International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Factors Influencing Adoption of Woodfuel Energy Saving Technologies in Nakuru County, Kenya

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Abstract: ***There have been efforts to promote use of woodfuel conservation technologies. These technologies include the improved charcoal stoves, the improved fuelwood stoves and the fireless cookers that can save woodfuel of upto 50%. This study was carried out to determine the social economic factors influencing adoption of these technologies. Income of the household and level of education were positively correlated to acquisition and use of the energy saving technologies. While the numbers of dependants and cost of improved woodfuel energy saving technologies were found as some of the social economic factors influencing adoption of these technologies.***

Keywords: Energy saving technologies, Woodfuel, Adoption, KCJ, improved charcoal stoves

1. Introduction

Over 3 billion people throughout the world rely on traditional fuels, such as wood, charcoal, dung, and agricultural residues, for cooking and heating [1]. The global total production of wood in 2000 reached approximately 3.9 billion cubic meters of which 2.3 billion cubic meters was used as woodfuels. This means that approximately 60 percent of the world's total wood removals from forests and trees outside forests are used for energy purposes [2].

Biomass energy provides 68% of Kenya's national energy requirement and it is expected to remain the source of energy for the foreseeable future. The current biomass demand in Kenya is estimated at 40.5 million tonnes against a sustainable supply of 16 million tonnes[3]. The demand for firewood and charcoal in Kenya has continued to rise as the population continues to grow.
The government has put a lot of restriction on collecting firewood from forests as this has led to severe deforestation in many parts of the nation causing environmental degradation. Dundori forest (in the study area) which is found within Dundori Division used to be the main source of firewood and charcoal for the people in the area while most of the people in Lanet division either depend on woodfuel purchased from traders or buy charcoal from charcoal dealers[4].

Following the 1980 United Nations Conference on New and Renewable Sources of Energy, many organizations began to work individually and collaboratively on improved stove development and dissemination. The organizations involved in the early 1980s included the Ministry of Energy, Ministry of Agriculture, the Appropriate Technology Centre, the Kenya Energy and environmental Organization (KENGO), United Nations Children's Fund, GTZ and many NGOs. Among the more popular stoves introduced were the charcoal burning '*Kenya Ceramic Jiko*' (KCJ), and the wood-burning '*kuni mbili'* and '*maendeleo jiko'* – known also as the *'Upesi'* stove [5].

The improved cookstoves use less woodfuel compared to the traditional three stone cooking stoves. When these stoves are used efficiently they can save 30% of the firewood [6]. The charcoal ceramic stoves (KCJ) are also energy conserving as compared to the metallic charcoal stove since they retain heat within the stove compared to metallic stove in which much heat is lost to the surrounding environment.

The current penetration of improved charcoal stoves in Kenya is estimated at 60% of the rural households and over 80% for the urban UNEP, (2006). The level of penetration of improved efficient woodstoves for the rural households is still below 5%, yet there is enormous potential [7]. The adoption of these technologies has been slow and unevenly extended as there are still many households which are unaware of the technologies. This is despite the fact that the technologies were initiated over 30 years ago. Thus the objective of the Kenya government to reduce demand on woodfuel, conserve the forests and thus mitigate against increase in green house gases (GHG) and reduce indoor air pollution is yet to be achieved.

Adoption and continued (sustained) use of improved biomass stoves in developing countries is therefore an important sustainability strategy which should be adopted by as many households as possible. There was need to research on the factors influencing acquisition and use of the woodfuel saving technologies in order to be able to find out how uptake of these technologies can be harnessed.

2. Literature Survey

2.1Wood fuel situation in Kenya

The current biomass demand in Kenya is estimated at 40.5 million tonnes against a sustainable supply of 16 million tonnes [3]. Biomass energy (mainly firewood and charcoal) constitutes 70 per cent of national energy supply, 90 per cent of which is consumed by households [8].

To date, firewood and charcoal are still the most significant energy resources in Kenya and will be in the foreseeable future. Firewood is mainly a rural fuel with more than 90% of the population using it for cooking and heating. Charcoal is predominantly an urban fuel with 82% of the urban population as users. Due to decreased wood availability, some parts of the country are opting for agricultural residue and animal dung as energy for cooking [3].

Since fuelwood is the major source of energy in rural areas of many developing countries, special efforts have to be made to improve one of the most efficient end-use namely, cooking. One of the ways to do this is by replacing the traditional "three stones" technique for cooking by improved stove [9]. Due to the important role woodfuel energy plays in the day to day life of majority of Kenyans, more research needs to be done in order to plan how this important resource can continue being utilized in a sustainable manner.

2.2 Some Energy conservation technologies applicable to woodfuel

Promotion of fuel wood energy saving methods and alternative energy technologies are usually aimed at reducing the woodfuel demand from forest and other sources. It is also aimed at improving livelihoods and enhancing productivity, because less time will be spent on fuelwood collection, an exercise normally performed by women and children. Woodfuel conservation technologies also aim at improving the indoor air condition by reducing the amount of indoor air pollution.
Two classes of benefits are at the core of most programs involving diffusion of improved stoves; those internal to the household –money and time saved on acquiring fuel, reduced smoke in the home and various conveniences in use and those external to the households principally pressure on forest and energy resources and reduced greenhouse gases. The main direct beneficiaries are women and people in the middle and lower levels of society [10]

There are many woodfuel conservation technologies in the country but the research study concentrates on the adoption of three technologies namely;

2.2.1 Improved Firewood cooking stove (Jiko Kisasa)

This is an improved type of stove which is more efficient in wood use. Firewood saving is mainly due to the fact that the fired clay liner ensures heat is retained in the stove over a long time. The fired ceramic liner provides the thermal insulation to minimize heat loss [11]. The stove can be fixed in the kitchen or can be portable by being enclosed in metal below. According to a research study done in Tanzania, a household using three stones stove consumes around 2880 kg/year of firewood. According to the study, through the use of improved firewood stove consumption is reduced to 1728 kg/year/household, annual saving is around 1152kg/household (equivalent to more than 20 trees/year) [12].

Figure 1: Portable fuelwood cooking stove
Source: [14]

2.2.2 Improved Charcoal wood stove (Kenya Ceramic Jiko)

The Kenyan Ceramic Jiko (KCJ) is a light, portable charcoal burning stove consisting of 2 distinct units - a metal cladding and a ceramic liner. At least 25% of the liner base is perforated with holes of 1.5 cm [15] diameter to form the grate. The standard model weighs about 6.kg.

The KCJ (Figure 2) stove was developed through a design process spearheaded by the Ministry of Energy. The jiko stove easily found acceptance among urban stove producers who were initially offered free training and marketing support by KENGO, working with the ministries of Energy, Agriculture, and Environment and Natural resources. Although most producers and dealers of the jiko stove have been men, many women in small urban areas have benefited immensely from the technology, significantly improving their standards of living through gains in time and income [5].

Figure 2: Kenya Ceramic Stove
Source:[22]

Reductions in fuel use associated with the KCJ and other improved stoves have been examined in a number of countries. In Kenya charcoal use among a sample of families using the KCJ fell from 0.67 to 0.39 kg/charcoal/day. This totals over 600 kg of charcoal/year for an average family, and a savings of over $US 60/year [15]. Other tests done in Kenya indicated an average decline in daily charcoal consumption from 0.7 kilogram to 0.4 kilogram per person with an improved stove, adding up to a total yearly saving of 613 kilograms per family[16].

According to Johnson and others up to the equivalent of 10 tonnes of carbon dioxide may be saved per household per year with an improved stove [17]. This would reduce the green house gases emission to the atmosphere and thus mitigate against global warming and climate change

2.2.3 Fireless cooker (Foodwarmer)

The first fireless cookers or hay stoves were boxes packed and made tight so as to conserve heat by insulation. Heat was put into food, and then it was quickly and closely shut into the insulator and did not lose its heat for many hours. Almost anything that can be boiled or steamed may be cooked in the fireless cooker with a great saving of the cook's time and labor as well as with an economy of fuel. There is a saving of work because the food does not need to be watched — it will neither burn nor boil over. Cooking utensils do not wear out so rapidly when used in a cooker as when used over a fire, and the kitchen is neither hot nor filled with odors. For Kenya, the most commonly used fireless cooker is made of a basket. This is basically an insulated cooking basket which helps to retain heat for a long time and therefore finalizing the cooking process without use of fire.

Figure 3: Fireless cooker (food warmer)

A fireless cooker is an important asset with regard to energy saving. The use of this basket reduces the amount of fire needed for cooking and also reduces the amount of work related to firewood collection.

2.3 Adoption of wood fuel energy conservation Technologies

Charcoal / firewood improved Stove and fireless cooker attributes, according to the theory of perceived attributes by Rogers [18] enable adopters of these innovations to judge and base their perceptions in view of five characteristics of innovation: trialability, observability, relative advantage, complexity, and compatibility. The theory holds that an innovation will experience an increased rate of dispersion if adopters perceive that the innovation:

- can be tried on limited basis before adoption and offers observable results;
- has advantages relative to other innovations and is not overly complex; and is compatible with existing practice and value[18], [19].

According to a research done by Makame poor quality of the improved stoves, costs, information and education about the stoves were found to be the major factors for failure to adopt improved charcoal stoves in urban Zanzibar [19]. The increase in the greenhouse gases due to use of traditional stoves can be curtailed by adoption of the improved stoves. Research on social economic factors influencing acquisition and use of the same technologies in Kenya is scarce and thus the need to concentrate on the same in this study.

3. Research Methodology

3.1. Area of Study

Lanet division is one of the 7 newly created divisions in the new Nakuru municipality District. It has an estimated population of 58,000 and the number of households is 10,119[20]. The division is composed of 2 Locations, Free Area and Lanet. It has six (6) sub-locations as follows; Menengai, Free area, Kiratina, Muguga, Mwariki and Lanet. Dundori division is a newly created division of the new Nakuru North District. It is composed of 2 locations namely Dundori and Lanet-Umoja location. The division has a population of 60,800, while the number of households is 9,482[20]. This is mostly an agricultural area with medium to high potential for agriculture. The division also has a government forest (Dundori forest) that has been a source of woodfuel for the community for a long time.

3.2 Sampling Methods

3.2.1 Population

The Population was taken as the total number of households in the two divisions which was 19,601[20].

3.2.2 Sampling procedure

Purposive, cluster, simple and systematic random sampling were used to select the districts, divisions, sub-locations and the households that were included in the study. The sample size (n) was calculated using the following formular [21]:

$$N = \frac{z^2 (p)(q)}{d^2} \quad (1)$$

Where:

- **Z** refers to the confidence limits of the study results. i.e. 95% confident where , Z=1.96.
- **p** refers to the proportion of the population who had acquired and were using the energy conservation devices. Estimation (0.5)
- **q**= (1-p) refers to the proportion of the population who have not acquired nor using the energy conservation devices. Estimation(0.5)
- **d** refers to the desired precision of the estimate (within a range of plus or minus 5%).

So, using these figures in the equation above, one get:

$$N = \frac{1.962^2 (0.5)(0.5)}{0.05^2}$$

A sample of 384 households (1.96% of the total population) was selected. Fisher formula (1) for selecting a sample of a population above 10,000 was used to get the sample size [22], [23]. A sample of 198 households in Dundori and 186 households from Lanet Division was randomly selected for this study. This was done as a proportion to the households in each Division.

3.3 Primary Data collection

3.3.1 Research tools

The study collected data from heads of the households (Male or Female). Both questionnaire and interview schedule were used to collect data pertaining to woodfuel energy saving technologies utilized in the homestead

3.3.2 Field Observation

Field observation was also done to verify the type of woodfuel devices in use in the households as well as the type of devices being promoted by the NGO and artisans operating in the study area.

3.4 Data analysis

Data were analyzed using the statistical package for social science (SPSS) computer software. Data analysis consisted of both descriptive and analytical components with a variety of statistical tools to describe the study population. SPSS was preferred because it is easy to use and accepts a wide range of data manipulation to give desired values and is also readily available as compared to other statistical packages.

3.4.1 Descriptive Statistics

Descriptive statistics was used to analyze the characteristics of the population studied. Means, Frequency tables, bar-charts and percentages were also used. These were used to describe demographic data such as age, education, employment status, number of dependent etc.

3.4.2 Inferential Statistics

Inferential statistics are used to make inferential statements about a population. It makes use of random sampling techniques to make sure the sample is representative. The Pearson correlation –coefficient was used to measure correlation for independent variables and dependent Variables in the interval or ratio scale, Spearman correlation –co-efficient was used to measure correlation involving ordinal variables while multiple regression analysis was used to determine the social economic factors that influence adoption of woodfuel conservation technologies. Similar method of analysis was used by Faham and others in analyzing factors that influence forest dwellers participation in reforestation and development of forest areas [24].

4. Result and Discussion

4.1 Socio- Economic Factors in relation to adoption of woodfuel energy saving technologies

This study was carried out in Nakuru Districts. Dundori Division represents the rural population, while Lanet Division represents the urban population. Generally the study area is composed of low and middle income earners and a small proportion of high income earners. The rural people were mostly engaged in farming activities while majority of the urban respondents were employed in the urban area or were small scale traders.

One of the objectives of the study was to find out which socio-economic factors influence adoption of woodfuel saving technologies. The independent variables considered were level of education, income of the household, employment status, cost of woodfuel devices, number of dependants, age of the respondent, knowledge about the technology, house ownership and house type as well as gender of the respondent. Both correlation and multiple regression analysis were used to determine the factors.

4.1.1 Gender of the Respondent

A majority of the respondents (73%) were female, while the rest (27%) were male (Table 1). However, the rural population interviewed comprised of 70% female and 30% male; compared to 76% female and 24% male in the urban population. Due to involvement in the domestic chores, women and children are also the most affected by indoor air pollution by use of energy inefficient stoves [7].

Table 1: Gender proportions of the respondents in Dundori and Lanet Divisions

	Division of respondent		
	Dundori	Lanet	
	Sex of the Respondent	Sex of the Respondent	Total
	%	**%**	**%**
Male	29.8	24.2	27
Female	70.2	75.8	73

There was a very weak positive correlation between the gender of the household head and the number of woodfuel saving technologies with Spearman's Rho Correlation value (r_{rho} = 0.046; n=384, p=0.05) (Table 5). Female headed households had acquired more woodfuel energy saving technologies as compared to the male headed households (Table 5).

4.1.2 Age of Respondents

The survey revealed that a majority of the respondents (26%) were aged between 26 to 33 years (Table 2). The overall majority of respondents (70%) fell between 18 to 41 years of age. Rural Dundori accounted for 64%, while the urban Lanet accounts for 75% of respondents in that age bracket. The urban respondents were composed mainly of young people since many of them had migrated to the urban areas in search of income as compared to the rural area where the older generation retire after active live in the urban areas during their younger age.

Table 2: Age categories of the respondents in Dundori and Lanet Divisions

	Age of the respondent		
	Dundori	**Lanet**	
Age (yrs)	%	%	Total %
18-25	17.20%	27.40%	22.3
26-33	26.30%	24.20%	25.3
34-41	20.70%	24.20%	22.5
42-49	9.60%	15.10%	12.4
50-57	5.10%	7.50%	6.3
58-65	9.60%	1.60%	5.6
>66	11.60%		11.6

There was a very weak correlation between the age of the respondents and the number of wood saving technologies a household was able to acquire with a Pearson's Correlation value (r = 0.018, n=384, p=0.05) (Table 5). Younger household heads had acquired more woodfuel saving technologies, unlike older household heads, who had acquired fewer technologies. The youth were more adaptive to new ideas compared to the old. In a study carried out in Kathiani, Kenya, it was found out that the age bracket 26-36 years had adopted more energy saving technologies as compared to those over 45 years. This was attributed to the fact that middle age respondents are in their reproductive and productive years and this age group had adopted energy conservation technologies for effective performance of both reproductive and productive activities [25].

4.1.3 Education status of the respondents

A Majority of the respondents had attained primary (40%) and secondary (39%) levels of education (Table 3). Overall, about 53% of the respondents had acquired at least secondary education. However, in Dundori, only 45% had acquired at least secondary education, compared to about 61% in Lanet. In Dundori, only 6% had college education, while in Lanet 17% and 6% had acquired college and university education respectively. This implies that the educated tend to migrate to the urban areas in search of employment while the less educated stay in the rural areas and get involved in menial jobs.

Table 3: Educational level of the respondents

Level of education of respondent	Dundori	Lanet	Total %
	%	%	%
None	10.10	3.80	7
Primary	45.50	34.90	40
Secondary	38.90	38.20	39
College	5.60	17.20	11
University	-	5.90	3

There was a positive correlation between the level of education of the household head and the number of woodfuel saving technologies acquired (Table 5) with Spearman's Rho Correlation value (r_{rho} = 0.232, n=384, p=0.01). The higher the level of education of the respondents, the more the number of woodfuel saving technologies they purchased/ owned.

Education level of the respondents tends to influence adoption of technologies as learned people usually adapts to new ideas faster than those who have not been to school. According to a research done in 2010, it was found out that people with higher education level have better access to information and knowledge that is beneficial in their domestic activities. They also tend to have higher analytical capability of the information and knowledge necessary to implement new technology and realize the expected result [26]. Hence the higher education level allows households to make efficient adoption decisions [27] and be the early adopters who can take advantage of new technology and profit from it [28]. Cotlear argues that formal, non-formal and informal education may provide specific or general knowledge, which provides the benefit and uses of new technology [29]. The result of this study shows that majority of the potential adopters (53%) had been through secondary schools.

The findings of this study agree with those of Karanja who found out that many of the non-adopters of energy saving technologies were those with no education while majority of the adopters had been either through primary (36%) or secondary school (37%) [25]. In this study about 26% (Table 4) of those without formal education had not adopted any energy saving technology and this means they were using energy inefficient technologies which tend to consume more woodfuel and release more pollutants to indoor air as well as to the atmosphere. The proportion of the respondents with two energy saving technologies seems to increase with increase in the educational level. The ability to make better choices on type of technology to use seems to increase with educational level (Table 4).

Table 4: Number of Technologies acquired against level of Education

Number of technologies acquired	*Primary*	*Secondary*	*University*
	%	%	%
0	11	3.4	-
1	84.5	90.5	81.8
2	3.9	6.1	18.2
3	0.6	-	-

4.1.4 Average Monthly Household Incomes

Majority of the respondents (33%) fall in the income bracket of Kshs. 5,001 and Ksh.10, 000 (Figure 4). Still, 25% earn a monthly income of Kshs. 10,001 to 15,000; while 20% earn less than Ksh. 5,000. Only 3% of the population earns an income above Ksh.100, 000 per month. However, income earnings varied between the urban and the rural households (Figure 4). Majority of the rural respondents earned Ksh. 5,001 – 10,000 (39%) and less than Ksh.5, 000 (35%). A majority of the urban respondents (40%) earned a monthly income of Ksh. 10,001 – 15,000, about 27% earned Ksh. 5,001 – 10,000, and only 3% reported earning over Ksh. 100,000

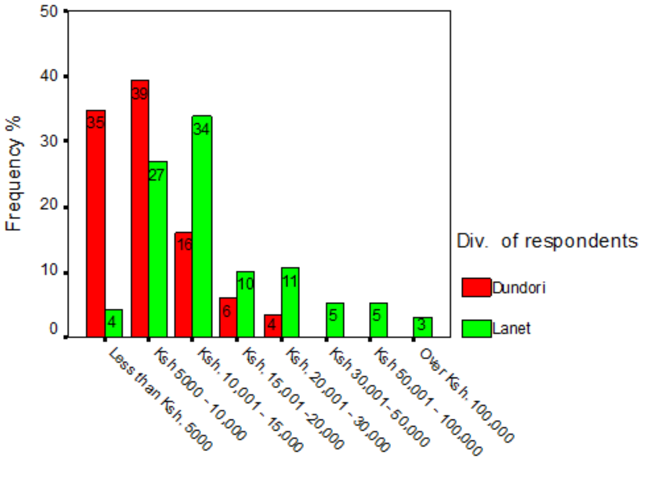

Figure 4: Average Monthly Household Income

There was a positive correlation between the average monthly household income and the number of woodfuel saving technologies with Pearson's Correlation value (r = 0.230, n=384, p=0.01) (Table 5). The higher the level of monthly income of the respondents, the more the likelihood of purchasing woodfuel saving technologies. Household income can be used as a proxy to working capital because it determines the available capital for the investment in the adoption of technologies and it is a means through which the effect of poverty can be assessed. According to the World Bank report, poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income [30]. Household income has a bearing on the socio-economic status of family. The low level of income of the households depending on biomass fuels is a major barrier to increasing the dissemination of improved stoves. For poor households stoves represent a high initial investment cost which prevents them from purchasing the product[31].

Income level plays a role in determining whether one acquires a new technology or not. The lower the level of income the lower the adoption of any technology while the higher the level of income, the higher the level of acquiring and usage of a new technology. This is because most of the new technologies have a cost implication and only those with money are able to adopt the technology faster.

Table 5: Correlation coefficient values of social economic factor compared to the number of woodfuel conservation technologies acquired

	r
Number of devices acquired	1
Gender of the Respondent	-0.046
Level of education of respondent	0.232
Income of the Household	0.23
Number of dependants per household	-0.196
House ownership	-0.042
Type of house	0.156
Cost of Improved firewood stove	-0.284
Cost of Improved charcoal stove	0.296
Cost of fireless cooker	-0.479
Age of the respondent	0.018
Information on Improved firewood Stove	0.022
Information on Improved charcoal Stove	-0.001
Information on fireless cooker	0.183

4.2. Multiple regression analysis of Social economic factors influencing adoption of wood fuel conservation technologies in Nakuru County

A multiple regression model was established that incooperated thirteen identified independent variables to predict the number of energy saving technologies acquired per household. A stepwise method was used in order to include in the model only those variables that explain additional variance. The result of the multiple regression is presented in Table 6. Table 6 indicates that among the independent variables that have significant correlation with the dependent variables are; Cost of improved firewood stove, cost of the improved charcoal stove, cost of the fireless cooker and the number of dependants. The four variables could explain 40% (see Adjusted R Square Value in step 4 of Table 6) of the variation in the adoption of the energy saving technologies.

Table 6: Multiple regression model summary

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.48	0.23	0.23	0.37
2	0.56	0.32	0.31	0.35
3	0.62	0.39	0.38	0.33
4	0.64	0.4	0.4	0.33

1) Predictors: (Constant), Cost of fireless cooker
2) Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove
3) Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove
4) Predictors: (Constant), Cost of fireless cooker, Cost of Improved charcoal stove, Cost of Improved firewood stove, Number of dependants

When analysis of Variance was done, the F statistics was found to be 63.905 with a significance value of less than 0.05. This results indicated that the overall model was statistically significant (F = 63.905 p = 0.000). This means that the independent variables considered play an important role in explaining the variation in the dependent variable (adoption of woodfuel saving technologies). This is also supported by the t-values of all the four independent variables being more than 3.0 where 'Cost of the fireless cooker had t-value of -11.385, Cost of improved firewood stove (t-value -6.6587), cost of improved charcoal stove (t-value 7.161) and the Number of dependants had a t value of -3.365 (Table 7)

Table 7: Multiple Regression Coefficients

	Unstandardized Coefficients	Standardized Coefficients	Sig.
	B	Beta	p
(Constant)	0.917		0
Cost of fireless cooker	0.001	-0.454	0
Cost of Improved charcoal stove	0.001	0.286	0
Cost of Improved firewood stove	0.001	-0.265	0
Number of dependants per household	0.027	-0.135	0
a Dependent Variable: Number of devices acquired			

4.2.1 Number of dependants per household

Most of the respondents had 4 dependants (22%) while other respondents had 5 dependants (20%); 3 dependants (17%) and 6 dependants (14%).

The study found out that the households with many dependants had acquired less energy saving technologies as compared to those with few dependants. About 50% of those with 11-14 dependants and 29% of those with 8-10 dependants had not adopted any form of energy saving technologies as compared to only 8% of those with 5-7 dependants and 5% of those with 0-4 dependants (Fig 5). The finding shows that the opposite happens for those who had adopted one energy saving technology where their proportion increases from those with highest number of dependants (50%) to those with the lowest number of dependants (87%).

Only those with the least number of dependants were able to acquire 2 or more energy saving technologies.

There was a negative correlation between the number of dependants in the household and the number of wood fuel saving technologies acquired with a Pearson's Correlation value (r = -0.196, n=384, p=0.01) (Table 5). The higher the number of dependants per household, the less was the likelihood of affordability by the household of such technologies holding other factors equal. Many dependants meant that more money was required to meet the basic needs thus acquiring of improved cook stoves was secondary.

This findings tally well with those of Karanja who found out that a family size of 1-3 and 4-6 children seemed to have adopted more energy saving technologies as compared to a family size of 7-9 and 10-12. She attributed low adoption of energy saving technologies by large families to strained budget to cater for the large family and thus their preference of the inefficient wasteful mode of cooking (open fire) [26].

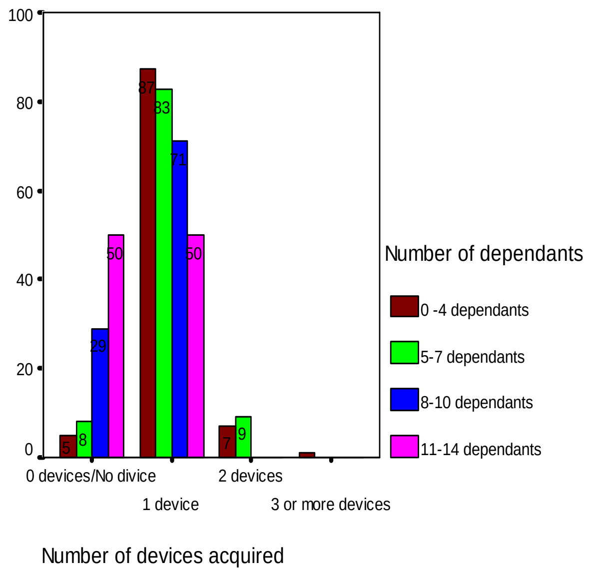

Figure 5: Number of dependants per household against number of technologies adopted.

The regression analysis p-value for the independent variable *dependants per household* against the number of devices acquired was 0.000 and a t-value of - 3.365 (Table 7). This means that number of dependants per household does influence acquisition and use of energy saving technologies. The more the dependants the less the acquisition and use of woodfuel saving technologies. This could also be due to the type of stove in the market such that they are small and medium in size thus unable to carry large pots (sufurias) to cater for a meal of a large family.

4.2.2 Cost of the woodfuel energy conservation technology

There was a moderate negative correlation between the cost of the fuelwood improved stoves and the number of devices a household was able to acquire with Pearson's Correlation value of r = -0.284, n=10, and p=0.05 (Table 5). There was similar findings when one compared the cost of fireless cooker and the number of devices acquired by household with a correlation coefficient of -0.479, an n value 19 and p value being 0.025 (Table 5). The higher the cost of the technology, the less was the likelihood of affordability by households hence not acquired.

There was a significant positive correlation between cost of KCJ and the number of devices acquired (r- 0.296, n-343 and p-value of 0.01) (Table 5). Thus cost of KCJ could be used to predict adoption or acquiring of these technologies due to the fact that the cost of this stove is relatively low ranging between Ksh. 100-300 with the mean price being Ksh. 150. The positive correlation could be attributed to the perception in the market that the improved stoves which are very cheap are of very low quality and thus might not last long. Thus the lower the price for this energy saving technology the less likely to be adopted. The Ksh 300 for a better quality stove is still within the reach of many households in Nakuru. These cookstoves were readily available in most shops both in the urban and the rural areas. Thus it was relatively affordable by both the low income earners as well as the high income earners.

When multiple regression analysis using the stepwise method was done, it was found out that the cost of the three technologies were good predictors for the adoption of these technologies where the cost of improved charcoal stove (t-value 7.161 and sig. p-value-0.000) had a positive influence while the cost of improved fuelwood stove (t-value - -6.658 and sig. p-value-0.000) and the fireless cooker (t-value - -11.385 and sig. p-value-0.000) had a negative influence (see Table 7). Thus the higher the cost of the improved fuelwood stove and fireless cooker, the less likely the household was able to acquire the technologies. The cost of the fireless cooker ranged between Ksh. 950 - 2,200 while the cost of improved fuelwood technologies ranged from Ksh. 400 – 3000. These prices were high, for many households had limited sources of income and would rather use the traditional methods of cooking than adopt new technologies.

From the multiple regression analysis, the independent variables that seemed to be good predictors of adoption of the energy conservation technologies identified were; cost of fireless cooker, cost of the improved charcoal stove (e.g. KCJ and rocket stoves), cost of the improved fuelwood stoves (e.g. *Kuni mbili*, and *maendeleo Jiko*) , and the number of dependants per household. According to Barnes and others , the price of stoves can be a significant barrier to their adoption [32]. Improved woodfuel stoves are typically about twice as expensive as the local traditional stoves while some traditional stoves are free e.g. the three stone. Surveys reveal that in most of Africa, middle-income families have adopted improved stoves far more quickly than poor families [33].

Other social economic factors that had a significant positive correlation were (Table 5) such as level of education (r-value, 0.232, p< 0.01), Income of the household (r-value-0.230, p< 0.01), information on fireless cooker (r-value 0.183, p< 0.01) and the type of house (r-value – 0.156, p< 0.01), but these independent variables overall contribution to the multiple regression model using the stepwise method was not significant.

5. Conclusion and Recommendations

5.1 Conclusion

Some of the factors identified that could influence adoption of woodfuel conservation technologies were income of the household (r – 0.230), level of education of the heads of the household (r-0.230), number of dependants (t-value -3.365), cost of the fuelwood stoves (t value -6.658), cost of the KCJ (t -value 7.161) and the cost fireless cooker (t value -11.385). It was also found out that majority of the respondents in the rural areas (67%) had never heard of a fireless cooker. This could also be a factor that could have hindered its uptake.

5.2 Recommendations and Policy implications

- There is need for aggressive campaign in dissemination of improved stoves (*maendeleo* stoves and *Kuni mbili*) technology in order to reduce pressure on forest and other woodlands surrounding in the region.
- There is need for standardization in the design and making of energy efficient stoves so that quality may not be compromised in expense of quantity in order to make more money. Compromise of quality may make households revert back to metallic stoves which lasts longer but are energy inefficient.
- It is recommended that the government and other donor agencies can look for ways in which production of these technologies can be subsidized.
- There will be need for concerted effort to promote the use of other cleaner forms of energy in the area. This will exceedingly reduce demand on woodfuel as people switch to these alternative forms of renewable technologies and therefore save the forests and woodland, reduce women drudgery, reduce indoor air pollution and eventually improve the local environment.

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