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ENERGY CONSUMPTION OF RURAL FARMING HOUSEHOLDS IN KWARA STATE, NIGERIA

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ABSTRACT

The rural people in low-income countries do not have access to sustainable energy need. It is necessary to expand access to modern energy services substantially in order to meet the needs of the several billion people who experience severe energy poverty in terms of inadequate and unreliable access to energy services and reliance on traditional biomass. They need to do so in a way that is economically viable, sustainable, affordable and efficient. The study therefore seeks to understand the rural energy consumption of the farming households. The data used for the study were obtained through a four-stage sampling procedure which resulted in a sample size of 120 households. Logistic regression procedure was used to determine the energy consumption pattern and the factors affecting the use. The relationships between the type of energy (modern or traditional) consumed by the household and educational status, household size, age, total monthly income, total amount spent on food per month and distance travelled per week to obtain fuel were established. The regression result showed that age of the household heads and distance travelled to obtain fuel was significant in explaining the variation in the type of energy consumed. Observed energy consumption pattern revealed that most of the respondents consumed more of traditional than the modern energy types. The study suggests that in order to reduce stress and health hazards associated with the traditional energy source, modern energy consumption should be encouraged among the rural households in order that they might reduce the stress and hazards encountered in obtaining and using the traditional energy and also, to reduce the exploitation of forest resources for traditional fuel. Farmers should also be educated by agricultural extension agents on the importance of sustainable farming and the use of sustainable energy.

Keywords: Energy, Tonnes of Oil Equivalent, Fuelwood, Agriculture, Sustainable development

INTRODUCTION

Energy is at the heart of most critical economic, environmental and developmental issues facing the world today. Clean, efficient, affordable, sustainable and reliable energy services are indispensable for global prosperity. Developing countries in particular need to expand access to reliable and modern energy services if they are to reduce

poverty and improve the health of their citizens, while at the same time increasing productivity, enhancing competitiveness and promoting economic growth and sustainable development. There are three key issues to consider in relation to use of energy in a way that is sustainable, these include; provision (access to the energy needed), efficiency and conservation. A well-performing energy system that improves efficient access to modern forms of energy would strengthen the opportunities for the poorest few billion people on the planet to escape the worst impacts of poverty. Such a system is also essential for meeting wider development objectives. Economic growth goes hand in hand with increased access to modern energy services, especially in low- and middle-income countries transitioning through the phase of accelerated industrial and sustainable development.

The growth in global demand for energy has played a key role in causing prices of different energy sources to rise dramatically (World Energy Council, WEC, 2008). The prices of all major fuel have continued to rise. Between January 2003 and summer 2008, the world has seen a cumulative price growth of 300% for oil and 200% for traded coal (Christof and Neelesh, 2008). According to Akin (2008), Nigeria has dual energy crises. The first concerns the recurrent severe petroleum products market shortages of which kerosene and diesel are the most prominent and the rice of petroleum product prices. The second dimension of Nigeria's energy crisis is exemplified by such indicators as electricity black-outs and brown-outs and pervasive reliance on self-generated electricity. Studies show that economic development based on the burning of fossil fuels makes a major contribution to climate change because their use results in the emission of greenhouse gases such as carbon dioxide and methane hence, the need to consider all opportunities to generate energy from sustainable or renewable resources. Promoting a shift to more sustainable consumption requires the increase of both supply and demand for sustainable products. Demand-side energy efficiency measures are an important option for improving the sustainability performance in households, offices and industry, and products play an important role here.

The dismal energy service provision has adversely affected the living standards of the population and exacerbated income and energy poverty in an economy where the majority of the people live on less than two dollars ($2) a day (Akin, 2008). Energy poverty is often defined as lack of access to modern energy services. The concept of energy poverty has been increasingly debated in recent years **(**International Energy Agency, IEA, 2002). At the policy level, significant development has been made in energy and rural electrification. However, in practice, progress appears to have been virtually non-existence (Lukman, 2003). The gap between energy supply and demand is widening with limited solutions in sight. Nigeria's ever-growing population and growth in the household sub-sector has further resulted in increased demand on its energy sub-sector.

Agricultural production is the basis of rural economies. The rural people are involved in subsistence production, processing and storage of agricultural products. These rural households are the major food producers in Nigeria. They produce over 80% of the food needs of the country and they have little or no access to electricity and petroleum products and therefore rely mainly on manual techniques and solar energy (Lukman, 2003). The rural populace do not have access to sustainable energy and therefore depend on biomass which include twigs, branches animal residues, crop residues, fuel wood, charcoal, wood shavings and sawdust (Lukman, 2003; NBS, 2005; Nabinta et al, 2007; Akin, 2008). This rural household energy use pattern which is dependent on their socio economic conditions has inevitably led to the continuous depletion of the energy resources and the emission of pollutants. In addition to fuelwood, charcoal and solid fuel mixtures that include wood in one form or another, new wood energy technologies of outstanding potential for sustainable development are now emerging in developed and developing countries alike.

According to Nabinta et al., (2007), 86% 0f rural households are primarily dependent on biomass as their source of energy. About 90% of the total annual round wood products serve as fuel wood and 60% of this total is used for household consumption. This has therefore created a huge shortage in the supply of fuel wood that might be needed for other industrial and commercial purposes. This fuel wood supply and demand imbalance now constitutes a real threat to the energy and livelihood security of the rural communities as it has led to a series of serious environmental problem such as deforestation, soil erosion, grassland degradation, desertification and some other problems such as human being diseases and loss of time for education and recreation; and even farming. All these have effects both directly and indirectly on agricultural production capacity, since each rural household is made up of small scale farmers who are the major food producers in Nigeria (Lukman, 2003).

The study therefore describes the pattern of the farming household energy consumption, examines the factors affecting energy consumption of the rural farming households and highlights the major challenges facing the present energy use of the farming households in rural areas.

METHODOLOGY

Area of study

The study was carried out in Kwara State of Nigeria, which has about 75% of her population living in the rural areas (KWADP 1989-1993). Over 90% of the rural population engage in various sizes and forms of agricultural activity. The state has about 185,000 farm families with an average of 6 or 7 people per farm family. The state is divided into four zones (A,B,C,D) by the KWADP. Abdulrahaman et. al (2006) also revealed extensive use of economic trees as timber woods and fuel woods in Kwara State. The forest resources are indiscriminately exploited by the poor

inhabitants who solely depend on the forest to earn their livelihood. Thus many forests have been turned to mere woodlands in the study areas.

Sampling method

The population for this study consists of rural farming households in some Local Government Areas in Kwara State with the exclusion of LGAs with cosmopolitan nature. A four-stage sampling procedure was used to collect the sample for the study. In the first stage, one (1) non-cosmopolitan zone (zone B) was randomly selected from the state. The second stage involved the random selection of two (2) LGAs (Edu and Patigi) from of the zone selected. Four villages (Gbadagun, Likpata, Bokungi, Kpangulu, Essanti, Bongi, Rifun and Tankpafu) were then randomly selected from each of the LGAs. Finally, fifteen (15) farming households were randomly selected from each of these villages. In all, one hundred and twenty (120) farming households were selected for the study.

Data collection

The data collected were tailored to get adequate information on the objectives. The primary data for this study were obtained by using structured questionnaire. Secondary data were obtained from related literatures like journals, reports and publication etc. Data that were collected include age, sex, educational status, religion, income, expenditure, farm size. Energy related data in the range of energy supply, energy demand and efficiency were collected. Data on sources of energy; cooking space, energy use, etc were also collected.

Descriptive statistics such as frequency distribution, percentages, averages, ranking and illustrations were used to analyze the level of availability of energy sources and the challenges facing energy usage by the household. Inferential statistics, Logistic regression procedure was also used to determine the energy consumption pattern and the factors affecting energy use.

Parameters from logistic regression model for this study is specified as follows

$$Si = \beta X_i + V_i$$

Where:

S_i = binary energy consumption status. It takes 1 if the household uses improved (modern) source and 0 otherwise.

β = vector of the respective parameter which is estimated using maximum likelihood method.

V_i = error term.

In logistic regression, the probability of an event occurring is estimated as:

$$prob(event) = \frac{1}{1+e^{-z}} \text{----------1) Norusis(1993)}$$

The cut-off value is 0.256284.

This was obtained by the formula $\frac{\text{Total modern energy consumed (toe)}}{\text{Total energy consumed by the household (toe)}}$

In general, when the estimated probability of the event is less than 0.256284, we predicted that the event will not occur, if otherwise we predicted that the event will occur (Norusis, 1993).

The odds that an event will happen = $\frac{\text{Probability of event occurring}}{\text{Probability of event not occurring}}$

Z is the linear combination and expressed as

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p \quad \text{---------- (2)}$$

For this study, the event is a household using the modern energy types

β_0 and β_i are the estimated coefficient of the parameters i= 1,2,3 and 4

X_i= the in dependent variables. And they are as follows:

X_1= Education status of the respondents in number of years spent in school, X_2= Household size of the respondents, X_3= Age of the respondents in years, X_4= Total monthly income of the respondents, X_5= Total amount spent on food in naira/month, X_6= Distance travelled per week to obtain fuel in Km (Heltberg, 2003).

RESULTS AND DISCUSSSION

Table 1 shows the summary of the socio-economic characteristics of the households.

Table 1: Socioeconomic Characteristics of the Respondents

Variables	Frequency	Percentage
Age		
Less than 30	17	14.2
30-39	55	45.8
40-49	21	17.5
50-59	23	19.2
60-69	3	2.5
70 and above	1	0.8
Total	120	100.0
Sex		
Male	76	63.3
Female	44	36.7
Total	120	100.0
Household size		
Less than 5	5	4.2
5-9	25	20.8
10-14	49	40.8
15-19	25	20.9
20 and above	16	13.3
Total	120	100.0
Total monthly income (naira)		
Less than 9,000	39	32.5
9,000- 18,000	72	60.0
Above 18,000	9	7.5
Total	120	100.0
Education		
No education	22	18.3
Quranic education	41	34.2
Primary education	12	10.0
Secondary education	16	13.3
Post secondary education	29	24.2
Total	120	100.0
Maximum number of years spent in school		
Less than 5	6	6.1
5-10	48	49.0
Above 10	44	44.9
Total	98	100.0
Marital status		
Married	112	93.3
Single	7	5.8
Widowed	1	0.8
Total	120	100.0
Religion		
Christianity	11	9.2
Islam	109	90.8
Total	120	100.0

Source: Data Analysis, 2010

Table 2: The energy consumption pattern of the rural farming households

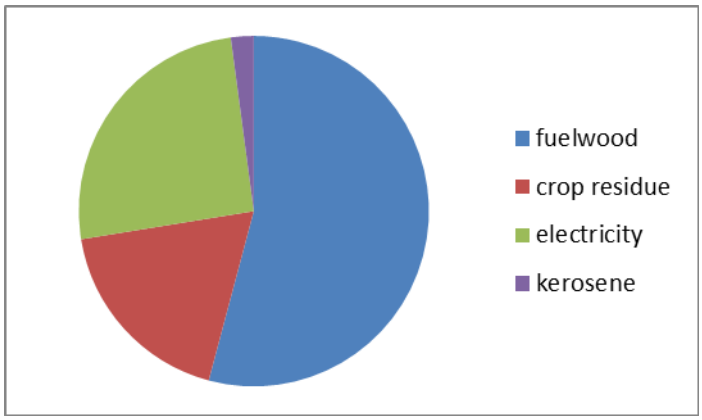
Energy types	Quantity consumed (toe/month)	Quantity consumed (%)	Frequency
Fuel wood	17.6928	56.9	120(100)
Crop residue	5.4264	17.5	109(90.8)
Kerosene	0.688128	2.2	120(100)
Electricity	7.27872	23.4	105(87.5)
Total	31.0860	100.0	

Majority of the respondents (63%) in the study area are male. The mean age of the respondents is 40 years with 60% of the total respondents below the mean age and 30.8% above this mean age. The modal age is 40 years and the median age is 37 years. The mean household size is 13. The modal household size group is 10–14; 40.8% of the respondents fall in this age group. About 48% of the respondents are below the mean household size and 40% are above the mean household size. The mean monthly farm income is N10,279. Majority of the respondents (78.3%) derived their income solely from farming and about 22% derived their income from farming and other occupations such as tailoring, driving and trading. The married respondents are 93.9% of the total sample and 18% of the total respondents are with no form of education. About half (49%) of those with education spent between 5 to 10 years in school. About 34% are with only quranic education as the highest level and 18.3% are with no education. The low litracy level (formal education) may hinder the adoption of modern energy use, sustainable energy use, modern agricultural production technology and sustainable farming. It can also be inferred that the study area is predominantly muslim dominated as 90.8% are muslims.

Majority of the respondents (63%) live in unpainted brick houses with zinc roofs. The respondents spent an average of 6 hours on the farm and go to farm 5 days a week on the average. The households in the study area spend an average of N11,375 per month on food. However, each household eat an average of 4 meals per day and eat at least one meal away from home while on the farm, market, school, and sometimes on journey.

The major sources of energy consumed include; fuel wood, crop residue, kerosene and electricity. Fuel wood and crop residue can be classified as traditional (biomass) energy type while kerosene and electricity are classified as modern (commercial) energy type (Hemlata (1990), All the respondents consumed fuel wood, 90.8% used crop residue, all (100%) used kerosene and 87.5% consumed electricity.

Figure 1: Energy Types and the Quantity of Energy Consumed 1

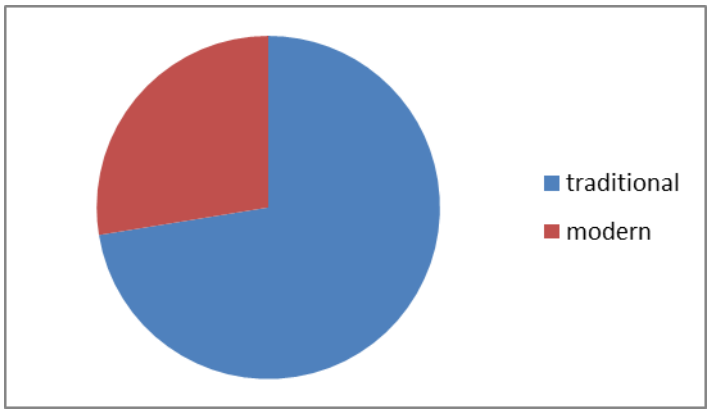


Source: Data Analysis, 2010

*Figures in parenthesis ( ) are percentages
Source: Data Analysis, 2010

Figure 1 is a pie chart showing the amount of energy consumed in a month by sampled household. About 57% of the energy consumed by the respondents are sourced from fuel wood while crop residue constituted only 17.4% of the total energy consumed. However, kerosene, and electricity constituted 2.2% and 23.4% of the total energy consumed respectively. Traditional energy constitutes 72% of the total energy consumed in the study area (figure 2).

Figure 2: Energy Types and the Quantity of Energy Consumed 2



Source: Data Analysis, 2010

*Figures in parenthesis ( ) are percentages
Source: Data Analysis, 2010

This is not without its implications on the environment, climate and sustainable development in the long run. The respondents advanced various reasons for sourcing their energy from various sources. These reasons are shown in Table 3.

Table 3: Reasons for Choosing the Different Energy Types

Reasons	Fuel wood Frequency	Crop residue Frequency	Kerosene Frequency	Electricity Frequency
Availability	111(92,5)	101(92.7)	43(35.8)	104(99.2)
Cheapness	15(12.5)	13(12.4)	5(4.2)	49(46.7)
Culture	31(25.8)	19(17.4)		
Necessary			67(55.8)	
Fastness			1(0.8)	
Convenient	33(27.5)	46(42.2)	85(70.8)	39(37.1)
Nil	1(0.8)	1(0.9)		9(8.6)
Not using		11(9.2)		15(12.5)

About 93% of the total respondents indicated that they use fuel wood mainly because of its availability. As shown in Table 4, 20.8% of the total respondents change the use of energy seasonally.

Table 4: Change of Energy Use with Season

	Frequency	
Yes	25	(20.8)
Reasons		
Rains	21	(17.5)
Nil	4	(3.3)
Total	25	(20.8)
No	95	(79.2)
Reasons		
Always available	3	(2.5)
Culture	47	(39.2)
Nil	45	(37.5)
Total	95	(79.2)
Total	120	(100.0)

*Figures in parenthesis ( ) are percentages
Source: Data Analysis, 2010

The change in the type of energy used is mainly due to the weather condition, i.e. whenever it rains , he fuel woods or crop residues are wet. Also, 79.2% do not change the use of fuel wood because of their beliefs, culture and tradition. Fluctuations in the prices of some energy types, like kerosene occur quite often, and these have led to the reduction in the quantity of kerosene consumed. About 65.0% of the total respondents collect fuel during the day and 34.2% collect any time of the day.

The result of the logistic model is as shown in Table 5.

Table 5: Parameter Estimate for the Logistic Regression Model

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
EDUCATION	-.012	.040	.094	1	.759	.988
HOUSEHOLD SIZE	-.048	.045	1.098	1	.295	.954
AGE	.044	.026	2.937	1	.087	1.045
MONTHLY INCOME	.200	.154	1.690	1	.194	1.000
AMT SPENT ON FOOD	.109	.108	1.014	1	.314	1.000
DISTANCE	.169	.070	5.771	1	.016	1.184
Constant	-1.520	1.207	1.586	1	.208	.219

Model Chi square 11.501
Overall case correctly predicted 62.5%
Sample size 120
Significant at 10%
Distance 5%
Age 10%

Source: Data Analysis, 2010

The logistic model explains 62.50% of the total variation in energy consumption of the households. The result shows that age of the household head and distance travelled to obtain fuel were statistically significant at 5% and 10% respectively. These two variables were positively related to the modern energy type. So, with increase in age of the respondents, the household is likely to use more of the modern energy type. This choice of less stressful energy source may be reasonable for the elderly people in the study. Also, the longer the distance travelled to obtain fuel, the higher the use of modern energy. The distance usually travelled to obtain fuel is farther away from the farm. Travelling long distance to obtain fuel may lead to loss of time for other economic and recreational activities

(Lukman, 2003). As shown by Exp (B) statistic, the odds in favour of using the modern energy types increased by 1.184 for distance travelled to obtain fuel and 1.045 for age of the respondents.

The probability of a household using the modern energy types estimated as: $1 / (1+e^{-z})$

Where $z= -1.520-0.012X_1- 0.048X_2+0.044X_3+0.000X_4+0.000X_5+0.169X_6$

This equation was used to predict that given the cutoff of 0.256284 for z, a household with above 0.256284 for z will likely use the modern energy types and below will use the traditional.

The respondents encountered different obstacles in obtaining the different types of energy. These obstacles are shown in Table 6.

Table 6: Constraints Encountered in Obtaining the Various Energy Types

Constraints	Fuel wood Frequency	Crop residue Frequency	Kerosene Frequency	Electricity Frequency
Far	36(30.0)	33(30.3)	66(55.0)	
Hard to cut	38(31.7)	4(3.7)		
Body pain	2(1.7)			
Injuries	24(20.0)	60(55.0)		
Stress	99(82.5)	85(78.0)	3(2.5)	
Dirt		3(2.8)		
Slow to gather		5(4.6)		
Rain				16(15.2)
Shock				25(23.8)
Flame			2(1.7)	
Nil	5(4.2)	7(6.4)	52(43.3)	63(60.0)

*Figures in parenthesis ( ) are percentages
Source: Data Analysis, 2010

Majority (83%) of the respondents went through stress in obtaining fuel wood. However, most of the respondents (53%) encountered no problem in obtaining electricity. About 43% of the respondents also encountered no problem in obtaining kerosene. But 55% have to travel long distance to obtain kerosene. The respondents travelled long distances in search of the traditional energy types and may encounter injuries and high cost of transportation where available. But electricity is in situ; they do not have to travel around to obtain it. Also, obtaining kerosene does not involve much stress.

In using the energy types obtained, households also encounter various problems. These problems are shown in Table 7.

Table 7: Problems Encountered in the Usage of the Energy Types

Usage problems encountered	Fuel wood Frequency	Crop residue Frequency	Kerosene Frequency	Electricity Frequency
Dust	36(30.0)	31(28.4)		
Eye problem	35(29.2)	38(34.9)	19(15.8)	
Cough	3(2.5)	3(2.8)	3(2.5)	
Heat	17(14.2)	14(12.8)	5(4.2)	
Nil	1(0.8)	1(1.0)	18(15.0)	53(50.5)
Smoke	105(87.5)	93(85.3)	95(79.2)	
Burns (flame)	2(1.7)	1(1.0)	19(15.8)	
Wet	3(2.5)	1(1.0)		
Shock				52(49.5)

*Figures in parenthesis ( ) are percentages
*Source: Data Analysis, 2010

Majority (88%) of the respondents have problems with smoke when using fuel wood. This is also true for crop residue as 85.3% have problem with smoke. Majority (79%) of the respondents also have problems with smoke in kerosene usage. But most (50.5%) of the households do not encounter any problem in using electricity. Other problems encountered in using fuel wood and crop residue include eye problem, cough, dust and heat etc. For electricity, 49.5% of respondents encounter electricity shock. The use of the traditional energy types in an unsustainable way may have negative impacts on the health of the users. It may cause eye irritation, running nose, skin irritation, difficulties in breathing, wheezing, chest pain, abortion and even death (Lukman, 2003).

CONCLUSION

The essence of sustainable development is that the maintenance of livelihoods for individuals and families, as well as on economic growth and environmental care are not separate but mutually inclusive. There is need for government policies to reinforce the existing policy for sustainable forest management. There is an urgent need to prevent the illegal felling of trees around the residential areas. These trees usually serve as wind breaks, cover the soil and prevent erosion. Continuous tree felling is a threat to the environment.

Use of energy saving appliances and practices aim at minimizing consumption of energy and hence achieving sustainable production. Advantages of energy saving kilns and stoves include providing time for women for other development activities, promoting the utilization of local resources and enhancing environmental sanitation by utilizing waste products such as sawdust and rice husks whose disposal is sometimes a problem**.** Anaerobic digesters

producing biogas (methane) offer a sustainable alternative fuel for cooking that is appropriate and economic in rural areas. Efficient wood burning stove technologies mean that women need to collect less fuelwood and the family's health improves as they are not breathing in wood smoke. To increase the life expectancy and enhance sustainable regional and rural development there is need to increase the supply of modern energy types. Farmers should also be educated by agricultural extension agents on the importance of sustainable farming and sustainable energy use.

There is a need for a policy shift towards encouraging the rural dwellers in the use of sustainable modern energy source. This may be the right step towards the preservation of our eco-system. The government involvement in rural energy systems is essential in providing an enabling environment. However, parallel operations by government must not compete with rural energy systems. Policies for ensuring synergistic government involvement are vital. However, the Power Holding Corporation of Nigeria is presently the sole provider of electricity and the electricity provided and generated is not sufficient. The removal of monopoly supply of electricity in the country can be a policy option. The electricity sector needs be privatized as in the case with communication.

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