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Full Length Research Paper

Analysis of household energy sources and woodfuel utilisation technologies in Kiambu, Thika and Maragwa districts of Central Kenya

Githiomi J. K.[1]*, Mugendi D. N.[2] and Kung'u J. B.[2]

[1]Forest Products Research Centre, Kenya Research Institute, P.O. Box 64636-00620 Nairobi, Kenya.
[2]Department of Environmental Sciences, Kenyatta University, P.O. Box 43844-00100 Nairobi, Kenya.

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This study was carried out in Kiambu, Thika and Maragwa districts of Central Kenya. Its objective was to analyze household energy sources and utilization technologies used. Primary data was collected from households using structured and non structured questionnaires. Trees on farm were found to be the major supply of the woodfuel energy where firewood was the main source of household energy followed by charcoal. Traditional three stones stoves were the most commonly used with 76 59 and 65 (household respondents) in Kiambu, Thika and Maragwa districts respectively. Improved charcoal stoves were the second commonly used while only a very negligible percentage used kerosene stoves and gas burners. Over 70% of the respondents were aware of the improved stoves but their adoption was less than 29%. The low adoption of improved stoves was due to their high cost as noted by the respondents. Over 90% of the households had the opinion that woodfuel sources were decreasing and there was a need to develop strategies for its future sustainability. The study recommended integration of woodfuel production to local farming systems and establishment of fuelwood plantations by Kenya Forest Service to substitute on farm sources. It also recommended promotion of improved stoves with higher efficiency to reduce the woodfuel used as well as improve on environmental pollution.

Key words: Farmlands, Central Kenya, improved stoves, firewood, charcoal.

INTRODUCTION

It is estimated that about 90% of Kenyan rural households use woodfuel either as firewood or charcoal (MoE, 2002) and it provides income to over 3 million people (ESDA, 2005). A significant portion of the rural population is employed in wood energy trade and it constitutes a major source of energy in Kenya (Republic of Kenya, 2002a). The Government of Kenya has been involved in promoting tree planting at the farm level with the aim of increasing tree cover to 10% by the year 2030 (Republic of Kenya, 2007). There have been successful tree planting programs involving rural communities in Kenya led by government rural forest extension services and various non governmental organizations (NGOs). Green Belt Movement is among the most active NGOs which have assisted planting of over 45 million trees in different parts of Kenya for the last three decades. Besides being the standard cooking fuel for the majority of Kenyan households, fuelwood is also an important energy source for small-scale rural industries such as tobacco curing, tea drying, brick making, fish smoking, and bakeries, among others. However, despite its importance, the available data is scarce and uncertain which is mainly due to the fact that it is handled in the informal sector and does not pass through monetized economy like in the case of liquefied petroleum gas (LPG), kerosene and electricity which are alternatives to wood energy. The energy sector concentrates more on national energy planning for conventional fuels while forestry sector focus more on planning for commercial wood supply and conservation of protected areas (Republic of Kenya, 2002a). These two key sectors deny

*Corresponding author. E-mail: josephgithiomi@ymail.com. Tel: 254 -722496795.

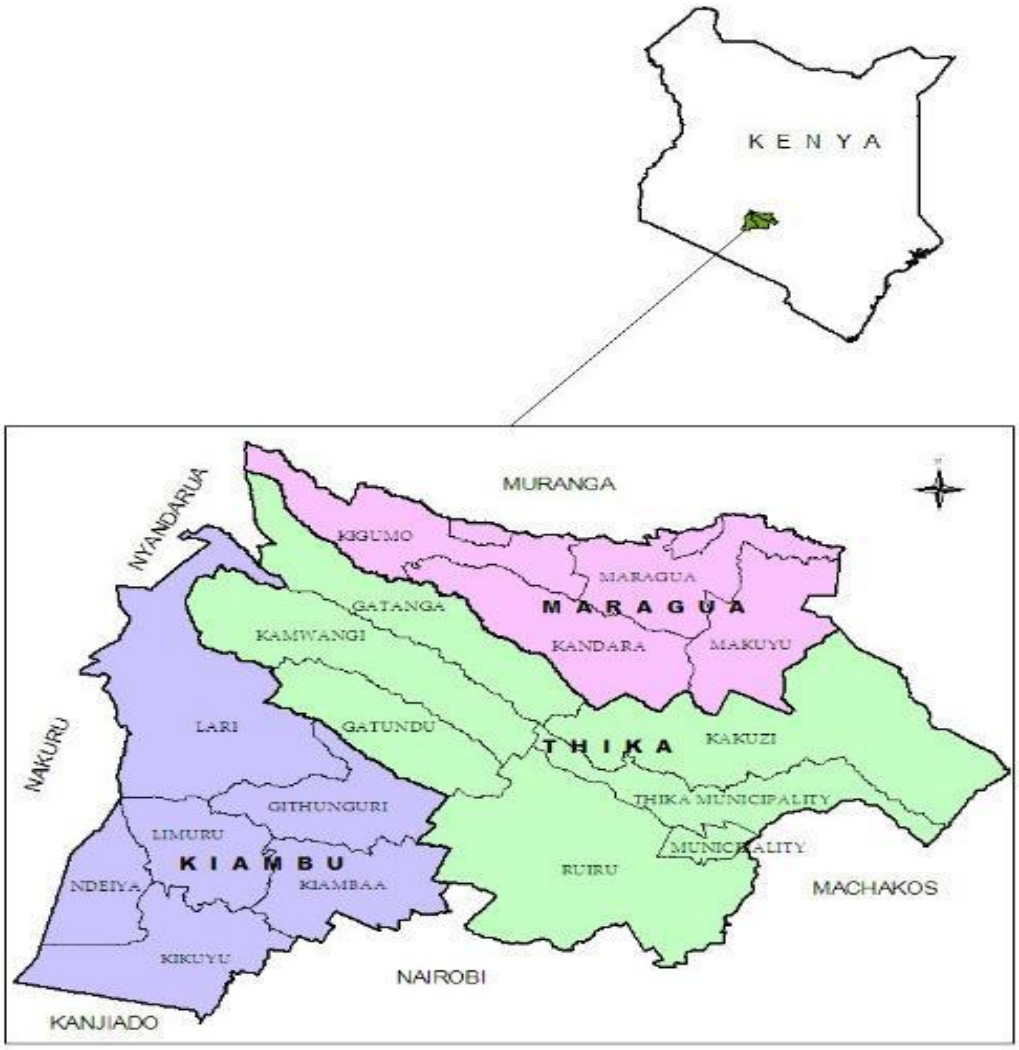

Figure 1. Map of the study area showing the Kiambu, Thika and Maragwa districts.

biomass energy the comprehensive consideration it deserves due to the role it plays in supply of energy to majority of Kenyans.

This study was undertaken between 2006 and 2007 and it was aimed at establishing household energy sources and its utilization technologies in Kiambu, Thika and Maragwa districts of Central Kenya. The data obtained is useful in policy formulations in these three districts.

METHODOLOGY

This study was carried out in Kiambu, Thika and Maragwa districts of Central Kenya as shown in Figure 1. The districts were purposively sampled on the basis of various factors which include diverse wood production systems (farmlands, plantations, and natural forests), diverse ecological conditions and population densities among others. The selected districts had rainfall range from 800 to 1400 mm, 500 to 2500 mm and 900 to 2700 mm for Kiambu, Thika and Maragwa districts respectively (Republic of Kenya, 1997a, b, 2002b). Sampling of the households was done using multistage stratified random sampling technique beginning with stratification sampling procedures as outlined by Lee-Ann and Martin (1997). Each of the three districts under study was stratified according to the weights in socio-economic and climatic activities as indicators. Following this procedure, at least 40% of the divisions with relatively homogeneous characteristics in each district were sampled. This ensured that heterogeneity was well captured and represented. Similar procedure was followed for selection of administrative locations and sub-locations. Based on these sampling procedures, Kiambu, Thika and Maragwa districts were stratified into four, three and two strata respectively. Each stratum in the district consisted of one or more divisions. A total of 200 households were sampled from each district. Allocation of the sampling units in each selected division was done proportionally to the total number of household obtained from the 1999 census (Republic of Kenya, 2001).

The data collection was done using structured and semi-structured household questionnaires which captured data on the source of woodfuel, supply trend, the type of energy sources used, cooking technologies and awareness on the improved stoves. The generated data was coded and entered in the computer using spread sheet MS-Excel. Statistical package for social sciences (SPSS) was used in analyzing the data.

Table 1. Sources of woodfuel in Kiambu, Thika and Maragwa districts.

District	Percentage responses on supply sources of woodfuel													
	Indigenous trees scattered on farm		Exotic trees scattered on farm		Planted woodlots		Purchase from vendors		Gazetted forests		Others		Total	
	%	n	%	n	%n		%	n	%	n	%n	%n		
Kiambu	4	8	24	49	4	9	57	117	9	18	2	4	100	205
Thika	26	50	12	22	3	6	57	109	1	1	3	3	100	191
Maragwa	40	80	31	63	21	42	5	10	2	4	1	1	100	200

Table 2. Responses on supply trend of woodfuel sources in Kiambu, Thika and Maragwa districts.

District	Source of woodfuel	Supply trend of woodfuel from different sources					
		Increase		Decrease		Total	
		%	n	%	n	%	n
Kiambu	Existing scattered indigenous trees on farms	33	2	67	4	100	6
	Existing exotic scattered trees on farm	7	3	93	39	100	42
	Planted woodlots	33	1	67	2	100	3
	Purchase from sellers	3	2	97	67	100	69
	Gazetted forests	0	0	100	18	100	18
	Others	0	0	100	3	100	3
Thika	Existing scattered indigenous trees on farms	13	6	87	41	100	47
	Existing exotic scattered trees on farm	14	3	86	18	100	21
	Planted woodlots	50	3	50	3	100	6
	Purchase from sellers	37	29	63	50	100	79
	Gazetted forests	0	0	100	12	100	12
	Others	0	0	100	3	100	3
Maragwa	Existing scattered indigenous trees on farms	4	3	96	70	100	73
	Existing exotic scattered trees on farm	19	11	81	47	100	58
	Planted woodlots	2	1	98	40	100	41
	Purchase from sellers	10	1	90	9	100	10
	Gazetted forests	0	0	100	11	100	11
	Others	0	0	100	2	100	2

RESULTS

The results on the woodfuel supply sources in the three districts under study (Table 1) showed that majority of the respondents from Kiambu and Thika districts (57%) purchased woodfuel from vendors whereas others obtained woodfuel directly from the farm. The woodlots were taken as an area in the farm set aside for tree planting while the other trees in the farm were either referred to as scattered indigenous or exotic. Maragwa district had the highest number of households sourcing woodfuel from indigenous trees scattered on farm. In Maragwa and Thika districts, there were less than 2% of the households sourcing woodfuel from the gazetted forests. Charcoal was the main product purchased from vendors as firewood was mainly sourced directly from the farms. Overall, there was a significant difference ($\chi 2=157.852$; d.f=2; $p<0.01$) among districts in terms of supply sources of wood energy.

The households' response to the trend of future supply sources which included existing scattered indigenous trees on farms, existing exotic scattered trees on farm, planted woodlots, gazetted forests and purchases from vendors showed a decrease in all woodfuel supplies sources (Table.2). Majority of the household respondents in Kiambu and Thika districts indicated that the purchase of woodfuel from sellers will decrease as compared to Maragwa who had the highest number (73) indicating the highest decrease was to be in existing scattered indigenous trees on farms which was also their main source of

Table 3. Sources of energy used by households in Kiambu, Thika and Maragwa districts.

District	Commonly used sources of energy											
	Firewood		Charcoal		Kerosene		Gas		Crop residue		Total	
	%	n	%n		%n		%n		%	n	%	n
Kiambu	87	181	12	25	1	1	1	2	0	0	100	209
Thika	80	159	15	30	4	7	1	2	1	1	100	199
Maragwa	96	192	1	2	2	4	1	1	1	1	100	200

Table 4. Cooking technology devices used in Kiambu, Thika and Maragwa districts.

District	Response on each technology used													
	Three stone fire		Traditional metal stove		Improved charcoal stove		Improved firewood stove		Kerosene stove		Gas burner		Total	
	%n		%	n	%	n	%	n		%n	%	n		%n
Kiambu	76	155	4	8	18	36	0.5	1	0.5	1	1.0	2	100	203
Thika	59	116	2	4	30	59	2	3	5	9	2	3	100	198
Maragwa	64	130	6	12	24	49	3	7	1	1	2	4	100	203

Table 5. Awareness of improved technology in Kiambu, Thika and Maragwa districts.

District	Aware		Not aware		Total	
	%	n	%	no	%	n
Kiambu	79	162	21	42	100	204
Thika	70	136	30	59	100	195
Maragwa	89	177	11	23	100	200

Table 6. Reasons for not using improved firewood stoves in Kiambu, Thika and Maragwa districts.

Reasons for not using improved firewood stoves	Respondents					
	Kiambu		Thika		Maragwa	
	%	n	%	n	%	n
Cost	31	56	25	31	57	74
Non availability	23	41	35	43	16	21
Not interested	34	62	22	27	14	18
Never heard of it	7	12	15	19	12	16
Very slow in cooking	5	10	3	3	1	1
Total	100	181	100	123	100	130

source of woodfuel. The results showed that there were significant differences ($p<0.01$) in the sources of energy used by households within the districts studied.

Firewood was commonly used as shown by 87, 80 and 96% of the households' respondents in Kiambu, Thika and Maragwa districts respectively followed by charcoal. Crop residue, gas and kerosene were the least used (Table 3). The average weekly firewood and charcoal consumption per household in the three districts was found to be 32 and 10.4 kg respectively.

The results of woodfuel utilisation technologies are shown in Table 4. Inferential analysis of the data showed that there were significant differences ($p<0.01$) among technologies used within each district where three stones was the most commonly used by the household respondents' with 76, 59 and 64% followed by improved charcoal stove with 18, 30 and 24% in Kiambu, Thika and Maragwa districts respectively. A very negligible household percentage used kerosene stoves and gas burners.

On the awareness of the improved technology, the results (Table 5) showed that over 70% of the respondents were aware of improved cooking technologies. This significantly varied among the districts ($\chi^2=21.162$; d.f=2; $p<0.00$) where majority were from Maragwa district followed by Kiambu. The adoption of improved charcoal and fire wood stoves was 19, 24.5 and 28% in Kiambu, Thika and Maragwa districts, respectively.

A number of reasons were cited for not using the improved stoves with cost of purchasing improved stoves being regarded as main reason for its non-adoption (Table 6). This was significantly different ($p<0.05$) across the three districts but it was highly pronounced in Maragwa followed by Kiambu district. Other factors that cause non adoption of these improved stoves are their non availability, and lack of awareness by potential users.

DISCUSSION

The significant difference among districts in terms of supply sources of wood energy implied that each supply sources of woodfuel had different weights in each district.

For example, Maragwa got its woodfuel mainly from scattered indigenous trees on farm as compared to Thika and Kiambu who purchase mainly from vendors. The study indicated that farmlands form a critical part of wood energy resource supply as observed in all districts and only a small proportion of household were sourcing woodfuel from the gazzeted forests. Similar observations were reported by Ministry of Energy's study on energy supply and demand for household, small scale industries and service establishment in Kenya where most woodfuel was found to be from the farmlands (MoE, 2002). Encouraging farmers to plant more trees could increase the supply of woodfuels and other wood products considerably within the study area. However, there is limitation in promoting woodfuel production as it is taken as a by-product of other activities (like timber) which are more valued.

The decreasing trend of major supply sources in the three districts was caused by scarcity of land for continuous tree planting, deforestation of gazetted and on farm forests and slow maturity of indigenous tree species. These constraints can be addressed through planting of fast growing species and adopting planting technologies that maximizes the woodfuel production in agroforestry systems. The decreased supply of woodfuel supports the need for wood energy planning in each of the study districts to avoid eminent deficit.

The high number of household residents using firewood as source of energy (over 80%) had also been observed in a study by Ministry of Energy on energy demand and supply for households where 89% of rural households were found to be using firewood countrywide (MoE, 2002). This also compares well with another study by Kenya National Bureau of Statistics which indicated that 87.7% of households in Kenya were using firewood (Ministry of Planning and National Development, 2007). On-farm tree planting has a significant role to play in woodfuel production in Kenya. The government of Kenya has promoted tree planting on farm and in gazetted forests through the Kenya Forestry service and several other projects by development partners and NGOs. Tree reforestation has been done in degraded areas like Mau forest and other Kenyan water towers.

The three stone stoves which were commonly used in the three districts despite having low efficiency of about 10% and high health hazards, however, are popular with the households as they are cheap and they also contribute to house warming. The reported percentages (59 to 76%) of the households' respondents using three stone stoves are lower than what was reported in a study by Mugo (1999a) on rural households, but the variation could be due to the fact that this current study considered both rural and urban centres.

The proportion of households aware of the improved cooking technology was over 70% in all the districts. However, despite this high awareness, majority of the respondents were using the three stone stoves and only a small proportion of less than 28% of the household respondent had adopted the improved charcoal and firewood stoves which was much lower than 47% reported in a study on Kenya's energy demand and supply for households by Ministry of Energy (MoE, 2002). The difference in adoption among the districts could be due to variation in household income among the three districts. In Maragwa district, the improved stove awareness was higher than the other districts as there was an NGO which had been promoting improved stoves. This could be the reason why the district also had relatively higher rate of adoption of improved stoves compared to the other two districts. It is known that three stone stoves consume a lot of firewood as they are not efficient and they emit several serious pollutants which cause health problems (Kirk, 1993; Pandey, 1997). The improved stoves need to be promoted as they use less woodfuel and have higher combustion efficiency which gives greater amount of heat and less smoke. The use of improved stoves will lead to reduced environmental related diseases as outlined in Kenya vision 2030. In addition, the use of improved stoves will also reduce the rate of deforestation and environmental degradation (Mugo, 2001). The use of less fuelwood by improved stoves also reduces the time used in fuelwood collection, which can be re-directed into other income generating activities. There is need for further sensitization on the importance of using improved stoves as most of those who were aware about them were not using them. The main reason for the low adoption of these stoves was their higher cost which can be reduced through facilitation of their production at the local level.

Some of the improved stoves that have been adopted in Kenya and the neighboring countries of East and Central Africa include Kenya Ceramic Jiko (KCJ). This is a simply traditional charcoal metal stove fitted with ceramic liner which increases its efficiency several times as compared to the traditional all metal alternative. The other stove which has been successfully produced by local women groups in western Kenya is the Upesi stove which also has simple molding of clay liner.

CONCLUSIONS AND RECOMMENDATIONS

The woodfuel supply trend indicated that it was decreasing and therefore there is need to integrate its production with local farming systems as agricultural sector has a key role to play in supplementing woodfuel. This can be supported through development of on-farm management regimes for use at the farm level to ensure sustainability of woodfuel production. The Kenya Forest Service should also develop plantations for woodfuel production as a national priority as it does with timber production. The firewood plantations should be established with appropriate fast growing trees which match specific environmental and ecological conditions for

maximum productivity.

The conservation of wood energy should be given a priority through promotion of improved stoves with higher efficiency as it was found that over 70% of the households in the study area use three stone stoves which were inefficient. The improved stoves to be promoted for adoption should consider users needs which include cooking comfort, convenience, health and safety. The improved stoves should also be of affordable prices as it was noted in this study that low adoption of improved woodfuel cooking devices was contributed by their high cost. This can be achieved through building capacity of making improved stoves at local level.

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