IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 10, Issue 2 Ver. II (Feb. 2016), PP 99-102
www.iosrjournals.org

Pattern of expenditure on fuel wood and cost benefits of energy efficient stoves adoption in North – Eastern Nigeria

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Abstract: *Millions of people are dependent on wood fuels for most of their energy needs, despite the problems associated with traditional use of wood fuels – including energy inefficiency, deforestation, air pollution and other environmental effects. The study investigated the pattern of expenditure on fuel wood and the economic benefits of EES adoption in North – Eastern Nigeria. the study revealed that there is a positive correlation between family size with per capita expenditure on fuel wood. It also revealed that adoption of EES will allow the respondent to save about 40-50% of what spend on fuel wood.*

Keyword: *Expenditure, Family, Fuelwood, Cost Benefits, Adoption*

I. Introduction

The primary source of energy includes electricity, coal, gas, fuel wood and solar energy. The most dominant traditional sources of energy in developing countries are fuel wood and charcoal, which are used primarily for cooking and heating homes (CAD 1991). According to Fecher *et al.,* (2005), the main challenges facing the global energy sector are two – fold, (i) to increase access to affordable modern energy services to poor countries that lack them; (ii) to find the mix energy sources, technology, policies and behavioral changes that will adverse environmental impact of providing the necessary energy services. It was revealed by United Nations Development, World Bank as well as FAO (Earl 1975: 10) that more than 90% of Nigerian energy is gotten from wood. The annual rate of deforestation in Nigeria averages 3.5%, based on this, it has been estimated that the country will lose all her forest by 2020.

Within the Nigerian context, fuel wood scarcity is more acute in Northern part of the country, which has savanna type of vegetation. The population density in the North is high and most of the settlements are rural. The rural dwellers depend on the savanna woodland where the regulation is sparse. These results in over – logging of the tree species. Consequently, the savanna woodland vegetation is not allowed to regenerate. As soon as the coppice re-growth reaches a certain size (mostly sapling), it is cut down for fuel (NEST, 1991). This threatens future supplies greatly and has profound effect on the environment. According to Fuwape and Onyekwelu (1995), the major factors responsible for scarcity of fuel wood supply and the attendant uncontrolled felling of trees are high population growth, high cost of conventional fuel, low 14 percent of the words primary energy (ITDG, 1994).

In Northern Nigeria, during the late 1990s, fuel wood, as a source of energy, plays a significant role in both urban and rural households. It accounted for 83.06 percent of total energy expenditure of rural households while kerosene accounted for the remaining 16.94 percent. Urban households spend 34.60, 25.68, 22.02 and 17.7 percent of their incomes on electricity gas, kerosene and fuel wood respectively (Kyiogwom *et al.,* 1997). It is apparent that a substantial part of incomes earned were spend on fuel wood.

Gordon (1994) further opined that household sector constitutes the major energy demand sector in many third world countries. They rely heavily on bio fuels such as wood, crop residues and charcoal, which tend to be used at relatively low efficiencies and cannot be used easily outside the household sector. As such, sectoral demand figures, aggregated across all fuels, are not in line with the level of energy services delivered to households and are poor indicator of the resource implications of household energy use. In any case, the importance of household energy lies more in the hardship imposed by inadequacies than in the level of energy that household demand.

As reported by (ECN, 2003), energy utilization in Nigeria is far from efficient. Apart from direct losses, using energy inefficiently has some implications. For example in the household sector, there is considerable energy loss due to inefficient traditional three – stone stove, used for cooking mainly in the rural areas. Although it is the cheapest stove to produce, but it has many problems, namely indoor air pollution is responsible for the death of 4.3 million people annually (WHO 2011), fuel is wasted as heat is allowed to escape in the open air. This requires more labour on the part of the user to gather fuel which will also increase

deforestation etc. The aim and objective of the study was to popularize the Energy Efficient Stove adoption in North Eastern states of Nigeria.

II. Materials & Methods

2.1 Population and Sampling Design.

The study used the primary methods of data collection with instrument of questionnaires which were administered to the target groups in the three-selected states of the north-eastern zone of the country. The states were selected based on the systematic sampling method, where the states were arranged in alphabetical order and systematically a state chosen and the next state is skipped until all the states are considered.

Mini Workshops were organized to the target groups who are women drawn from the three state on the need to use the EES. They were allowed to use the stoves for a period of 1-2 weeks. Five hundred (500) questionnaires were administered to workshop participants in each state.

Clustered Sampling Technique (CST) was used to select the respondents from the study (states) where each of the wards are considered as a cluster and simple random sampling was used to select the ward for study. Each of the ward had equal chance of being considered as a respondent, structured interview was conducted to 90 households in each of the three states.

III. RESULTS & DISCUSSION

3.1 HYPOTHESIS

Amount individuals spent on firewood is independent of individuals' family size

(Chosen Alpha value = 0.05)

H_0 : Amount individuals spent on firewood is independent of individuals' family size

H_1 : Amount individuals spent on firewood is dependent on individuals' family size

Hypothesis was formulated to test and establish the influence of family size on the expenditure on fuel wood.The null hypothesis was rejected because the Alpha value 0.05 is greater than the p-value = 0.05. It can be concluded that the amount individuals spent on fuelwood significantly depend on individual's family size.

Table 1: Contingency Table showing the Family Size and amount spent on firewood per day by the respondents.

Family Size	Amount spent on Firewood per day (Naira)		
	N 50 – 100	N 100 - 200	Above N 200
1 – 4	43.24 %	37.83 %	18.92 %
5 – 10	13.21 %	58.49 %	28.30 %
Above 10	16.67 %	40.00 %	43.33 %

Calculated Value = 15.027, p-value = 0.005, DF = 4, x = 0.05

The results on table 1 present the family size and amount spent on fuelwood per day. It can be observed that the amount spent on fuelwood rises with increasing family size. The analysis indicated that the respondents with family size above 10 constitute a greater percentage of those that spend above #200 on fuelwood thus accounting for 43.33% followed by 5 - 10 family size which constitute. The greater percentage of these that spend N100 – N 200 (50%). Similarly, the 1 - 4 family size constitute the greater percentage of respondents that spend #50 - #100 accounting for 43.24%. The implication of these results is that the larger the family size the higher the amount spent on fuelwood. The result agrees with the findings of Tukur (2009) which revealed that household with 15 and above family size use more fuelwood (40%) than others. In related studies by Chambwera (2004) and Gebreeziabher et al. (2009) household is besides income an important determinant of a households fuel choice which can also affect amount spent on fuel. Brown et al (2005) indicated the effect of individuals family size and composition of its members on consumption and technology adoption pattern.

Table 2: Response from structured interview on amount spent by the respondent before and after using EES by different family sizes:

Family Size	Amount spend using TTS				Amount spend using EES			
1 – 4	60	50	60	70	40	30	35	30
	50	60	60	60	30	40	40	30
	70	50	60	70	35	30	30	30
	60	50	60	60	35	40	40	30
	70	50	50	60	30	35	30	30
	50	50	60	70	40	30	30	35
	60	50	60		35	40	30	30
	70	50	60		30	35		
5 – 10	100	150	100	120	70	60	60	70
	120	100	130	110	50	60	70	50
	100	120	130	100	60	60	70	50
	110	120	150		50	50	60	70
	150	110	120		60	70	50	60
	120	100	120		60	60	50	50
	140	110	120		70	70	50	60
	150140	160	120		50	50	60	70
		120	120		60	60	70	60
Above 10	250	250	200		150	120	100	100
	250	300	200		120	100	100	120
	300	250	200		150	120	120	120
	250	200	250		150	120	150	130
	250	200	300		150	120	120	110
	200	250	250	220	150	130	140	100
	200	250	200	300	120	100	120	
	250	200	200	250	120	100	100	
	300	250	250					

Source: Field Survey, 2011

Table 3 prevents the calculations on the usage of Energy Efficient Stove and Traditional Three Stone Stove shows the following ratios from the cost benefit graph shown below.

Table 3: Cost Benefit Ratio of Energy Efficient Stove Adoption

Family size	Amount spent per day on firewood (N)	
	Traditional Three Stone	Energy Efficient Stove
5	55	32
1	11	6
10	116	42
1	116	42
20	230	100
1	11.5	5

From the ratio it still shows that Traditional Three Stone Stove is more costly to use than the Energy Efficient Stove. The cost-benefit shows that the EES will benefit the respondents as they can save about half of their money by using it.

Cost Benefit Of Energy Effcient Stove Adoption

Family Size and average amount of money spent on firewood per day using traditional stove & Energy Efficient Stove.

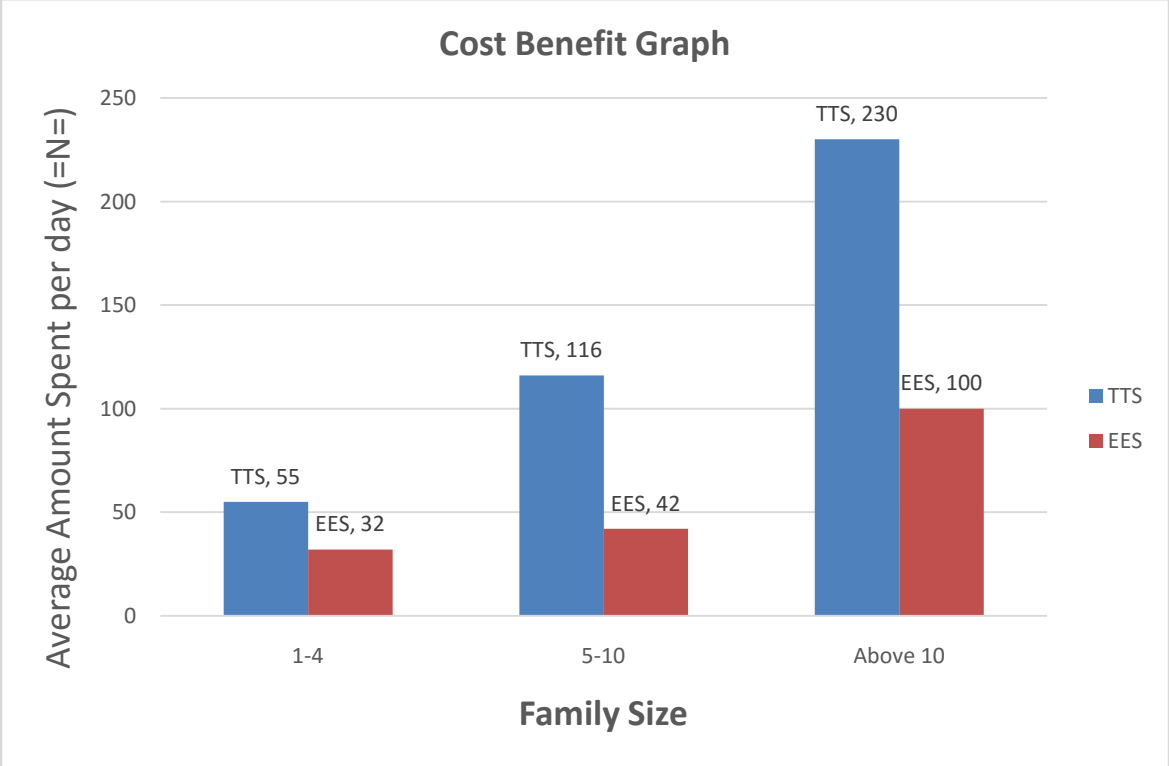

Fig 1 presents the amount of fuelwood consumption and the corresponding average expenditure of the respondents by comparing their former daily expenditure with the new expenditure. Since they use their new stoves, it turns out that people reduced their fuelwood consumption for a considerable amount and consequently, they reduced their fuelwood expenditure. It also suggest that using energy efficient stove can lead to subsequent reduction in the consumption of fuelwood as cooking time becomes faster and fuelwood efficiency is increased with energy efficient stove compared with traditional. In a similar study, it was reported that installation of an institutional biomass stoves leads to reduction of firewood consumption from 24 – 8 tonnes per term in a particular secondary school. (www.sustainergyweb.eu/improved-biomass, Accessed August 23, 2014). In another study by UDCP (2008), it was found out that certain settlements and tourist camps in Mongolia experienced a reduction in their monthly expenditures and savemoney by the use of the Energy Efficient Stove.

The energy efficient stove present more benefits than the traditional stove. From the above discussion, it is clear that the benefits of using energy efficient from the respondents is highly significant.

III. Conclusion

The Study was able to establish that the adoption of Energy Efficient Stove reduces the expenditure of the user substantially by about 40 – 50%.

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