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Analysis of Household Use of Traditional Fuels and Possible Contribution to Deforestation in Kisii County, Kenya

Ondiek Renish Awuor[1], Olorunnisola Abel Olajide[2], Basweti Evans[3]

[1]Department of Environmental Management, Pan African University, Life and Earth Sciences Institute, University of Ibadan, Ibadan, Nigeria
[2]Department of Wood Products Engineering, University of Ibadan, Ibadan, Nigeria
[3]School of Agriculture and Natural Resource Management, Kisii University, Kisii, Kenya
Email: renishawuor1@gmail.com, abelolorunnisola@yahoo.com, eabasweti@gmail.com

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Abstract

A large majority of Kenyans still rely on traditional fuels to meet their domestic cooking needs. The demand for traditional biomass is therefore likely to increase in the coming decades as long as they remain the most readily available and affordable in comparison to modern energy options. This research sought to analyze the household use of traditional fuels and its possible contribution to deforestation in Kisii County. The willingness of respondents to adopt alternative biofuels and energy efficient stoves and barriers encountered were also assessed. Two structured questionnaires that contained both open and close-ended questions were administered to 436 households and 40 wood fuel sellers respectively. Analysis of variance and regression analysis were used to analyze the alternative hypotheses of the study. It was established that the use of charcoal was the most prevalent compared to other fuels. Household consumption of traditional fuels contributed to an estimated loss of 39 ha of forest cover per annum. However, since 89.7% of the wood fuel used was sourced from other counties, the loss of biomass did not occur in Kisii County. Given a chance, about 63% of the respondents were willing to adopt alternative biofuels and energy efficient stoves. However, the greatest barrier to the adoption of these alternatives was the high cost of purchase. Other barriers identified included lack of government support and unwillingness to let go of traditional cooking practices. It was recommended that the Kenyan government and other stakeholders should promote local technologies for producing energy efficient stoves to make them more affordable to the populace.

Keywords

Traditional Fuels, Energy Efficient Stoves, Alternative Biofuels, Biomass Loss

1. Introduction

Energy use at the residential level accounts for the largest proportion by percentage of the total energy used in the world. According to [1], households consume 40% of the primary energy in the world hence they contribute about one third of the emissions of greenhouse gases. Residential cooking constitutes the largest end use of energy [2]. Some of the widely used energy products by households include Liquefied petroleum gas (LPG), electricity, charcoal, firewood and kerosene [3]. In sub-Saharan Africa, about 700 million people are dependent on the use of solid fuel for cooking. Despite the availability of LPG, its use is limited in many countries [4] due to the cost and accessibility. This means that a large proportion of the population is at the risk of diseases and premature deaths caused by use of dirty fuels. Middle income countries are often the most affected [5] because the non-electric fuel sources are predominantly used for cooking and heating [6]. Therefore, the demand for and use of traditional biomass in sub-Saharan Africa is projected to increase in the coming decades as long they remain most readily available and affordable in comparison to kerosene, liquid petroleum gas (LPG), and electricity [7]. However, the rate of extraction of traditional biomass is unsustainably high [8] contributing to climate change and posing a threat as extensive losses lead to rapid environmental degradation [9] [10]. Environmental degradation such as forest loss threatens the survival of many species and reduces the ability of forests to provide vital services [11] besides causing devastating ecological effects in the tropical regions because charcoal production for instance, targets specific preferred species found in natural forests and woodlands [12]. Wood fuel accounts for more than 80% of the primary energy supply in Sub-Saharan Africa [13] [14] thus improving access to affordable and reliable energy is essential to reducing adverse environmental and health effects [15]. Planning for energy and other infrastructural needs has proved difficult due to population growth and uncontrolled rural-urban migration. Besides, lack of reliable information on the consumption patterns at household level is one of the barriers to improving the efficiency and sustainability of household energy [11] because for instance, a very small fraction of charcoal produced and consumed is assessed and recorded [16]. By extension, the question of what specific driver (*i.e.*, logging for charcoal production, expansion for agriculture) can be attributable to what fraction of deforestation cannot be answered for many developing countries [17]. This means that there is still need of more research in this area. As at Kenya's independence in 1963, the forest cover stood at approximately 11%. The country however has, since then been losing about 12,000 hectares of forest a year to deforestation [18]. The recommended forest cover for Kenya is 10%. However, currently, Kenya's forest cover stands at about 6 percent with charcoal production being one of the contributors to deforestation. Consumption of clean energy sources in Kenya still remains relatively low at the household level [19] as projections indicate that in the next 20 years, use of domestic fuel wood will remain relatively stable while the demand for charcoal will increase [20]. Charcoal is the principal fuel in Kenya providing energy for 82% of urban and 34% of rural households [21]. A study conducted by [22] shows that about 20% of energy is lost as a result of lack of adoption of improved biomass cook stoves (both wood-based and charcoal-based). Therefore, focus should be shifted to the propagation of energy saving stoves and kilns, and more research on the willingness to adopt alternative biofuels or barriers encountered [23]. Thus, the aim of this study was to analyze household use of traditional fuels in Kisii Town, Kenya, and their possible contribution to deforestation in Kisii County. The study further sought to specifically quantify household use of traditional fuels in Kisii Municipality, determine the extent of biomass loss annually, assess willingness of respondents to adopt alternative biofuels and energy efficient stoves and the barriers encountered and finally to determine the relationship between adoption of energy efficient stoves and income. The study was conducted in Kisii Town which is the capital city of Kisii County one of the 47 Counties in the Republic of Kenya.

2. Methodology and Data

2.1. Study Area

The study was conducted in Kisii town, the capital city of Kisii County which is one of the 47 Counties in the Republic of Kenya (shown in **Figure 1**). It shares common borders with Nyamira County to the North East, Narok County to the South and Homabay and Migori Counties to the west. The County lies between latitude 0˚40'38.4" South, and longitude 34˚34'61" East and covers an area of 1317.5 km^2. The county exhibits a highland equatorial climate resulting in to a bimodal rainfall pattern with average annual rainfall of 1500 mm. The long rains are between March and June while the short rains are received from September to November. Maximum temperature ranges between 21˚C and 30˚C while the minimum temperature range between 15˚C and 20˚C [24].

Kisii town is located 120 km South of Kisumu city and about 400 km West of Nairobi and covers an area of 35 km^2 out of which 15 km^2 falls within the central business district which is leasehold, while the rest consists of peri-urban settlements in freehold areas. It has an average population of 200,000 [25]. The town is located on a confluence of numerous valleys surrounded by gentle to steep hills. In the South West lies Nyanchwa Hills at an altitude of 1800 metres above sea level and to the North East are the Mwamosioma Hills rising to about 1800 metres above sea level. To the South is the mountainous Bobaracho and Gesarara rising up to 1950 metres above sea level. It is also drained by several streams which are tributaries of River Riana [24].

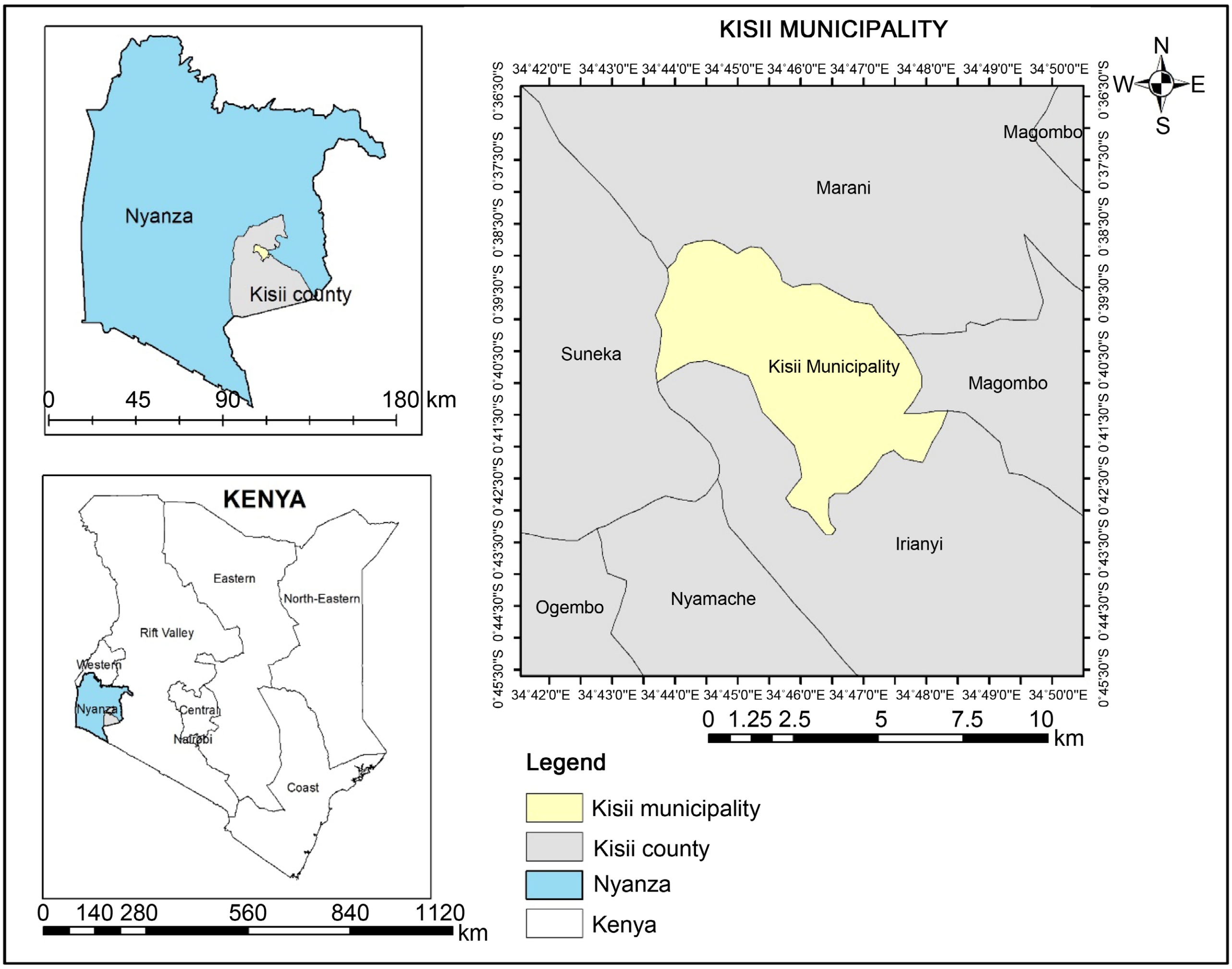

Figure 1. Study area. Source: Author.

2.2. Data Collection

The study utilized both primary and secondary data. For primary data collection, two structured questionnaires containing both open ended and closed ended questions were developed and administered. The first questionnaire was administered on 436 households with valid responses received from 400 which accounts for 92% of the sample. The second questionnaire was administered on 40 wood fuel sellers with valid responses received from 95% of them. The questionnaire administered to households was structured into three parts. The first part comprised of the demographic information of the respondents such as age, sex, income, family size and educational level. The second section of the questionnaire gathered information on energy use profile. That is, types of fuel used by respondents and their costs per week, number of times they cook in a day, and whether or not their kitchen is ventilated. Finally, the third part of the questionnaire sought information on use of alternative biofuels and energy efficient stoves. The second questionnaire administered on wood fuel sellers (those selling charcoal and firewood) was divided into two parts. The first part requested for personal information of the respondents while the second part elicited information on the amount of wood fuel, source and quantity sold per week and lastly an inquiry on the quantity of charcoal that can be harvested from one fully grown tree.

The total population of Kisii Town in 2019 was 200,000 with averagely 4.1 people per household [26]. With this information, the Slovin's formula was employed in calculating sample size for the household survey as follows:

$$\text{Number of households} = \frac{\text{Total population of the Town}}{\text{Average number of households}}$$

$$\text{Number of households} = \frac{200000}{4.1}.$$

Number of households = 48,780.

The Slovin's formula for calculating the sample size is:

$$n = \frac{N}{1 + \left(N \times e^2\right)}$$

where

n = the desired sample population.

N = is the total population of interest.

e = is the error margin at 95% confidence level.

$$n = \frac{48780}{1 + \left(48780 \times 0.05^2\right)} = 396.746$$

Giving a non-response margin of 10%;

$$N_0 = n + 10\%n = 396.746 + \frac{10}{100} \times 396.746 = 436.4186 \approx 436$$

Therefore, the sample used = 436 households.

A systematic random sampling technique was applied in which the first household was randomly chosen and subsequent households chosen at intervals of three. The sampling interval was calculated by dividing the total number of basic sampling units (BSU) in the population by the number of sampling units needed for the sample. Priority was given to females because they are the ones majorly responsible for cooking in each household. For secondary data collection, relevant literature was reviewed including published and unpublished books, magazines, journals and reports relevant to this study. Government publications, thesis and internet were the other sources of secondary data.

2.3. Methods of Analysis and Presentation

Data analysis and presentation were done using SPSS and MS-Excel statistical tools. Frequency tables, graphs and charts have then been used to present the thus summarized data. Inferential statistics was applied to make inferences from the data collected using the Statistical Package for Social Scientists (SPSS). The study had three hypotheses. Analysis of variance (ANOVA) test was used to test the first hypothesis that, there was no statistically significant difference in extent of deforestation/biomass loss attributable to household consumption of traditional fuels. The second hypothesis that there was no statistically significant difference in the relationship between adoption of energy efficient stoves and income, was also tested using analysis if variance (ANOVA). Finally, regression analysis was employed to test the third hypothesis that, there was no statistically significant difference in barriers to the adoption of energy efficient stoves and alternative biofuels.

3. Results and Discussion

3.1. Demographics of the Respondents

A majority of the respondents (72%) were females as shown in **Figure 2**. This can be explained by the fact women are more conscious of their new role and the implications for family dynamics [27] and decision-making regarding energy consumption [20]. Challenges were encountered during the survey, as most of the respondents were not willing to disclose their age. Nevertheless, from the responses obtained and presented in **Table 1**, respondents within the age group of 0 - 20 years had the least representation that is 1.0 percent of the sample. From the findings, the majority of those below 20 years or above 60 years could probably be school going children or the elderly hence less represented in the findings.

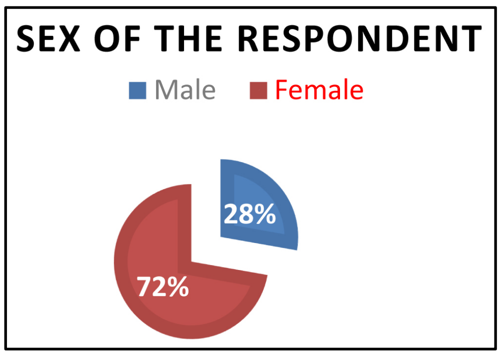

Figure 2. Gender distribution of respondents in Kisii town.

Table 1. Age distribution of respondent.

Age	Frequency	%
0 - 20	4	1.0
20 - 29	97	24.25
30 - 39	127	31.75
40 - 49	96	24.0
50 - 59	58	14.5
Over 60	18	4.5
Total	**400**	**100**

As shown in **Table 2**, most (42.5%) of household heads acquired tertiary education which conforms to previous reports from Kisii County Government of the high literacy levels at 10.45% [25]. Most (51.5%) of households' size had 4 to 6 members (**Table 3**). [25] reported that in kisii town, the mean household size is 4 - 6 people. Most people (44%) had income ranging from Ksh 10,000 to 29,000 (**Table 4**) and 69.3% of interviewees cooked three times per day (**Table 5**). People with lower income tend to spend slightly more time on food preparation [28]. Majority (43%) of the respondents acknowledged trading as their main occupation.

3.2. Types of Fuel Consumed by Respondents

As shown in **Figure 3**, charcoal was used for cooking by a majority of respondents followed by gas, firewood, electricity and kerosene. While about 88% of the respondents used charcoal, gas was used by 79.3%, firewood by 42%, electricity by

Table 2. Education level attained by respondents.

Education Level	Frequency	%
No formal Education	19	4.75
Primary	47	11.75
Secondary	164	41.0
Tertiary	170	42.5
Total	**400**	**100**

Table 3. Size of household of the respondents.

Size of household	Frequency	%
1 - 3	105	26.25
4 - 6	206	51.5
6 - 10	81	20.25
Above 10	8	2.0
Total	**400**	**100**

Table 4. Distribution of respondents by average income.

Average Income	Frequency	%
Below Ksh 10,000	127	31.75
10,000 - 29,999	176	44.0
30,000 - 39,999	53	13.25
40,000 - 49,999	23	5.75
Above 50,000	18	4.5
Missing System	3	0.75
Total	**400**	**100**

Table 5. Number of times respondents cooked in a day.

Number of times respondents cook in a day	Frequency	%
Once	5	1.25
Twice	70	17.5
Three times	277	69.25
More than three times	48	12.0
Total	400	100

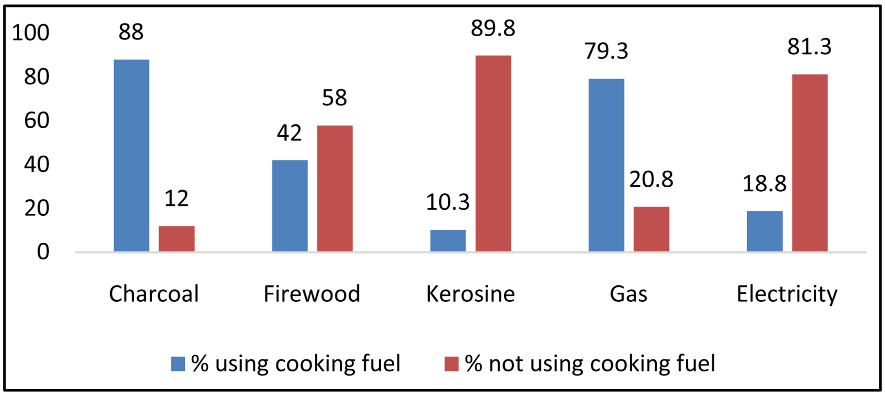

Figure 3. Types of fuel used for cooking by the respondents.

18.8% and kerosene by 10.3%. Thus, use of charcoal was most prevalent compared to other fuels. The use of different sources of fuels by the respondents interviewed was compared on the basis of average income, respondents' occupation and the size of the respondent's household. It was assumed that income level would influence the choice of fuel used. Findings (Table 6) showed that charcoal was the main energy form used by the respondents who earned an average income of between below Ksh 10,000 - Ksh 29,999. This could be interpreted to mean it was the most affordable in terms of cost in relation to their income. Kerosene and electricity were the least energy forms used by the respondents.

It was also observed that charcoal was used widely by respondents whose main occupation was trading (38.8%), followed by Civil servants and farming who accounted for 19.8% and 16.8% respectively (Table 7). Un-expectedly, the artisans constituted only 10.5% of the respondents who used charcoal. It was also assumed that the household size could influence the number of times meals were prepared in a household and ultimately reflected in the choice and amount of energy fuel used. Findings showed that highest amount of fuel consumed cut across all of the respondents. About 43.6% of the respondents whose household size comprised of 4 - 6 members consumed 1 - 5 tins of charcoal per week (Table 8). As earlier mentioned, respondents were asked to supply information on the number of times they prepared meals in a day to establish whether it had an effect in the choice and amount of energy fuel used. As shown in Table 9, most of the respondents cooked three times a day and charcoal was used by 62% of respondents, followed by gas (55%). Electricity and kerosene were the least

Table 6. Distribution of respondents' fuel use by their average income.

Average income In Ksh	Charcoal		Firewood		Kerosene		Gas		Electricity	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
<10,000	29.0	3.0	17.4	14.6	4.8	27.2	19.6	12.3	2.3	29.7
10,000 - 29,999	39.3	5.0	17.6	26.7	4.0	40.3	37.0	7.3	6.5	37.8
30,000 - 39,999	11.3	2.0	3.0	10.3	1.0	12.3	12.6	0.8	4.8	8.6
40,000 - 49,999	4.5	1.3	2.0	3.8	0.3	5.5	5.8	0.0	3.8	2.0
>50,000	3.8	0.8	1.8	2.8	0.3	4.3	4.0	0.5	1.5	3.0

Table 7. Distribution of respondent's fuel use by their occupation type.

Occupation	Charcoal		Firewood		Kerosene		Gas		Electricity	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Farming	16.8	1.8	12.8	5.8	3.5	15.0	11.8	6.8	1.2	17.2
Trading	38.8	6.2	15.2	27.8	3.5	39.5	35.5	7.5	7.8	35.2
Artisan	10.5	1.5	6.2	5.8	1.0	11.0	7.5	4.5	1.0	11.0
Civil/Public Servant	19.8	2.5	6.0	16.2	2.0	20.2	21.0	1.2	8.8	13.5
Others	4.2	0.0	1.8	2.5	0.2	4.0	3.5	0.8	0.0	4.2

Table 8. Distribution of amount of fuel use per week by household size.

Household Size	Charcoal			Firewood			Kerosene		Electricity bill/month		Gas capacity			
	1 - 5 tins	6 - 10 tins	>10 tins	1 - 5 stacks	6 - 10 stacks	>10 stacks	1 - 5 litres	6 - 10 litres	Ksh 1 - 499	Ksh 500 - 1000	3 kg	6 kg	13 kg	Others
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1 - 3	20.8	2.3	0.6	10.7	1.2	0.0	24.4	0.0	15.4	5.1	0.9	21.6	4.7	0.0
4 - 6	43.6	8.3	1.4	47.6	5.4	1.2	51.2	4.9	26.9	20.5	2.5	36.6	14.1	0.0
6 - 10	15.4	4.8	0.9	23.8	6.0	0.6	17.1	0.0	16.7	12.8	0.3	10.0	8.1	0.3
>10	1.4	0.3	0.3	1.2	1.8	0.6	2.4	0.0	1.3	1.3	0.0	0.3	0.6	0.0

forms of energy used and accounting for 11% and 8% of the respondents in the sample study respectively.

3.3. Average Quantities of Charcoal and Firewood Used by Households

Findings showed that the average weekly quantities of charcoal and firewood

Table 9. Distribution of fuel use by the number of times the respondent cooks in a day.

Frequency of cooking/day	Charcoal		Firewood		Kerosene		Gas		Electricity	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	%	%	%	%	%	%	%	%	%	%
Once	1	0.25	0	1.25	0.25	1	1.25	0	0.25	1
Twice	14.3	3.25	6.25	11.25	1.5	16	12.25	5.25	2.75	14.75
3 times	62	7.25	30.5	38.75	8	61.3	55	14.25	11	58.25
>3 times	10.7	1.25	5.25	6.75	0.5	11.5	10.75	1.25	4.75	7.25

used were 3.8 tins and 1.98 stacks respectively. The annual average resulted to 201.76 tins and 102.96 stacks respectively. These findings validate the report by [29] on the total annual charcoal consumption estimated at 1.6 million tonnes, generating an estimated annual market value of over US$ 427 m.

3.4. Sources of Charcoal and Firewood Sold by the Respondent

The respondents who sold wood fuel were asked to supply information about their sources of the wood fuel they sold. The respondents were also asked for information about the locality from where they obtained the wood fuel they sold. This information helped in the determination of whether the deforestation being investigated was within Kisii county or not. As shown in **Table 10**, only 10.3% of the respondents got their fuelwood, that is charcoal and firewood, supply from Kisii County while 89.7% got obtained fuel wood supply from other counties neighboring Kisii. These finding was helpful in attempting to answer the research question on whether deforestation leading to biomass loss could be happening in Kisii County as a result of household consumption of traditional fuels. It is evident that any ongoing deforestation in Kisii County might not be as a result of the prevailing fuelwood consumption as 89.7% of the fuel wood is obtained from other counties.

3.5. Annual Biomass Loss

Previous studies have shown that charcoal and firewood consumption for cooking in urban areas had resulted in concerns over their environmental impact [30]. Annual biomass loss for this study was calculated as follows: According to the data obtained from the fuelwood sellers, the average Number of bags of charcoal that can be harvested from one fully grown tree is 5.65.

- ✓ Average number on bag from one full grown tree = 5.65 Bags.
- ✓ Amount of charcoal in (Tins) used per year for individual household = 201.76 Tins.
- ✓ Number of tins that make one bag is 50.

If 1 full grown tree gives 5.65 bags.

1 Bag = 50 tins what about 201.76 tins.

Table 10. Sources of wood fuel sold by the respondents.

Source of wood fuel	Freq.	%
Government Forests	9	23.1
Farmlands	8	20.5
Community/Private Forests	4	10.3
Other Charcoal/Firewood sellers	18	46.2
Total	**39**	**100.0**

201.76/50 tins = 4.0352 bags of charcoal.

Number of trees cut per year per household therefore is 4.0352/5.65 = 0.7142 which is approximately one tree. Number of trees cut /year/households = 1.

Therefore, multiplying the number of trees cut/year/household with target population gives the estimated biomass loss. The target population, that is, the total number of households in the study area was 48,780. The number of trees in a hectare may vary from 1000 to 3000 [31] and average number of trees can be found by in a hectare is 1250. Thus 39 ha per year was found to be the actual the extent of biomass loss. The average amounts of charcoal and firewood used were calculated and the findings indicated a clearing of 39 hectares was required annually for charcoal production and consumption by the households in the study area. This is in agreement with the results obtained by [30] who reported that for the whole urban population, the forest area needed to meet consumption of charcoal and firewood would be from 34 ha to 274 ha. ANOVA test results established that there was a statistically significant overall difference in mean standardized weekly amount of charcoal and firewood consumed by households that contributed to deforestation/biomass loss $F(14, 4424.191 = 1.848, p < 0.031)$. According to these results, consumption of traditional fuels at household level contributes to deforestation/biomass loss as [32] also stated that firewood and charcoal biomass are among the major causes of deforestation in the Sub-Saharan region of Africa.

3.6. Willingness of Respondents to Use Alternative Biofuels and Energy Efficient Stoves

The study also enquired from the respondents their willingness to adopt alternative biofuels and energy efficient stoves as well as the barriers encountered. A majority (63%) were willing to use alternative biofuels and energy efficient stoves if given an opportunity. The respondents were also asked to give reasons for their willingness to adopt alternative biofuels and energy efficient stoves. As shown in **Figure 4**, the reason given by a majority (52.4%) of the respondents was eco-friendliness, which accounted for previous studies showed that women, that are most of the time in charge of cooking, are very interested in improved cooking stoves [33]. Environmental factor is one of the major factors of biofuel adoption [34] [35]. On the adoption of energy efficient stoves, 24% of the respondents used Jikokoa, 17% used firewood cook stove, while 67.5% used ceramic

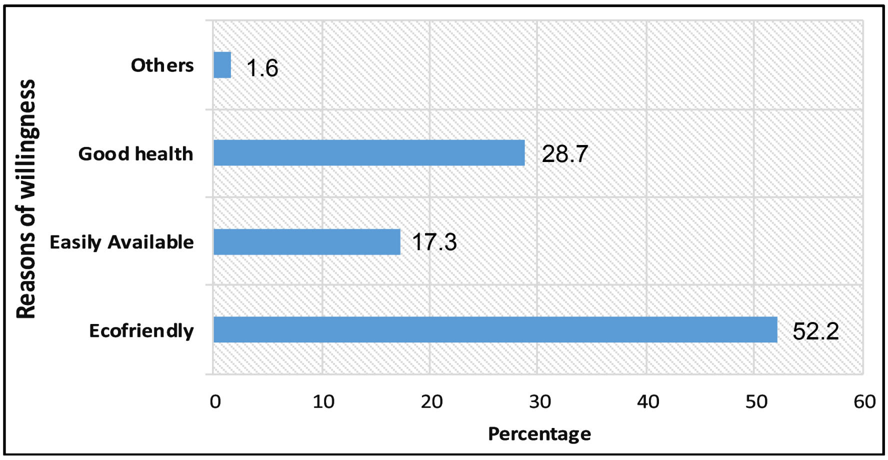

Figure 4. Reasons for willingness to adopt alternative biofuels and energy efficient stoves.

jiko stove. This is due to the affordability of ceramic jiko stove compared to the other energy efficient stoves. The study further investigated if there could be a relationship between adoption of energy efficient stoves and income. The results of ANOVA test show that the F statistic value is 2.732, with a p-value of 0.029 (which is less than the 0.05 alpha level) for Jiko koa. This means there is a statistically significant difference between the means of the different levels of average income of the respondents who either use or do not use Jikokoa. Thus, average income level was significant only in the case of adoption and usage of Jikokoa. This means that there is no statistically significant relationship between adoption of other energy efficient stoves and income. This study also sought to establish the barriers to the adoption of energy saving stoves and alternative biofuels among residents in Kisii Town. As shown in **Table 11**, the relatively high cost of purchase of energy efficient stoves was a major barrier, mentioned by 55% of the respondents, followed by inability to let go of traditional cooking practices mentioned by 35.3%. Indeed, cultural practices may be hard to break and such reluctance could greatly impact adoption of energy efficient stoves despite the benefits they come with. Other barriers mentioned included lack of knowledge on benefits of energy efficient stoves and lack of technical know-how for their production. The major reasons hindering the respondents from adopting alternative biofuels were cost (61%) and low energy content of some alternative biofuels (69.5%). Other barriers mentioned included the lack of technical know-how and, lack of government support. Generally, the cost factor cut across adoption of both alternative biofuels and energy efficient stoves and this may be attributed to the average income of the respondents.

According to [36] educational level of the household head and fuel processing requirement of energy efficient stove were found to be barriers for adoption. [37] also reported that the major barrier for adoption biofuel is affordability or financial capacities and the technology. Regression analysis was performed on the dataset in this study to further investigate whether the barriers specified by the respondents had any significant relation to the adoption of the use of biofuels.

Table 11. Barriers to the adoption of alternative biofuels and energy efficient stoves.

Barriers to adoption of alternative biofuels	Yes		No	
	Freq	%	Freq	%
Expensive	244	61	156	39
Low Energy content	278	69.5	122	30.5
Lack of Technical Know-how	111	27.8	289	72.3
Lack of Government Support	38	9.5	362	90.5
Other Barriers	2	0.5	398	99.5
Barriers to adoption of Energy efficient stoves	**Yes**		**No**	
	Freq	**%**	**Freq**	**%**
High cost of purchase	220	55	180	45
Traditional Cooking Practices	260	65	140	35
Lack of Knowledge	97.2	24.3	302.8	75.7
Other barriers	3	12	397	88

Result obtained indicated a low positive degree of correlation between whether or not respondents used biofuels and the barriers specified by the respondents (R = 0.230). The R^2 (0.053) indicated that 23% of variation in biofuel use could be explained by the barriers specified by the respondents.

4. Conclusions and Policy Implications

4.1. Conclusions

1) The findings of this study confirmed that charcoal was the main form of energy fuel used for cooking in Kisii town and that income level influenced the choice of energy fuel used by the households. It was established that charcoal mainly used by the respondents who earned an average income of between below Ksh 10,000 - Ksh 29,999 was the most affordable source of energy, while kerosene and electricity were the least affordable energy products for the respondents. The causality between level of income and energy consumption has been studied by many other scholars. [38] and [39] proved that the relationship between energy and income is not a neutral one, hence, energy consumption is influenced by the income variation.

2) Based on the sources of wood fuel sold by the respondents and the quantities of charcoal and firewood used, the extent of biomass loss was estimated at about 48,780 trees per year representing about 39 ha of forest land. However, it was established that only 10.3% of the respondents got their fuelwood from Kisii County while a whopping 89.7% got their fuel wood from other counties neighboring Kisii. Thus the attendant deforestation/biomass loss takes place outside Kisii County.

3) Majority of the respondents were willing to adopt the use alternative biofuels and energy efficient stoves largely due to their perceived eco-friendliness,

availability and promotion of good health of users. However, affordability predicated on the cost factor is a major barrier to their adoption. It was thus established that households within Kisii town have knowledge of the various forms of alternative biofuels and energy efficient stoves even though the rate of adoption is still relatively low due largely to non-affordability.

4) Policy interventions and government sensitization towards adoption of alternative biofuels and energy efficient stoves in Kisii town are relatively weak and ineffective as most respondents mentioned the lack of government support among the barriers to adoption.

4.2. Recommendations

1) Kenyan Government should provide mass sensitization on the harmful health effects of unclean energy fuels and make plans to ensure these clean energy forms are affordable and available in all rural and urban areas of Kisii town.

2) The government and other stakeholders should promote local technologies for producing energy efficient stoves since they can be more affordable to the locals.

3) Civic education on the benefits of clean energy fuels to the environment and households should be promoted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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