appendix II: Household Questionnaire

Dear Respondents,

I'm a student at The University of Eldoret undertaking Master of Science degree in Bio-energy and Environment. As part of my course requirements, am undertaking a study on "*Accessibility of Wood Fuel in Trans-Nzoia and West-Pokot Counties*". Am administering questionnaires to the local people of Trans-Nzoia and West-Pokot Counties. Please assist by taking your time to fill the questionnaire as truthful as possible.

SECTION A: PERSONAL DETAILS (*Tick where applicable*).

1. Residence County () West-Pokot () Trans-Nzoia

2. Area of residence () Rural area () Urban area

3. Gender ( ) Male ( ) Female

SECTION B: WOOD FUEL PRODUCTS AND ACCESSIBILITY MEASURES

4. **What is the household's head main economic activity**?

() crop farming () pastoralist () Trade

() Employed formerly () employed informally () others (specify.....)

5. What is the household's head monthly income? ..... **(Kshs)**

6. What type of wood fuel you used () charcoal () Firewood () both

7. **How do you obtain your wood fuel** () collect by yourself () Purchase () both

8. If you use firewood, and you collect by yourself, fill the table below, if not leave it blank

Parameter	Measure	M.c	Dry Mass	Measure per unit kg	Level of accessibility
a).Collection trips per month					

b) No of head-loads per trip					
c) No of head loads per trip based on the market size					
d) Average mass of market size head-load (kg)					
e) Average mass of firewood collected per trip (c*d)kg					
f) Average Cost per market head-load (Kshs) based on the market value					
g) Average cost of firewood consumed by the family per month (c*f) Kshs					
Average Distance travelled to collect one head-load (km)					
Average Time taken to collect one head-load (hrs)					
Budgetary Allocation (g/monthly income)100					

9. if you use charcoal or you purchase firewood, please fill in the table below

Charcoal	Measure	M.c	Dry Mass	Measure per unit kg	Level of accessibility
a) No of charcoal Sacks per month					
b) Average mass per sack of charcoal (kg)					
c) Total mass of charcoal consumed per month (a*b) kg					
d) Average Cost per sack of charcoal (Kshs)					
e) Average total costs of charcoal consumed per household (a*d) Kshs					
Budgetary allocation (e/monthly income)					
Firewood					

a) Number of firewood stacks consumed per month					
b) Average mass per stack (kg)					
c) Total mass of firewood consumed per month (a*b)kg					
d) Average cost per stack of firewood (Kshs)					
e)Average total cost of firewood consumed per month (a*d)Kshs					
Budgetary Allocation (e/monthly income)					

10. Apart from charcoal and firewood, what are other forms of energy you use?

.....

.....

SECTION C: FACTORS AFFECTING WOOD FUEL ACCESSIBILITY

11. What land tenure system do you practice?

() Customary land tenure () Freehold tenure () Leasehold tenure

() Public tenure () Squatter

12. Are you restricted from planting trees for firewood in your piece of land?

()yes () No

13. Are you restricted from collecting firewood from the piece of land?

() yes () No

14. Are you restricted from planting trees for charcoal production? () Yes () No

15. Are you restricted from cutting trees for charcoal production? () yes () No

16. What is the size of your family? .....

17. Amongst the following biomass cookstoves, which one do you use for cooking frequently?

() three stone stove () improved fuelwood jiko () metallic jiko no modifications

() metallic with shape modifications () highly improved like KCJ

18. Why do you like using the selected cookstove in question 17

.....

.....

19.Are you aware of rules and regulations governing production, transportation and utilization of charcoal and firewood? () Yes () No

20.If the answer in 18 is yes, then are you restricted from planting trees in your piece of land by any regulation or laws? () yes () No

21. Are you restricted from collecting firewood by any regulations or laws?

() yes () No

22. Are you restricted from transporting firewood? () yes () No

23. Are you restricted from producing charcoal? **()** yes () No

24. Are you restricted from Transporting charcoal? **()** yes () No

Thank you for taking your time, may God bless you.

Appendix III: Small-Scale Enterprises' Questionnaire

Dear Respondents,

I'm a student at the University of Eldoret undertaking a Master of Science degree in Bio-energy and Environment. As part of my course requirements, I am required to undertake a research thesis in a relevant field. I am carrying out a study on "*Accessibility of Wood Fuel in Trans-Nzoia and West-Pokot Counties*". Am administering questionnaires to small-scale industries in Trans-Nzoia and West-Pokot Counties. Please assist by taking your time and fill the questionnaire as truthful as possible.

SECTION A: INDUSTRY PROFILE (*Tick where applicable*).

1). Industry County () West-Pokot () Trans-Nzoia

2). Industry classification ( ) Brick making () small scale hotel

SECTION B: WOOD FUEL PRODUCTS AND ACCESSIBILITY

3).What are your kitchen costs per day, or costs per batch? ..... (kg)

4). What type of fuel do you use? () Charcoal () Firewood

5). If the answer in question 4 is firewood, then fill in the table below, and if both, provide information for firewood, if you use charcoal, leave it blank

No of firewood stacks consumed per day/batch	Measure	M.c	Dry Mass	Measure per unit kg	Level of accessibility
Average mass per stack (kg)					
Average total mass of firewood per day/batch (kg)					
Average cost of firewood per stack (Kshs)					
Total cost of firewood per day/batch (Kshs)					
Average Distance travelled collect enough firewood for a day/batch (km)					

Average Time taken to collect enough firewood for a day/batch (hrs)					
Budgetary allocation					

6). If the answer in question 4 is charcoal or both, fill in the table below with charcoal information.

Parameter	Measure	M.c	Dry Mass	Measure per unit kg	Level of accessibility
No of sacks of charcoal per day/batch					
Average mass per sack (kg)					
Average mass of charcoal consumed per day/batch (kg)					
Cost of charcoal per sack (Kshs)					
Average cost of charcoal consumed per day/batch (Kshs)					
Budgetary allocation					

7). Apart from charcoal and firewood, what are other forms of energy you use?

.....

.....

SECTION C: FACTORS AFFECTING WOOD FUEL ACCESSIBILITY

8). Do you collect charcoal or firewood () yourself () Buy () Both

9). if you collect charcoal or firewood by yourself, then what is the type of land tenure system practiced by the community at the source of your biomass energy products? () Customary land tenure () Freehold tenure

() Leasehold tenure () Public tenure () Squatter

10). What is the average number of customers/day, or number of bricks per batch? ..... (Customers/bricks)

11). If the enterprise is a kiosk, then amongst the following biomass cookstoves, which one do you use for cooking frequently?

() three stone stove () metallic jiko () improved fuelwood jiko

() improved charcoal stove

12). If the enterprise is brick making, then which brick making technology is used? () Traditional Kiln Technologies () Improved Brick Kiln Technology

13). Why do you like using the selected technology in 9 or 10?

.....

.....

14). **Are you aware of any rules and regulations governing production Transportation and utilization of charcoal and firewood?** () Yes () No

15). If you collect firewood by yourself, and your answer in 12 is yes, then are you restricted from collecting firewood? () yes () No

16). If you collect firewood by yourself, and your answer in 12 is yes, then are you restricted from transporting firewood by any regulations or laws? () yes () No

17). If you produce charcoal by yourself, and your answer in 12 is yes, then are you restricted from producing charcoal by any regulations or laws? () yes () No

18). If you produce and transport charcoal by yourself, and your answer in 12 is yes, then are you restricted from transporting charcoal by any regulations or laws? () yes () No

Thank you for taking your time, may God bless you.

Appendix IV: Interview Guide

This interview guide is being used to collect information concerning woodfuel accessibility in Trans-Nzoia and West-Pokot Counties. It will be used in establishing woodfuel accessibility levels and factors affecting accessibility. The information obtained in this interview will add value and clarifying information obtained through questionnaires in the same study areas. The collected information in this interview will only be used for academic purposes and will be treated with high confidentiality levels.

1). What is your Name (Optional)
2). What is the name of the organization you work for?
3). What is your position in the organization?
4). How long have you worked in this position?
5). What are the average costs of:

Firewood

Charcoal

6). For households using firewood, what is the total distance travelled to collect at least a head load of firewood firewood?
7). For households using firewood, what is the total time taken to collect at least a head load of firewood?
8). Please explain why people travel such a distance and spent such time to collect a head load of firewood?
9). What distance does firewood supplies especially in urban
10). Assuming that households use only firewood, what is the average percentage of main household's income is spent on firewood in rural areas?
11). Assuming that households use only firewood, what is the average percentage of main household's income is spent on firewood in urban areas?
12). Assuming that households use only firewood, what is the average percentage of main household's income is spent on firewood in rural areas?
13). Give reasons for explaining why families spent such a percentage on firewood?
14). Assuming that households use only charcoal, what is the average percentage of main household's income is spent on charcoal in urban areas per month?
15). Assuming that households use only charcoal, what is the average percentage of main household's income is spent on charcoal in rural areas per month?
16). Give reasons why families spent such a percentage on charcoal?
17). For SME hotels, what is the average percentage of charcoal costs on total enterprises' daily Kitchen costs?

18). Give reasons why charcoal holds such a percentage on kitchen costs?

Appendix V: Chi-square Test of Association (Firewood Accessibility)

Factors	Pearson Chi-Square	Exact Sig. (2-sided)	Pearson Chi-Square	Exact Sig. (2-sided)
	Kolongolo		Kitale	
Distance and land tenure	2.643[a]	.453	1.333[a]	1.000
Distance and regulations	.317[a]	.980	2.880[a]	.467
Distance and cookstove technology	9.007[a]	.125	5.317[a]	.563
Distance and family size	9.083[a]	.489	9.400[a]	.176
Time and land tenure	2.698[a]	.475	2.286[a]	.456
Time and regulations	1.755[a]	.650	.629[a]	1.000
Time and cookstove technology	7.187[a]	.292	.865[a]	1.000
Time and family size	9.471[a]	.216	12.286[a]	.052
Monthly expenditure and land tenure	16.113	.002	13.572	.053
Monthly expenditure and regulations	.947	.828	1.965	.737
Monthly expenditure and cookstove technology	5.791	.395	8.127	.536
Monthly expenditure and family size	24.309	<.001	8.224	.270
Budgetary allocation and land tenure	8.533	.034	3.308	.619
Budgetary allocation and regulations	4.398	.245	33.443	.344
Budgetary allocation and cookstove technology	7.229	.317	3.071	.988
Budgetary allocation and family size	18.003	.035	6.657	.359
	Kacheliba		Makutano	
Distance and Land tenure	4.086[a]	.700	1.041[a]	.820
Distance and regulations	2.660[a]	.479	1.053[a]	.818
Distance and cookstove technology	2.222[a]	.540	3.685[a]	.126
Distance and family size	1.261[a]	1.000	2.980[a]	.849
Time and Land tenure	5.393[a]	.476	3.968[a]	.274
Time and regulations	1.343[a]	.750	1.989[a]	.783
Time and cookstove technology	2.286[a]	.543	1.007[a]	.837
Time and family size	6.079[a]	.751	2.636[a]	.837
Monthly expenditure and land tenure	41.017	.001	3.085	.395
Monthly expenditure and regulations	1.457	.722	3.452	.325
Monthly expenditure and cookstove technology	5.544	.126	8.602	.547
Monthly expenditure and family size	17.717	.037	10.111	.101
Budgetary allocation and land tenure	6.766	.330	2.238	.556
Budgetary allocation and regulations	.545	.936	1.782	.687
Budgetary allocation and cookstove technology	9.406	.023	9.155	.467
Budgetary allocation and family size	9.171	.411	4.386	.662

Appendix VI: Chi-square Test of Association (Charcoal Accessibility)

Factors	Pearson Chi-Square	N	df	Exact Sig. (2-sided)
Kolongolo				
Monthly expenditure and Land tenure	7.117[a]	24	3	.067
Monthly expenditure and regulations	3.709[a]	24	3	.308
Monthly expenditure and cookstove technology	6.900[a]	23	3	.370
Monthly expenditure and family size	13.350[a]	24	6	.029
Cost/kg and Land tenure	4.200[a]	24	3	.051
Cost/kg and regulations	.273[a]	24	1	.565
Cost/kg and cookstove technology	8.144[a]	23	2	.092
Cost/kg and family size	6.825[a]	24	2	.078
Budgetary allocation and Land tenure	3.535[a]	24	3	.383
Budgetary allocation and regulations	.878[a]	24	2	1.000
Budgetary allocation cookstove technology	3.720[a]	23	3	.717
Budgetary allocation family size	5.730[a]	24	6	.541
Kitale				
Monthly expenditure and Land tenure	17.578[a]	86	3	.007
Monthly expenditure and regulations	.257[a]	86	3	.984
Monthly expenditure and cookstove technology	1.837[a]	86	3	.648
Monthly expenditure and family size	44.752[a]	86	6	<.001
Cost/kg and Land tenure	2.858[a]	86	4	.499
Cost/kg and regulations	2.975[a]	86	2	.283
Cost/kg and cookstove technology	4.012[a]	86	2	.206
Cost/kg and family size	3.500[a]	86	4	.354
Budgetary allocation and land tenure	1.494E2[a]	86	3	.390
Budgetary allocation and regulations	75.580[a]	86	2	.350
Budgetary allocation cookstove technology	73.018[a]	86	3	.623
Budgetary allocation family size	1.574E2[a]	85	6	.161
Kacheliba				
Monthly expenditure and Land tenure	3.500[a]	7	3	.657
Monthly expenditure and regulations	2.917[a]	7	2	.429
Monthly expenditure and cookstove technology	4.167[a]	6	3	.800
Monthly expenditure and family size	8.250[a]	6	3	.133
Cost/kg and Land tenure	a. No statistics are computed because Accessibility level based on cost per Kg of charcoal is a constant.			
Cost/kg and regulations				
Cost/kg and cookstove technology				
Cost/kg and family size				
Budgetary allocation and land tenure	3.208[a]	7	3	.886
Budgetary allocation and regulations	1.896[a]	7	2	.657
Budgetary allocation and cookstove technology	4.667[a]	7	3	.600
Budgetary allocation and family size	3.000[a]	6	4	1.000
Makutano				
Monthly expenditure and Land tenure	11.298[a]	73	3	.009
Monthly expenditure and regulations	2.690[a]	73	2	.481
Monthly expenditure and cookstove technology	1.082[a]	7		.809
Monthly expenditure and family size	35.584[a]	73	6	<.001
Cost/kg and Land tenure	.097[a]	73	2	1.000
Cost/kg and regulations	1.746[a]	73	2	.455
Cost/kg and cookstove technology	1.413[a]	73	2	.545
Cost/kg and family size	1.023[a]	73	3	.902
Budgetary allocation and land tenure	3.875[a]	73	3	.267
Budgetary allocation and regulations	.901[a]	73	3.804	.804
Budgetary allocation cookstove technology	1.507[a]	73	3	.667
Budgetary allocation family size	4.56[a]	73	6	.498