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Coping strategy for curbing wood fuel scarcity in Nyamache sub-county, Kisii County, Kenya

Marube Justin Ochenge and Ambia Anncletas Atamba

Abstract
Wood fuel shortage has existed worldwide since the 1970s during oil energy crisis; accelerating wood fuels scarcity hence coping strategies. This study on local community based strategy for curbing wood fuel shortages was conducted in Nyamache Sub-county, Kisii County, Kenya. The study assessed the establishment of woodlots as an affordable strategy adopted by the households for wood fuel availability. The specific objective analyzed the coping strategies adopted by the households for curbing wood fuel shortages in the study area. Descriptive research design was adopted in gathering information on establishment of woodlots for wood fuel availability in the study area. It was based on binary-choice model. A sample size of 379 households selected from a target population of 26,458 people was used. The study employed stratified purposive and snowballing techniques of both probability and non-probability sampling designs in selection of informants. Data was collected by use of structured questionnaire, observation checklist, Focus Group Discussion and key informant interview guides. The study data was of both primary and secondary sources. The data were analyzed using frequency distribution tables, percentages, spearman's rank correlation analysis and Chi-square. Chi-square test analyzed independent variables on establishment of woodlots against the dependent variables of pressure on wood fuel resources and wood fuels shortages. Statistical tables, charts, plates, maps and photographs were used to present the data. Establishment of woodlots for wood fuel availability was the most significant strategy adopted in Nyamache Sub-county at ($x^2 = 3.15 < 7.81$ at df=3) at 0.05 as compared to other strategies. The study concluded that establishment of woodlots for wood fuel availability was significantly sustainable at (x^2 =0.68<15.09 at df= 5) at 0.05. The researcher therefore, recommended that establishment of woodlots be adopted in the area, local communities engage in establishing woodlots and be positive in wood fuel scarcity alleviation strategies country wide and local politicians to sensitize households on woodlots established on their farms.

Keywords: Coping Strategy, wood fuel, woodlot, households, energy, biomass, fuelwood, charcoal

1. Introduction
Wood fuel shortage is an energy problem that has existed worldwide since the 1970s when there was an oil energy crisis (Mugo, 2001; Githiomi & Oduor, 2012) [32, 17]. Wood fuel is regarded as energy produced from wood biomass. Mugo (2001) [32] argues that most of the households rely more on wood fuels for their vast domestic energy needs and inability to obtain alternative energy sources. Globally, households are establishing responsive strategies for wood fuel availability and accessibility sustainably (Kaale, 2005) [24]. Despite the adopted strategies for availability and accessibility of sustainable wood fuels, wood fuel shortage has been persistent in the developing countries and in particular Kenya (Tabuti, Dhillion & Lye, 2003; Yikii, Agea & Kaboggoza, 2006) [39, 42].

Existing studies show that wood fuel scarcity has been a persistent recurrent problem which has attracted many responses globally (FAO, 2009 & FAO, 2010). FAO (2009) [14] and FAO (2010) [14] further asserted that it may take several years for developing countries to realize other alternative sources of energy. Yikii *et al*., (2006) [42] projected that by the year 2000; about 9 million African households could have had adequate wood fuel energy supply from within their farms. However, this projection was not realized by a number of households. Therefore, there is the urgent need to assess the role of established strategies by the households within their farmlands for curbing wood fuel shortages both nationally and locally. In response to wood fuel shortages, measures at different levels are sought trying to solve this enormous perennial problem.

Global households have been noted to advance a number of strategic mechanisms such as switching to clean fuels, conservation methods, raising energy efficiency by adoption of modern stoves, increasing wood fuel production and establishing woodlots (Arnold, Persson & Shepherd, 2003) [3]. However, by late 1980s, researchers have realized that the "gap model" describing the difference between wood fuel production and demand was overestimated and simplified. Arnold *et al*., (2003) [3] further proceeded to investigate households' strategic responses sought to wood fuel shortages sustainably at international, regional, national and local levels.

Consequently, most profound strategic interventions were advanced purposely for increasing the supply of wood fuels. For instance, a huge government initiative was established in South Korea within which village households were encouraged to plant collective woodlots on their farms to access wood fuel needs easily (Dewees, 1989) [9]. To some extent, the Social Forestry Programme in India recommended households to be encouraged to grow trees on their farms for easy accessibility of wood fuels (Dewees, 1989) [9]. Despite all these interventional responses of advancing strategies to increase wood fuels among the households, the scarcity still persisted.

Existing studies show that households worldwide establish woodlots in their farms as a strategic response to wood fuel scarcity (Calvo, 1994; Heltberg, 2003; Jagger, Pender & Gebremedhin, 2005; Wanambwa, 2005; Mutua, 2006; Kituyi, 2008) [7, 19, 23, 41, 33, 27]. However, wood fuel scarcity has been relatively addressed using establishment of woodlots as a strategy for wood fuel availability. Adoption of woodlots has been a success case in provision of wood fuels in countries such as Asia, Nepal, Bangladesh, Ethiopia, Burkina Faso and Nigeria (ETC, 1987; Githiomi, Mugendi & Kung'u, 2011; Waris & Autahal, 2014) [16, 12]. Likewise studies carried out in Egypt, Rwanda, Zimbabwe and South Africa showed that those households whose serious challenges of wood fuels had adopted establishment of woodlots in their farmlands (Calvo, 1994; Arnold *et al*., 2003; Ouedraogo, 2006; Nellie & Githiomi, 2003) [7, 3, 33]. However, the enormous household wood fuel demands by aforementioned countries have not been met hence failure cases.

The Kenyan households have recognized the role of establishment of woodlots and the contribution to their livelihoods (Kituyi, 2008) [27]. This has necessitated a comprehensive adoption of establishment of woodlots as a strategy to address persistent wood fuel shortages. However, a sustainable wood fuel has not been achieved. Most researches in Kenya have focused on establishment of woodlots as the impact on the environment (Mutua, 2006; Nzamba, 2007; KIPPRA, 2010; Githiomi *et al*., 2011 & Waris *et al*., 2014) [16, 33, 37, 26]. However, less emphasis has been put on establishment of woodlots as a strategy for curbing wood fuel scarcity. The study therefore, assessed the coping strategy for curbing wood fuel shortages in Nyamache Sub-county, Kisii County.

1.1 Objectives of the study

The purpose of this study is to make an assessment of the establishment of woodlots for wood fuel availability in Nyamache Sub-county, Kisii County, Kenya. The specific objective was to analyze the coping strategies adopted by the households for curbing wood fuel shortages in Nyamache Sub-county.

2. Description of the study area

The study area was in Nyamache Sub-county (Figure 1) that is located in Bobasi constituency in Kisii County (IEBC, 2012) [21]. It lies in western Kenya between latitude 0^0 47′ 00″ South of Equator and Longitude 34^0 50′ 00″ East of Greenwich Meridian and is placed at an altitude of 1700 m above sea level (KNBS, 2013 & IEBC, 2013) [22]. It is relatively located as follows; Kisii Central Sub-county to its North, Gucha South Sub-county to the South, Trans Mara Sub-county to the North East, Kenyenya Sub-county to the West and Sameta Sub-county to the North West. It is approximately 20 km from Kisii town which is the head-quarter of the county government of Kisii.

According to the 2009 census, Nyamache Sub-county in Kisii County had five (5) administrative locations namely; Bassi Central, Bassi Masige East, Bassi Masige West, Bassi Bogetaorio and Nyacheki. The sub-county where the study was carried out covers an area of 162.5 km^2 and it supports a population of 126,262 people with a population density of 807.34 persons/km^2 and 26,458 households (KNBS, 2009) [28]. The population density was expected to grow at 1.5 percent annually. However, the high population has put a lot of pressure on resources wood fuels inclusive, which would continue to increase over the coming years (NEMA, 2007; NEMA, 2009) [35-36]. Description of Nyamache Sub-county is highlighted in the Table 1.

Table 1: Description of Nyamache Sub-county as per the 2009 Census

Location	Households	Population	Area in sq. Km	Density
Bassi Central	4,923	23,346	33.1	704
Bassi Masige East	4,100	19,170	21.1	909
Bassi Masige West	3,755	18,492	27.6	671
Bassi Bogetaorio	5,328	12,385	14.6	849
Nyacheki	8,352	52869	66.1	904
Total	26,458	126,262	162.5	807.34

***Source*:** KNBS, (2009) [28].

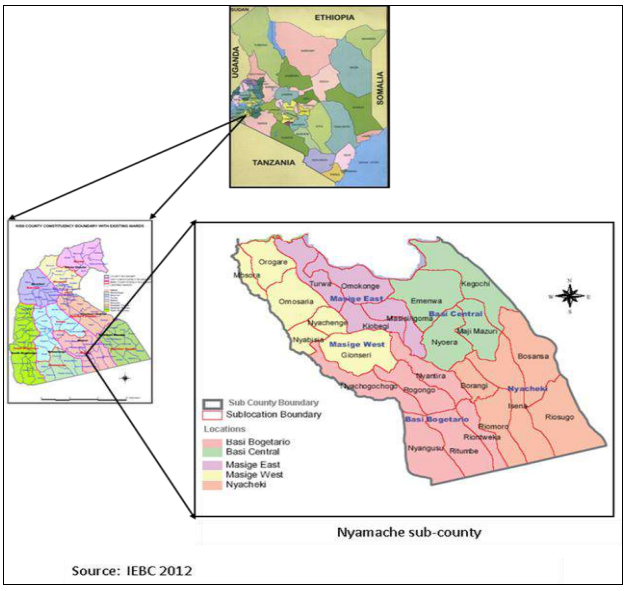

Fig 1: Map of Kenya Showing the Relative Position of Nyamache Sub-County

3. Methodology

This study adopted descriptive research design in which qualitative and quantitative data collection procedures, methods and analysis were described to understand the research problem (Best & Khan, 2003) [4]. It was to assess the local community based strategy for curbing wood fuel shortages in Nyamache Sub-county, Kisii County, Kenya. The researcher used; questionnaires, key informant interviews, observation and Focus Groups Discussion as the main tools for collecting data. They were mainly concerned with views and perceptions of the household respondents. The study was both explorative and interpretive in nature by surveying physical barriers faced by the households in accessing wood fuel and generating information from both quantitative and qualitative data using inferential statistics respectively (Kothari, 2004) [30].

The targete population was 26,458 households who were drawn from the five locations of Nyamache Sub-county with a total population of 126,282 people (KNBS, 2009) [28]. According to KNBS (2009) [28], the five locations purposively selected in the sub-county included; Bassi Central, Bassi Masige East, Bassi Masige West, Bassi Bogetaorio and Nyacheki. The target population constituted all the household units, in particular those who have had great interaction with woodlots establishment for wood fuel availability (ETC, 1987 and Bradley, 1987) [12]. Also government agents such as forest department officers and NEMA officials in the sub-county were contacted and their information sought which generated relevant data for this study.

The study sample size of 379 households out of the target population of 26, 458 consisting of men, women and children was used. The sample size was arrived at by carefully taking into account the objectives being studied using the Krejcie and Morgan's formula (Krejcie & Morgan, 1970) [31]. This sample size was justified by the Morgan and Krejcie's table and graph for determining sample size from a given population and sample size vis-a-vis total population respectively (Krejcie *et al*., 1970) [31], calculated as follows;

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where

S = required sample size.

X^2 = Table value of chi-square for 1 degree of freedom at the confidence level, which is $3841\ i.e\ 1.96 \times 1.96$.

N = population size.

P = proportion assumed to be 0.5.

d = degree of accuracy expressed as a proportion which is 0.05.

$$S = \frac{3.841 \times 26{,}458 \times 0.5 \times 0.5}{0.05^2(26{,}458-1) + 3.841 \times 0.5 \times 0.5} = 379$$

This number, 379 households, was again purposively stratified proportionately into different location strata as indicated in Table 3.2 (Amin, 2005) [2]. A sample of 72 households in Bassi Central, 57 households in Bassi Masige East, 53 households in Bassi Masige West, 76 households in Bassi Bogetaorio and 121 households from Nyacheki locations respectively were purposively selected for this study.

Table 2: Sampling frame per location in the study area

Location	Households	Proportion	Sample size
Bassi Central	4,923	0.19	72
Bassi Masige East	4,100	0.15	57
Bassi Masige West	3,755	0.14	53
Bassi Bogetaorio	5,328	0.20	76
Nyacheki	8,352	0.32	121
Total	26,458	1.00	379

Source: KNBS, (2009) [28]

4. Results and Discussion

4.1 Socio-Demographic Characteristics of the Household Respondents

The characteristics of the household respondents in relation to establishment of woodlots for wood fuel availability in Nyamache Sub-county, Kisii County, Kenya, were tabulated and recorded as per the data (Table 3). These characteristics included the following; sex, age, marital status, occupation, educational background, dependents and size of land as were tabulated from the questionnaires. Results indicated that more than half of the household respondents (62.7%) were females while 37.3%. This was an apparent reflection of the major role played by women in wood fuel collection in the African set up (ETC, 1987) [12]. Majority of the respondents (52.8%) were aged between 30 and 49 years whose mean age of 38.4 of the households authenticated the results of this research given the Kenyan age of above 18 years in the constitution of Kenya (GOK, 2010) [18].

Table 3: Socio-demographic characteristics of the household respondents in Nyamache Sub-county (n=346)

Characteristics	Responses	%age	Characteristics	Responses	%age
Sex			**Educational background**		
Male	129	37.3	None	039	11.3
Female	217	62.7	Elementary	048	14.0
Age			Primary	203	58.8
≤29	100	29.0	Post-primary	037	10.8
30-49	183	52.8	Post-secondary	019	05.5
≥50	063	18.2	**Dependents**		
Mean age	38.4		0	016	04.7
Marital status			1-4	111	32.2
Married	194	56.2	5-9	209	60.4
Single	041	11.9	≥10	010	02.9
Divorced	023	06.6	Mean (dependents)	5.3	
Separated	027	07.9	**Size of land**		

Widowed	061	17.6	≤1 ha	083	24.0
Occupation			2-3 ha	253	73.3
Idlers	046	13.3	≥ 4 ha	010	02.7
Peasants	209	60.4	Mean size	2.2	
Business men/women	053	15.3	**Place of residence**		
Civil servants	029	08.4	Bassi Central	066	19.0
Politicians	009	02.6	Bassi Masige East	052	15.0
			Bassi Masige West	048	14.0
			Bassi Bogetaorio	069	20.0
			Nyacheki	111	32.0

***Source*:** Researcher's Field Data, (2019)

4.2 Coping Strategies Adopted by the Households in Response to Wood fuel Shortages

Table 4: Coping strategies adopted by the households in Nyamache Sub-county (n=346)

Coping strategies	Locations					Total
	Bassi Central	Bassi Masige East	Bassi Masige West	Bassi Bogetaorio	Nyacheki	
	(N=66)	(N=52)	(N=48)	(N=69)	(N=111)	(N=346)
woodlots	69 (95.4)	48 (92.3)	45 (93.8)	59 (85.5)	92 82.9)	313(90.5%)
Wood fuel energy saving technologies	28 (42.4)	23 (44.2)	09 (18.8)	26 (37.7)	28 (25.2)	114 (32.9%)
Use of wood fuel conservation methods	32 (48.5)	34 (65.4)	30 (62.5)	51 (73.9)	83 (74.8)	230 (66.5%)
Use of alternative sources of energy	07 (10.6)	10 (19.2)	04 (08.3)	23 (33.3)	14 (12.6)	058 (16.8%)

***Source*:** Researcher's Field Data, (2019)

Table 4 portrayed establishment of woodlots as the main strategy for wood fuel availability at the study area by more than three quarters of the household respondents (90.5%). The results were in agreement with FAO, (2010) [14]'s perception; for households viewed establishment of woodlots as an affordable response to wood fuels scarcity. However, the strategy is a response which needs to be adopted and practiced abundantly (Cooke, 2008; Githiomi, 2010) [8, 15].

The percentage of farms presenting established woodlots was high in the Bassi Central location at (95.4%), followed by Bassi Masige West at (93.8%) and least at Nyacheki (82.9%). Bassi Masige East responded at (92.3%), while Bassi Bogetaorio location was at (85.5%) respectively (Table 4). For the entire study area, the woodlot owners accounted for about 90 percent whereas non-woodlot owners represented a percentage which was less than 10 meaning the strategy was an amicable solution to wood fuel scarcity. Many woodlots farms were found on the infertile edges of farms and on steep slopes (Majid, 2006 & Beyene, 2013) [5] (Plate 1).

Plate 1: Established woodlot at Kionyo in Bassi Masige East location

A third (32.9%) of the household respondents claimed that wood fuel energy saving technologies was adopted at the scarce of wood fuels (Table 4). The respondents indicated that they own at most one technology in place of perennial wood fuel scarcity experienced. Adoption of wood fuel energy saving technologies was aimed at decreasing high demand for wood fuels (KENGO, 1991) [25]. In addition, the technologies improved the households' livelihoods and enhance sustainable wood production (Eckholm, 1982; KENGO, 1991) [10, 25]. Despite the use of energy saving technologies, a section of the respondents in the study area were unable to adopt such technologies may be because of lack of information about them and the love they have towards the wood fuels.

Source: Majid, (2006)

Fig 2: Kenya Ceramic Stove

Source: Researcher, (2019)

Fig 3: Food warmer

Source: Researcher, (2019)

Fig 4: Food warmer

Table 4 shows that more than half (66.5%) of the household respondents claimed to be using wood fuel energy conservation methods (Figure 2, 3 and 4 respectively). The study found that the number of collecting times had increased from an average of 2 times a week to 3 times a week. This could also involve movement of women and girls in search of wood fuels. Given the sustained increase in distance to source wood fuel the study has concluded that this is a strong indicator of wood fuel scarcity in Nyamache Sub-county, Kisii County. When faced with wood fuel shortages, rural households sometimes resort to using cheaper and less efficient sources of energy. This was a strong indicator that mature trees could not meet the wood fuel demand of the area.

The study also found that households with some wood fuel available still used maize cobs and stalks after the harvest season and postponed use of wood. Maize cobs were commonly used to boil foods and warm water (Plate 3). However, they were unpopular with households because of their tendency to smoke. When households lacked the time to source for split wood they would resort to using dry maize stalks. Maize stalks were used as an alternative to split wood (Plate 2). Maize stalks were also unpopular because a household required a big bundle to make a meal and they burned out fast forcing one to keep feeding the fire with more. Though, most respondents indicated that maize stalks burned out quickly and therefore one has to use much of them whenever they are used as alternatives at the time of serious wood fuel shortages.

Plate 2: Dry maize stalks

Plate 3: Dry maize cob

Slightly, less than a third (16.8%) of the households in the study area used alternate energy sources of fuel such as kerosene, biogas, solar, LPG and electricity in times of wood fuel scarcity (Table 4). The energy sources were used for cooking, heating and lighting in the developing world (Heltberg, Channing & Sekhar, 2000) [20]. However, household respondents do not afford the alternative energy sources sustainably because of high prices attached to them (Githiomi, 2010) [15]. For instance, in Lurambi District, Kenya, alternative energy sources provide an effective source of fuel in times of wood fuel scarcity (Githiomi *et al*., 2012) [17]. Among the households, 10 percent cited the use of alternative sources of energy for wood fuel as per Githiomi, (2010) [15]. This is comparable to Akther (2010) [1] in a study on household adaptation to wood fuel shortage among 60 households in Bangladesh found that 23 percent of the households adapted to wood fuel scarcity by use of alternative sources of energy.

Table 5: Summated chi-square of the coping strategies adopted by the households in Nyamache Sub-county (n=346)

Coping strategies	Local communities' attitude			
	Observed	Expected	x^2- Calculated	x^2- Tabulated
Establishment of woodlots	313	346	3.15	7.81
Wood fuel energy saving technologies	114	346	155.56	7.81
Use of wood fuel conservation methods	230	346	38.89	7.81
Use of alternative sources of energy	058	346	239.72	7.81

***Source*:** Researcher's Field Data, (2019)

Table 5 showed that establishment of woodlots for wood fuel availability was the most significant strategy in Nyamache Sub-county, Kisii County at ($x^2 = 3.15 < 7.81$ at df=3 at 0.05) level of significance compared to other strategies. Individually adopted strategies though, statistically insignificant included; wood fuel energy saving technologies ($x^2 = 155.56 > 7.81$ at df=3 at 0.05) level of significance, use of wood fuel conservation methods ($x^2 = 38.89 > 7.81$ at df=3) and use of alternative energy sources ($x^2 = 239 > 7.81$ at df=3 at 0.05) level of significance (Table 5).

5. Conclusion

Based on the research findings the study concluded that establishment of woodlots helped mitigate wood fuel shortages statistically significant at (x^2 =0.68<15.09 at df= 5) at 0.05 levels of significance. This is because wood fuel was the most preferred source of fuel by majority (79.5%) of the household respondents in the study area. It is crystal clear that established woodlots play a vital role in provision of wood fuels to the households' demand (Githiomi, 2010) [15]. However, establishment of woodlots has not been widely adopted by the rural households at the local levels. Woodlots establishment as an affordable strategy for curbing wood fuel shortages has been widely adopted by majority (90.5%) of the household respondents. However, the rate at which households adopt the establishment of woodlots has been very slow both in theory and practice.

6. Recommendation

The researcher therefore, recommended that establishment of woodlots be adopted in the area, local communities engage in establishing woodlots and be positive in wood fuel scarcity alleviation strategies country wide and local politicians to sensitize households on woodlots established on their farms. However, there is need to formulate clear policies and by-laws to guide and escalate well adoption mechanisms of woodlots establishments. Additionally, the local politicians whose influence is immense on the electorates should offer moral and financial support to achieve this objective.

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