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Determinant of Rural Household Poverty Nexus Fuel Consumption among Fisherfolks in Kwara State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author YUO designed the study, perform the statistical analysis, wrote the protocol and first draft of the manuscript. Authors ZA, AMA and SAA managed the literature searches, analyses of the study and further literature searches, review of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The study examined rural households' fuel consumption pattern in Kwara State, Nigeria. Primary data using a structured questionnaire and interview were administered to select randomly 110 rural farming households. The result revealed a link between forests, agricultural production and poverty as about 79% of sampled respondents titled towards using biomass for their energy sources. About three-fifth (63%) of the rural fishery households could be considered to have a low energy expenditure pattern because they fell below energy poverty line of ₦640 ($4.05) per adult equivalent per month. Result also estimated the log-likelihood ratio to be -28.7, the adjusted R^{-2} of 0.557 implies that the explanatory variables were collectively able to explain about 56% of the total

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variation in energy consumption pattern among the rural households. The study recommend designing more economical, efficient and less pollutants cooking stoves and lighting equipments that uses local bio-fuels (renewable) and harnessing modern energy source to supplement the use of biomass for rural farming households to reduce energy poverty level.

Keywords: Bio-fuel; poverty; renewable; shea butter oil.

1. INTRODUCTION

Nigeria is one of the most energy resource endowed nations in the world and energy export is the mainstay of its economy. These comprise of energy resources which are renewable such as solar, wind, tar sand, geothermal, hydro and biomass as well as non-renewable such as petroleum, coal and natural gas. Nigeria has an estimated 176 trillion cubic feet of proven natural gas reserves, giving the country one of the top ten natural gas endowments in the world and the largest endowment in Africa. Natural gas is a natural occurring gaseous mixture of hydrocarbons gases found in underground reservoirs. It consists mainly of methane about 70% - 95% with small percentage of ethane, propane, butane, pentane and other heavier hydrocarbons with some impurities such as water vapour, sulphides and carbon dioxides [1].

With proven oil reserves exceeding 9 billion tons, Nigeria is one of the largest hydrocarbon feedstock producers in Africa and ranks twelfth place worldwide. The country relies heavily on its petroleum industry for economic growth, the sector accounts for about 80% of government revenues and provides 95% of foreign exchange [2]. It is also endowed with rich vegetation and abundant water resource, about 214 billion m^3 of surface water and 87 km^3 of ground water both of which are capable of generating hydro-electric power. According to [3], total wood removals from Nigerian forests in 2005 amounted to 86,626.797 km^3 and removals for wood fuel from forests in the year 2005 were 72,710.935 km^3, the difference being made up by industrial round wood, which accounted for 13,915.862 km^3. In many parts of Nigeria, more than 90% of the rural population relies on fuel-wood and charcoal, and the reality is that the correlation between forests and poverty is strong [4]. With a reserve of over 2 billion metric tonnes of coals, Nigeria produces about 200,000 to 600,000 tonnes yearly [1].

Despite these enormous energy resource potentials and endowment, the country could not provide affordable energy for majority of its citizenry and, energy poverty remains a critical developmental challenge. Suffice to note that the development and exploitation of such energy sources have been skewed in favour of the fossil fuels, mainly petroleum products and of recent natural gas which are non-renewable resources. Energy services are fundamental to achieving sustainable development. In many developing countries, provision of adequate, affordable and reliable energy services has been sufficient to reduce poverty and improve standards of living. To provide such energy services for everyone in an environmentally sound way will require major investments in the energy-supply chain, conversion technologies and infrastructure particularly in rural areas [5]. Despite its declining share in energy, global consumption of wood energy has continued to grow. The study was aimed at domestic energy consumption pattern of rural fishery households in Kwara State, North Central Nigeria, specifically, to identify various energy sources and determine factors affecting rural fishery household's fuel consumption pattern.

2. METHODOLOGY

2.1 Study Area

The study was carried out in randomly selected villages of Kwara State, North Central Nigeria. The study area has two distinct seasons with mean annual rainfall ranges from 800 mm to 1600 mm. The rainfall is concentrated between the months of April and October with two peaks in July and September which serves as a condition that facilitates growing of herbs, shrubs and economic trees for fuel wood production. Economic trees found in the area includes: *Citrus sinensi, Parkia biglobosa, Butyrospermum parkii, Azadiracta indica, Mangifera indica, Acacia species, Delonix regia and Anacardium occidentale.*

2.2 Methods of Data Collection

Kwara State is located between latitude 7º 45" and 9º 30"N and longitude 2º 30" and 6º 25"E. It is bounded in the North by Niger State, in the South by Oyo, Osun and Ekiti states, in the East

by Kogi state and in the west by Benin Republic (Fig. 1).The State has a land mass of 32,500 km^2 or 3,682,500 hectares with a topography that is mainly plain lands to slightly gentle rolling. The State's population and farm families were projected in 2014 to be about 3,043,222 and 306,585 respectively with average density of about 90/km^2 [6]. The climate of the area is tropical with two main seasons and an intervening cold harmattan period occurring mostly from December to January. A humid tropical climate prevails over the State with two distinct seasons, the wet and dry seasons. The minimum average temperature throughout the State ranges between 21.1ºC and 25ºC while the maximum average temperature ranges from 30ºC and 25ºC. The State is primarily agrarian with great expense of arable land and rich fertile soils [6].

Primary data were obtained using a structured questionnaires and interview. A multi-stage random sampling technique was employed for selecting the representative of rural fishery households in Kwara State, Nigeria. The first stage involved the random selection of the four fishing Local Government Areas in Kwara State viz. Asa, Lafiagi, Moro and Patigi LGAs (Fig. 1). Two villages were randomly selected from each of the 4 LGAs. Finally, with combined efforts of Agricultural Development Project staff and '*Sarkin Ruwa'* or village heads, 15 fisherfolks were randomly selected from each of the villages making a total of 120 fishery household heads for the study. The selected villages were Laduba, Gboroko, Chewuru, Likpata, Kungu, Ikpata-Jebba, Gbaradogi and Rogun.

Primary data were obtained using a structured questionnaires and interview. Information on the sources of energy used for cooking, heating and lighting include: Fuel wood, charcoal, dung, saw dust, crop residue (traditional) and kerosene and electricity (modern) were sought from sampled households.

2.3 Analytical Techniques and Tools

Energy poverty line was generally considered to be the value of energy consumption that is required to meet the minimum energy needed for an individual or household to be acceptable in the community. Energy poverty line was measured as:

Per capita energy consumption=

$$\frac{Totalhouseholdmonthly\ \text{energy}\ \ expenditure}{AdjustedHouseholdSize} \quad (1)$$

The poverty line that was used for this study was defined as the two-thirds of mean energy expenditure per adult equivalent. Adult equivalent was generated from Organization for



Fig. 1. Map of Nigeria (a; inset) and (b) map of Kwara State (modified from [6])

Economic Corporation and Development (OECD) Scale as follows:

$$\mathrm{AE} = 1 + 0.7\,(\mathrm{N}_{1\mathrm{adult}} - 1) + 0.5\mathrm{N}_{2\mathrm{children}} \quad (2)$$

Where, AE represents adult equivalent, N_1 represents the number of adult aged 15 and above and N_2 is the number of children aged less than 15.

In logistic regression, the probability of a household consuming 2/3 of mean energy consumption was determined by an underlying response variable that captures the true economic status of rural fishery households. It is assumed that rural fishery households that consumed above the 2/3 has tendency to adopt modern energy or shift in favour of modern energy source. The underlying response variable y* in the case of binary choice is defined by the multivariate logit regression relation in equation 3:

$$y^* = \Sigma x_i \beta_j + \mu \quad (3)$$

The relevant logistic expressions are given as equations 4 and 5:

$$Prob(y* = 1) = 1 - F * \left(\Sigma X_i \beta_j\right) = \frac{e^{\Sigma X_i \beta_j}}{1 + e^{\Sigma X_i \beta_j}} \quad (4)$$

$$Prob(y* = 0) = F * \left(\Sigma X_i \beta_j\right) = \frac{e^{\Sigma \mathrm{xi\beta j}}}{1 + e^{\Sigma \mathrm{xi\beta j}}} \quad (5)$$

Where:

1 = If household spent at least 2/3 of mean total energy consumed/month (₦),
0 = If household spent less than 2/3 of mean total energy consumed/month (₦),
F = the cumulative distribution function for μ_i.

The explicit logit model was expressed as:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta_5 X_5 + u \quad (6)$$

Where:

Y = Energy expenditure per adult equivalent of household (₦) per month;
X_1 = Age of household head (years);
X_2 = Education (years of formal schooling);
X_3 = Adjusted household size by OECD scale;
X_4 = Total amount spent on energy divide by total expenditure (₦) per month and
X_5 = distance travelled per month to energy source(km);

$\beta_1 - \beta_5$ = The coefficients for the respective variables in the logit function and u = error term.

In capturing the degree of poverty among the rural fishery households, a Foster-Greer-Thorbecke (FGT) index [7] was used to describe influence of expenditure from energy source (output) and/or whether energy source was local or modern techniques on welfare of rural households. The test of robustness of poverty line was carried out by plotting the CDFs of the two distributions against the specified range of poverty line, of expenditure for two household groups (modern or traditional) at a defined poverty line, varied at 70%-145%.

3. RESULTS AND DISCUSSION

3.1 Descriptive Variables Used in the Logit Model

Analysis of summary of socio-economic and institutional variables used in the Logit Model is presented in Table 1. Results revealed that rural fishery household heads in the study area dominated by average productive age of 48 years with mean adjusted household size of 7 and estimated mean years of schooling of rural households of 1.1 years, skewed towards informal education and below 2011 UNDP mean education index of 5 years for Nigeria. Seventy three percent of rural fishery households travelled at least 1 Km to search for energy either for cooking or lighting (Fig. 2).

Therefore, lack of access to affordable, reliable and modern energy service (energy poverty) often accompany by travelling a long distance to search for biomass may have adverse effect on ecosystem. These include deforestation, desertification, soil erosion and reduced agricultural productivity by devoting productive time for searching for fuel wood. In addition, biomass such as fuel-wood, roots, agricultural residues and animal dung constitute about 61% major fuel used by rural households. Biomass energy produce high emissions of carbon monoxide, hydrocarbons and particulate matter which are linked to acute respiratory infections, chronic obstructive lung diseases, low birth weights, lung cancer and eye problems, primarily, among women and children [8].

3.2 Energy Expenditure Patterns

The result of the analysis of amount spent on energy as a part of household expenditure is on Table 2. The result showed that 63% of sampled fisherfolks were below energy poverty line.

Table 1. Definition and dominance indicators of the variables used in the logit model

Variables description	Dominance indicators	Mean	Min	Max	*a priori*
Age (years)	65% below 50 years	46	21	71	positive
Level of education (years)	68% had no primary educ.	0.99	0	12	positive
Adjusted household size	76% had adjusted size of 7-9	7.5	4	17	positive
Distance travelled (km)	73% travelled above 1km	2.3	0.5	8.0	negative
Energy expenditure (₦)	56% spent <10% of total Ex.	1500	400	2970	positive
Monthly expenditure (₦)	63% had >₦7400 ($47)PAE	7300	3980	18450	-
OOO Major occupation	92% engaged in fishing	-	-	-	-
MMajor fuel types	61% uses biomass				
Energy Expenditure (₦)	63% below 2/3 monthly/PAE	dependent variable			-

Source: field survey, 2014. Ex. is expenditure & PAE connotes per adult equivalent

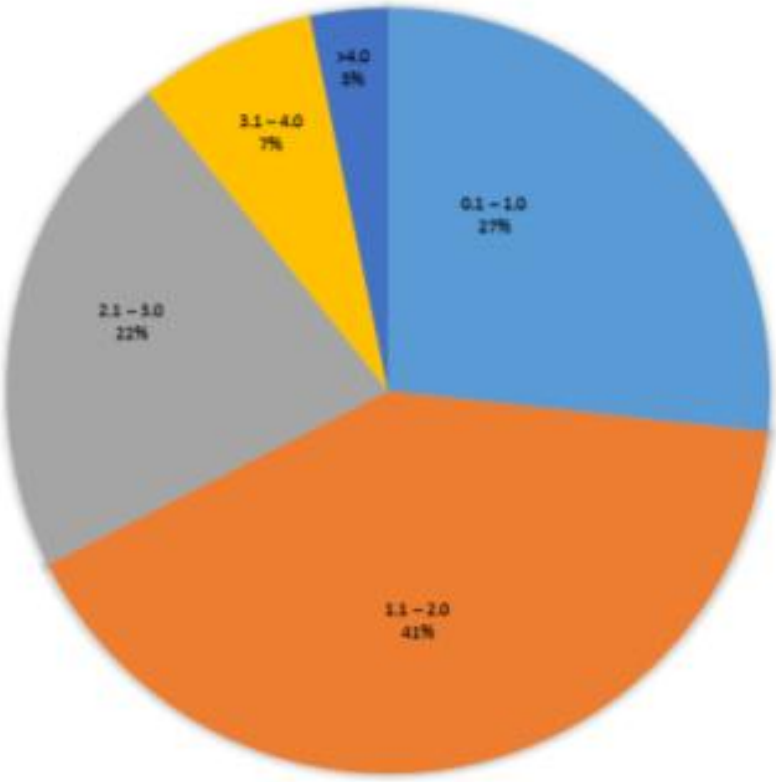


Fig. 2. Distribution of households' based on distance to energy source

The result also showed that the bulk value of rural fishery households (78%) of energy expenditure went for biomass or traditional source and about 22% of households' energy expenditure was captured by electricity and fossil fuel mostly kerosene. Other traditional method of energy sources include animal dung and locally made lantern such as "Jango" and " Fitila" that uses fuel such as Shea butter oil, palm oil, kernel residues and kerosene (lighting). This shows a link between forests, agricultural production and poverty as about 73% of sampled fisherfolks titled towards using biomass that comprises of traditional energy sources.

It is very clear from the result of the analysis of energy source that the bulk of rural fishery households depend largely on biomass for cooking and local or improvised lighting source. The rural household that uses electricity as a means of lighting portray higher level of well-being and measure of good health and invariably reduced poverty status. This was because the multiplier effect of electricity aside for cooking and lighting may enable the rural households to

have access to fishery related information, nutrition and health matter through gadgets such as television, telephone and radios. However, the bulk of households who are only exposed to local lamps portend higher poverty status, since they may be exposed to high emissions of carbon monoxide, hydrocarbons and particulate matter and deprived of some privileged health and fishery information through radio battery only. The study is comparable with findings of [9-11].

Fig. 2 show households' distribution based on distance to energy source. About 41% of rural households travelled between 1 and 2 km before they could obtain either biomass or modern energy such as kerosene, while about 11% would travel at least 3 km to acquire energy for cooking or lighting. This could be attributed to a number of factors such as distance of gasoline station to fisherfolks' settlements, arbitrary prices, scarcity of fuel commodity to the respondents' house or village and near absence of adequate gasoline and electricity facilities in the study area. Therefore, non-utilization of modern energy facilities is an indication of low level of well-being. It suffices to note that far distance to energy has significant opportunity cost on time [12] and could expose rural households to hazards such accumulated stress and body pains which may be aggravated to ailments.

3.3 Poverty Status Based on Energy Consumption

The rural fishery households' mean per adult equivalent expenditure disaggregation is presented in Table 3. The result shows that energy expenditure value had a range of ₦295 ($1.82) to ₦2670 ($16.48) per adult equivalent per month with a mean of ₦1700 ($10.49). About 63% of ruralfishery households could be considered to have a low energy expenditure pattern because they fell below energy expenditure line of ₦640 ($3.95).This implies that only about 37% of fishery households were above the poverty threshold consisting of 13.3% and 7.5% energy expenditure subgroups respectively. Therefore, the energy expenditure subgroup is also another pointer towards poverty status of rural fishery households in the study area. For example, energy expenditure range of ₦1.0–₦319 ($0.006–$1.97) could be classified as extremely poor; ₦320–₦639 ($1.98–$3.94) as moderately poor and ₦640–₦960 ($3.95–$5.93) as transient non-poor; while the other two sub-groups, ₦961−₦1280 ($5.93–$7.90) and those above ₦1280 ($7.90) may be identified as non-poor sub groups.

Alternatively, the expenditure pattern with a poverty threshold of ₦640 ($3.95) drew a demarcation between poor and non-poor. This result was in line with the view of [13] who posited that analysis of poverty status identifies and groups those who experience poverty most intensely, deepening the understanding of poverty and ensure that key groups are not neglected in analysis and action.

3.4 Determinant of Poverty of Fishery Households

The logistic regression result of the determinant of energy poverty among the rural household is shown in Table 4. An additional insight was also provided by estimating the log-likelihood ratio to be -29.8, the Adjusted R^{-2} of 0.408 and the LR (Chi-square) of 34.7 (significant at 1% level) implies that the overall model is fitted.

Table 2. Distributions of average energy consumed (₦)/month per adult equivalent

Sources	Amount (USD=$)	Amount (₦)	(%)	Cum. Freq (%)
Traditional				
Firewood	2.59	420	43.8	
Charcoal	1.17	190	19.8	63.6
Saw dust	0.22	35	3.6	67.2
Crop residue	0.37	60	6.3	73.5
Others (local)	0.25	40	4.2	77.7
Modern				
Kerosene	0.68	110	11.4	89.1
Electricity	0.65	105	10.9	100
Total	5.93	960	100.0	
Energy poverty line (2/3)	3.95	640		

Source: field survey, 2014, note: ₦ denote Nigeria currency (Naira) and 1USD ($) = ₦162 during field survey

Table 3. Poverty status and expenditure of energy consumed (₦)/month/AE

Amount (₦)	Amount (USD=$)	Frequency	Percentage (%)
1.0 - 319	0.006–1.97	29	24.2
320 - 639	1.98–3.94	47	39.2
640 − 960	3.95–5.93	19	15.8
961 - 1280	5.93–7.90	16	13.3
>1280	7.90	9	7.5
Total		120	100

*Field survey, 2014; note: energy poverty line=₦640 ($3.95); * =poverty class interval*

Only three variables: Adjusted household size (X_3); expenditure ratio (X_4) and distance travel to obtain energy (X_5) were statistically significant at 1%, 5% and 10% respectively. However, the regression co-efficient for adjusted household size (-0.075) and distance travel (-0.178) implies that decrease in these variables would reduce the poverty level. However, an increase in expenditure ratio (0.035) above 2/3 will decrease the propensity of a household falling below the poverty line and the rural farming household may likely use more of the modern energy types (for cooking and lighting) such as kerosene, electric stoves, electric boilers, rechargeable lamp and electricity. The use of modern energy such as electricity and generator powered by petrol and diesel are also health and information driven since household would be opportune to use gadgets such as fan, television, radio and mobile phones.

Table 5 presents the profile of the poverty status of the rural fishery households based on source of energy for lighting and cooking. There was prevalence of poverty among rural fishery households that utilize local or traditional methods (0.775) for lighting in their houses. The use of local or traditional lighting materials however has negative implication on pollution and health hazards for the rural fishery households as was observed by several studies such as [14,15,12,16]. The households that utilize either kerosene stove or electrical appliances (P_0=0.226) had lower poverty incidence compared to the households that utilize traditional method. Further, about 76% of rural fishery households that utilized local materials for cooking were impoverished. Only 25% of rural fishery households that utilize either kerosene stove or electrical appliances for cooking were poor. Therefore, rural households that have access to and utilize modern sources of energy such as electricity for lighting and cooking is an indication of higher level of well-being for the rural household.

Suffice to note that rural households in the study area have low income and barely lived above subsistence level. Installation of modern energy facilities such as electrical and LNG gas appliances are virtually non-existent since it required fund which might not be readily available to the rural households. This resulted in the use of impoverished local/ traditional cooking stove that uses fuel wood and charcoal and lighting (lantern) materials such as ‘‘Jango’’ that uses shea-butter oil, palm kernel residue and seldom kerosene, with possible negative effect on their health status [16].The result confirmed that the assertion that fuel wood and charcoal account for over 80% of national energy consumption [17].

Further, [8] confirmed that rural households in developing countries that uses biomass tend to expose to significant amounts of pollutants that causes about 1.5 million premature deaths per year and more than 4000 deaths per day and biomass use is directly responsible for more deaths than malaria, almost as many as tuberculosis and almost half as many as HIV/AIDS (Fig. 3).

The result of decomposition of poverty based on energy sources (traditional or modern) in Table 5 was reinforcing in Fig. 4. The Cumulative Distribution Function (CDF) of households that utilise modern energy for cooking and lighting lay completely above other households with traditional energy facilities. This gave an indication of presence of stochastic dominance meaning that this sub-group of households with local energy source will always be poorer than their counterparts. It further implies that the head count ratio was robust to all possible choices of poverty lines within the specified range. Therefore, rural households that utilize modern energy will always maintain a better standard of living compared to households that utilize traditional energy sources.

Table 6 presents all the possible pairs of the energy categories with their poverty incidences, gaps and severity, significantly different from one another (0.01>P<0.01). This implies that both energy sources (lighting and cooking) affect the level of poverty incidence, gaps and severity.

Table 4. Maximum likelihood estimation of the logit model for artisanal fishing poverty

Variables	Co-efficient (β)	Standard error	t-value
Constant	0.102*	0.056	1.82
Age of household head (X_1)	0.471	0.312	1.51
Level of education (X_2)	-0.093	0.082	-1.13
Adjusted household size (X_3)	-0.075***	0.031	2.42
Expenditure ratio (X_4)	0.035**	0.016	2.18
Distance travelled (X_5)	-0.178*	0.094	1.89
No of observation	120		
Log likelihood	-31.4		
LR Chi^2	34.7		
Prob>Chi	0.000		
Pseudo R^2	0.408		
Adjusted R^2	0.371		

*Source: logit result, 2014; note ***; **; * significance at 1%, 5% and 10% respectively*

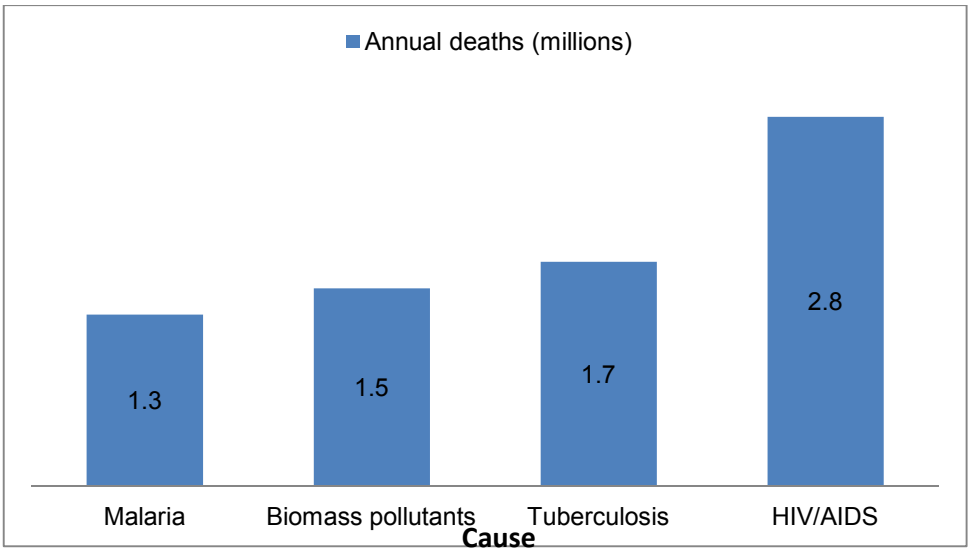


Fig. 3. Comparative global deaths and cause [8]

Table 5. Identified poverty sub-groups based on sources of energy

Variables	P_0	P_1	P_2	n	Share of poverty	
					q	%
Source of Energy (lighting)						
Local/traditional	0.775	0.006	0.000	89	69	90.8
Modern: kerosene/electricity	0.226	0.001	0.000	31	7	9.2
Source of Energy (cooking)						
Fuel wood/Charcoal/crop residue	0.761	0.006	0.000	71	54	71.1
Kerosene stove	0.514	0.002	0.000	37	19	25.0
Electrical appliances (electricity)	0.250	0.000	0.000	12	03	3.9

Field survey, 2014; note: P_0, P_1, P_2 were the headcount, poverty gap & squared poverty gap indices and energy poverty line (₦640) was used to identified households as either poor or non-poor while n and p are the total no of households and the total no of poor households respectively

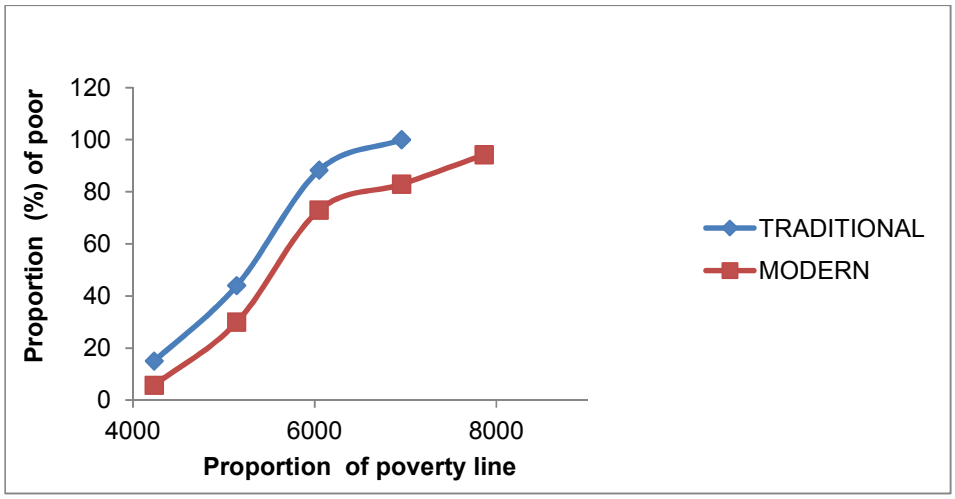


Fig. 4. Distribution of dominance analysis by types of energy source

Table 6. Test of significant of pair of energy variables

Variables	P_0	P_1	P_2
Source of Energy (lighting)			
local versus modern	-4.031***	1.920**	-1.240
Source of Energy (cooking)			
111ff biomass (fuel wood) versus kerosene (fossil)	5.241***	-1.670*	1.150

*Field survey, 2014; ***; **; * significant at 1%; 5% & 10%*

4. CONCLUSION AND RECOMMENDATIONS

It is very clear from the result of the analysis of energy source that the bulk of rural households lack access to modern energy. The bulk of sampled fishery households depend largely on traditional biomass for cooking and local or improvised lighting source. Therefore, improving the local biomass supplied and used for cooking and lighting such as designing more economical, efficient and less pollutants cooking stoves and lighting equipments that uses local bio-fuels (renewable) in the study area is recommended.

Harnessing and installation of modern energy source both renewable and non- renewable in the rural areas to supplement the use of biomass for rural farming households' viz. Fossil fuels, Electricity, biogas, coal, wind and solar will reduce energy poverty level. Ultimately, this will make substantial progress on the global targets, the first Millennium Development Goals (MDG) of halve the percentage of people in extreme poverty and hunger, the third goal of promoting gender equality and empower women, the sixth goal of combating diseases and the seventh goal of ensuring environmental sustainable policy of global objective.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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