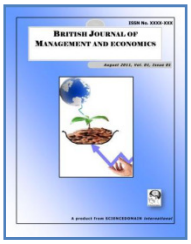

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Economic Analysis of Fuelwood Production and Consumption: Evidence from a Nigerian State

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Research Article

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ABSTRACT

Aims: Against the backdrop of global and national energy crisis leading to lingering demand and supply gap of cooking energy in Nigeria, this study was designed to identify the consumption pattern of fuelwood products, profitability of fuelwood supply and the major supply determinants in Kogi State, Nigeria.
Study design: Cross-sectional study.
Place and Duration of Study: Kogi State, Nigeria.
Methodology: A total of 90 respondents were randomly selected comprising of 30 respondents each from 3 Local Government Areas (LGAs) of the state (i.e. Olamaboro, Lokoja and Idah LGAs, each representing an agricultural zone). An interview schedule and a set of structured questionnaire were used to collect data from the respondent. Data collected were analyzed using descriptive statistics, various measures of profitability and multiple regression analyses. The semi-log model was chosen as the lead equation out of other three functional forms. The model was subjected to econometric diagnosis (tests for multicollinearity and heteroscedasticity) and having passed the test, it was used for economic analysis.
Results: It was found that majority of the respondents used fuelwood for cooking and food processing/preservation. Fuelwood supply business was very profitable with a Profitability Index of 75% and an average profit of about US$3470.03 per annum/supplier. The profitability of the business was largely influenced by education level, experience, market price of fuelwood and distance of supplier/producer from the forest.
Conclusion: It was recommended that government should promote the business in a sustainable manner as a way of poverty alleviation, employ extension agents to train the suppliers and plant more forests near urban and rural areas.

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Keywords: Fuelwood supply; fuelwood consumption pattern; fuelwood profitability; fuelwood supply determinants; Kogi State; Nigeria.

1. INTRODUCTION

One of the most useful forest resources consumed by man is fuelwood. Fuelwood comprises of wood and wood pulp material obtained from trunks, branches and other parts of trees and shrubs used as fuel for cooking, heating or generating energy through direct combustion. It was noted that among all tree products, fuelwood is the mostly utilized in Nigeria (Ezema, 2001 in Ebe, 2006). The rural population traditionally relies on the forest for various food products and fuel wood (NTFPs), both for own consumption and for sales to the urban sector. Chukwu (2001) observed that over 70 percent of the total population of Nigeria relies on fuelwood or charcoal as their major source of energy for cooking and heating purposes. International Food Policy Research Institute (IFPRI) publication (Onyema, n. d) indicated that about 50 percent of Nigeria's total energy consumed for agriculture and other domestic food processing activities came from fuel wood. This observation was buttressed by another recent data published by The Solar Cooking Archive (2011) which put the estimate of Nigeria's fuelwood consumption as percentage of energy at about 87 percent. The household sector accounted for 15 to 25 percent of primary energy use in developed countries. It has been noted that fuelwood trading is a very profitable business (Ebe, 2006). Ebe also indicated that in Enugu State of Nigeria, fuelwood supply were influenced largely by socio-economic and production factors such as farmer's age, education, household size, transportation cost, price of fuelwood, labour time, income, price of alternative sources of energy. He maintained that the increase in consumption of fuelwood in Nigeria could be attributed to the following two major factors: 1) rapid urbanization brought about by migrants from rural areas who carried along with their rural ways of life; 2) scarcity of conventional fuels such as kerosene, cooking gas and the subsequent increase in the prices of these fuels. With increasing demand for fuelwood in urban areas and rural areas of Nigeria (Remedio, 2004) a market system was being developed for the product thus creating new business opportunities that is capable of reducing poverty among the rural farmers who have access to the Savannah and forest vegetations of Nigeria where fuelwood are mostly found. The problem of cooking fuel scarcity was exacerbated by increasing energy crisis in the world which makes conventional fuel derived from crude oil less affordable. Whereas the fossil-fuel crisis affected mainly urban households in developed countries, the firewood crisis was said to be affecting rural households in developing countries. It manifested itself as a severe shortage of firewood, the main cooking and heating fuel used by such households (Arnold et al., 2003). It is therefore worrisome to observe that the current reserve potential of 80 million cubic metres of fuelwood per year in Nigeria, according to Community Research and Development (CREDC, 2008) in Onyema (n. d.), is still underutilized. Despite the significance of fuelwood in both rural and urban households in Nigeria, it is surprising to observe that not much research has been carried out to verify the supply determinants and on the aspects of fuelwood consumption in Nigeria, especially, in Kogi State of Nigeria. Ebe (2006) and Onoja and Idoko (2008) in their studies respectively focused on marketing of fuelwood in Enugu State and demand aspects of fuelwood in Kogi State. They do not attempt to uncover the determinants of fuelwood supply and consumption patterns in Kogi State, located in the Guinea Savannah region of Nigeria. This study therefore makes a bold attempt at closing this research gap.

1.1 Objectives of the Study

The broad objective of this research is to evaluate the consumption patterns of fuelwood, its profitability as a business and fuelwood supply determinants in Kogi State, Nigeria. Specifically the study was designed to:

1) describe the households' relative distribution of fuelwood products utilization in the study area;
2) determine the profitability of fuelwood production/supply in the study area; and to
3) determine the factors influencing fuelwood profitability among producers/suppliers in the study area.

1.2 Theoretical and Analytical Frameworks

Shortages of fuelwood have occurred in many societies during the course of human history and in this respect Africa's problems are not new and the key factors that have shaped and continued to drive the fuelwood supply are the forest cover, population and public forest policy including institutional, legal and regulatory frameworks of forest management (Energy Division/ CILSS, 2004). According to Olayide and Heady (1982), the two world problems of agriculture, under capacity and over capacity, have some striking features in common. First, both are associated with low returns to labour resource and in this case the low return is absolute for the former and relative for the latter. Second, both have become the focus of concern by policy makers. Third, under capacity and over capacity are both deeply rooted in the resource structure of agriculture. Fourth, both are partly characterized by the level and status of agricultural technology as reflected in the types and magnitudes of resources employed. They also defined resource structure as the overall framework of institutions, behavioral and technological relationships which determine resource employment and hence output, efficiency and income in agriculture. This framework, they noted, could be systematized into a set of demand, supply and production functions.

According Samuelson and Nordhaus (2005), producers supply commodities for profit and one major element that underlie supply curve is the cost of production, which are determined primarily by the prices of inputs and technological advances. They also noted that other major forces determining the supply curve were market price of the commodity, price of related goods, government policy and other special influences (e.g. weather, expectations etc). In fuelwood supply examples of special influences could be other socio-economic variables such as age of farmers, household size, gender, experience in production, distance from the forest where fuelwood are harvested from and technology used in production (Ebe, 2006). The indicator theory identified factors influencing fuelwood scarcity (supply and demand) which include labour, time, consumption of less preferred types of biofuel, cutting of live wood, and the people's perception of fuelwood (Dewee, 1989). The indicator theory considers many variable unlike the gap theory of fuelwood marketing which held that fuelwood was being depleted because of the gap between demand and supply. The gap theory estimated the gap between demand and supply using the Malthusian's model approach which was based on the premise that fuelwood supply is influenced by population and the supply of fuelwood is normally measured by the increment or yield of fuelwood (World Bank, 1985). Of particular interest for policy makers is the effect of wages, market prices, income, natural resource availability, and various household characteristics such as ethnicity and education level, on supply and demand decisions. Estimating fuelwood

demand and supply equations that contain these key explanatory variables should therefore be a primary goal for empirical economic work (Heltberg et al., 2000; Cooke et al., 2008).

1.2.1 Gross margin (GM)

Johnson (1982) and Kay (1986) recommended the use of Net Farm Income (NFI) in ascertaining the profitability of farmers. NFI, according to them is derived after obtaining the Gross Margin (GM). GM is the amount of money realized after deducting variable expenses or costs from total sales or income. It is usually used when NFI is obtained by adjusting net cash farm income for total depreciation, net inventory changes and value of products consumed at home. Gross Margin = Total Income (TI) – Total Variable Costs (TVC). NFI = GM – TFC (where TFC = Total Fixed Costs).

1.2.2 Regression analysis

According to Koutsoyiannis (2001) the primary objective of regression analysis is to determine the various factors which cause variations of the dependent variable. SPSS software defined it as the estimation of the linear relationship between a dependent variable and one or more independent variables or covariates.

2. METHODOLOGY

The study, a survey design, was carried out in Kogi State of Nigeria. Kogi State is bordered by nine other States and is the most centrally located State in Nigeria. Kogi State has an average maximum temperature of 33.2℃ and average minimum of 22.8℃ (Kogi State Government, 2007). The State has two distinct weathers – dry season, which lasts from November to February and the raining season that lasts from March to October. Annual rainfall ranges from 1016mm to 1524mm. The study was undertaken in three Local Government Areas chosen randomly from three agricultural zones noted for commercial production of fuelwood in Kogi State. A total of 90 respondents were selected using stratified random sampling technique out of which 30 each were drafted from each Local Government Area (LGA) (Bassa, Lokoja and Ankpa LGAs) each representing an agricultural zone in the state. For collecting relevant data from the respondents, an interview schedule was prepared considering the objectives in view. Personal Interview was conducted with all the 90 respondents using interview schedule.

2.1 Empirical Data Estimation Method

Simple descriptive statistics like percentage, mean, range etc were calculated and at the same time Gross Margin and Net Income were calculated following Kay (1986) and used to determine the profitability of the fuelwood producers/marketers in the state. From the results of the budgetary analysis, the following ratios were obtained.

– Profitability Index (PI) or Return on sale = NI/TR
– The rate of return on Investment (RRI) = NI/TC *100
– Rate of return on variable cost (RRVC) = TR-TFC/TVC *100
– Operating Ratio (OR) = TVC/TR

Where,
TVC = Total Variable Cost
TC = Total Cost

TR = Total Revenue
NI = Net Income
TFC = Total Fixed Cost.

Multiple regression analyses were conducted to ascertain the determinants of fuelwood supply in the study area. Four functional forms, (linear, semi-log, Cobb-Douglas and exponential functions) were used out of which the best model was selected based on its performance with respect to its estimated F-Ratio, Akaike Information Criteria and conformity of most of the coefficients' signs to theoretical expectations. Before using the lead equation it was subjected to econometric diagnostic tests, particularly, tests for heteroscedasticity (See Appendix I) and presence of severe multicollinearity in the model (Appendix II). Using Breusch-Pagan-Godfrey test in EViews 7 econometric software, an F-statistic of 1.1917 was obtained. It was not significant even at 10 percent alpha level of significance, implying that heteroscedasticity was not a problem in the model. These tests were deemed necessary in order to ensure the model used will not give spurious regression results in line with recommendations of Greene (2008) and Gujarati and Sangeetha (2007). The test for presence of severe multicollinearity in the model was done using Variance Inflation Factor (VIF) which was computed using SPSS 16 econometric package. According to Gujarati and Sangeetha (2007) any VIF of above 10 indicates a problem of severe multicollinearity for the particular variable in the model. In this analysis, none of the 9 explanatory variables had VIF greater 2 implying that the explanatory variables of the model used here were not under any threat of problematic multicollineairty. We therefore consider our model fit for further econometric analyses. The implicit form of the multiple regression model was: $Qs = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 + \mu)$.

The explicit form of the models is presented here.

3. RESULTS AND DISCUSSION

3.1 Distribution of Various Uses of Fuelwood in Kogi Households

The frequency distribution table in Table 1.0 gives the frequencies and percentages of the various uses of fuelwood in the study area. The results indicated that fuelwood is utilized mainly for cooking (63 %), followed by drying/preservation and for heating (13 %). It is not surprising that a very significant proportion of the consumers of fuelwood in the state (19%) used fuelwood for drying and preservation when one notes that Kogi State is one of the major producers of fish, cassava (including garri) and other food products which require preservation and drying.

Table 1: Distribution of households according to pattern of utilization of fuelwood

Sl. No.	Uses of Fuelwood	Frequency of Response	Percentage
1	Cooking	57	63.33
2	Drying/Preservation	17	18.89
3	Ironing	4	4.44
4	Heating	12	13.33
	TOTAL	90	100

Source: Field Survey, 2011.

That majority of the consumers used the product as a source of cooking energy also affirmed the earlier observation by Chukwu (2001) who indicated that over 70 percent of the total population of Nigeria relies on fuelwood or charcoal as their major source of energy for cooking and heating purposes.

3.2 Analysis of Fuelwood Profitability in Kogi State

Results of profitability analyses are presented in Table 2.0. The average revenue obtained by fuelwood sellers/farmers in the study area was N715,000.00. The total cost incurred per enterprise was N73,675.00. Labour had the highest percentage of total cost of production with 46.5%, followed by cost price of the fuelwood itself (36%) and transport expenses with 12.43%. The total variable cost constituted 95% while the fixed cost constituted just 5% of the total cost of production. The enterprise had an average net income of N541,325.00 per farmer in a production cycle of 12 months.

Table 2: Profit for the average fuelwood Sellers

Item Amount (N)	Total Amount (N)	Total Amount (N)
Revenue		
Annual Sales	715,000	
Total Revenue		715,000
Costs		
Cost Price	62500	
Transportation	21600	
Off-loading	8350	
Splitting of log	72360	
Total Variable Cost	164810	
Gross Margin (TR - VC)		550,190.00
Fixed Costs:		
Annual Rent	7000	
Depreciation on Barrow	800	
Depreciation on axe	680	
Depreciation on matchet	385	
Total Fixed Cost	8865	
Net Profit		**541,325.00**

Source: Field Data, 2010.

Profitability Index (PI), Rate of returns on Investment (RRI), Rate of Returns on Variable Cost (RRVC) and Operating Ratio (OR). The average PI for all farms was 0.76, indicating that out of every Naira earned, about 76 kobo accrue to the farmer as net income. Also, with an RRI of 312 percent, a farmer therefore earns N312 profit on every naira spent on waterleaf production. RRVC was estimated to be about 0.04% per production season. In other words, every N 1 cost incurred on variable inputs generates about N 0.04K. This suggests that improvement in the profitability of waterleaf production in the area will require increasing the efficiency of use of these variable inputs. Moreover, the OR of 0.23 indicates greater total revenue over total variable cost. It can therefore be concluded that fuelwood

production in the area is profitable. During the field work component of this study, most of the farmers expressed a high level of satisfaction with the profit level of the business.

Table 3: Profitability Estimates of Fuelwood

Measures of Profitability	Estimates
Profitability Index (PI)	0.757098
Rate of Return on Investment (RRI)	311.6885
Rate of Return on Variable Costs(RRVC)	0.042845
Operating Ratio (OR)	0.230503

Source: Field Data, 2010.

3.3 Factors Influencing Output of Fuelwood Supply in Kogi State

Results of regression analysis are presented in Table 4.0. Of the four models tried, it was found that the growth model (semi-log model) had the best fit based on its value of Akaike Information Criteria (AIC). It had an AIC of -2.0481, the lowest among the four and at the same time recorded high adjusted R-square and F-statistic (significant at 1% alpha level just like other counterpart models tried). The choice was not really dependent on adjusted R-Square because in modern econometrics, it had been advised that choice of best fit model among competing models should not be based on the strength of R-square but rather on considerations of signs of the coefficients with respect to economic theory, lowness of Akaike Information Criteria or Schwarz Criterion (Greene, 2008; Gujarati, 2006). The semi-log model met most of these criteria.

The adjusted R-Square (0.72) indicated that 72 percent of the variation in output of fuelwood among the suppliers in the sample was brought about by variation in the explanatory variables used in the model. The significant F-statistic affirmed that the hypothesis of no joint effect of the explanatory variables on the output of fuelwood in the sample remained rejected at 1 percent alpha level. The coefficient of years of formal education was significant at 1 percent alpha level and positively signed. The positive relationship implies that the more years a producer of fuelwood spend in attaining formal education the more the increase in output of his/her product would be. It can therefore be said that education has the power of giving farmers and traders an edge over their competitors since their level of awareness of market information and use of more efficient technology that will enhance their output or sales might be help them increase their productive capacities. Years of fuelwood business experience also returned a positive sign signifying its relevance in enhancing the productivity or supply levels of the producers and marketers of fuelwood in the State. The variable was significant at 1 percent alpha level. The relevance of these two socio-economic factors in influencing fuelwood supply had earlier been established by Ebe (2006) and the supply theory in Samuelson and Nordhaus (2008) who noted that socio-economic variables and special influences such as educational attainment, age of suppliers, professional experience and government policy could influence supply level positively.

The assertion in the theory of supply which also stated that market price of the commodity is a major force determining the supply curve was affirmed by the findings of this study too as it recorded a positively signed coefficient for this factor. The t-statistic of 1.9097 estimated for this variable indicated that the variable was significant at 10 percent significance level.

Table 4: Results of the multiple regression analysis/Production function estimates

Variables/Coefficients	Linear Model	Semi-Log Model (or growth model) {a}	Double-Log Model (Lin-log model)	Exponential Model
Intercept	b = 668962.3	13.47084	12.15594	-262604.6
t-ratios in parenthesis	(11.5612)***	(145.0653)***	(16.8221)***	(-0.6000)NS
Age of producer/seller	b = -375.4329	-0.000424	-0.006285	-2584.663
t-ratios in parenthesis	(-0.580564)NS	(-0.4086)NS	(-0.1469)***	(-0.0997)NS
Years of formal education	b = 5198.519	0.007974	0.061756	39382.97
t-ratios in parenthesis	(2.165612)**	(2.0698)**	(2.5009)**	(2.6330)**
Years of fuelwood business experience	b = 5904.531	0.005605	0.042022	47846.34
t-ratios in parenthesis	(4.8974)***	(2.8966)***	(1.3886)NS	(2.6102)**
Household size	b = -1071.632	-0.001298	-0.016534	-12603.5
t-ratios in parenthesis	(-0.6134)NS	(-0.4629)NS	(-0.8157)NS	(-1.0266)NS
Labour cost per annum	b = 0.030292	5.77E-08	0.051687	33289.02
t-ratios in parenthesis	(0.28655)NS	(0.3402)NS	(1.7953)*	(1.9090)*
Marketing expenses (transport, packaging, rates, taxes)	b = 0.281	3.24E-07	0.011378	13634.66
t-ratios in parenthesis	(0.7840)NS	(0.5626)NS	(0.2557)NS	(-0.5058)NS
Price of Kerosene (substitute)	b = -235.3001	-0.000495	-0.059778	-26285.33
t-ratios in parenthesis	(-1.0005)NS	(-1.3106)NS	(-1.4460)NS	(-1.0497)NS
Price of fuelwood per tonne	b = 18.79235	2.56E-05	0.106417	64260.54
t-ratios in parenthesis	(2.2522)**	(1.9097)*	(2.7345)***	(2.7261)**
Distance to the nearest forest	b = -26487.99	-0.045282	-0.12793	-84788.54
t-ratios in parenthesis	(-7.5352)***	(-8.0267)***	(-5.3183)***	(-5.8193)***
MODEL FIT TESTS				
Adjusted R-squared	0.76	0.717536	0.663433	0.731091
F-statistic	32.52	26.12048	20.49272	27.88528
Prob(F-statistic)	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Akaike Information Criterion	24.64	-2.048153	-1.872906	24.75541

Source: Econometric analysis output from EViews 7 software based on Field Data (2010).

Similarly, the distance of fuelwood producers and sellers from the forest (source of fuelwood supply) was significant at 1 percent alpha level and was negatively signed; indicating that the closer a farmer is to the forest the more likely his supply of fuelwood will be enhanced. This variable had a slope coefficient of -0.0453 which implied that on the average a proportional decrease of output of fuelwood had been recorded valued at the rate of -0.0453 naira for every kilometer that a supplier resides or settles farther from the forest. This also corroborates the economic theory which held that business should be cited closer to the source of their raw materials (Samuelson and Nordhaus, 2008).

4. CONCLUSION

Using appropriate farm management, statistical and econometric tools this study had found, among other things, that fuelwood which is used mostly for cooking and preservation/processing of farm and domestic products in Kogi State of Nigeria is a very important product whose supply or production/sales holds a great potential for income generation as it was found to be a very profitable business. In areas where forest is very dense and underutilized unemployed youths can be trained on the rudiments of sustainable harvesting and marketing of fuelwood products as a way of alleviating poverty and easing the burden of unemployment in Nigeria. Since education is a very important factor in enhancing the skills of suppliers of fuelwood products, government policy on compulsory formal education in form of Universal Basic Education (that is already ongoing) should be promoted in addition to making available extension officers who would be better equipped to train farmers or unemployed youths or graduates that may be interested in making huge profits and a more comfortable livelihood out of this enterprise whose potentials is yet to tapped optimally in the country. Those with more experience in the business are more likely to succeed in the business than novices but there are lots that can be learnt from those experienced suppliers if the new comers can team up with them by joining a cooperative that involves fuelwood suppliers. Those planning to start the business are equally to locate their firms closer to forests to enable them save costs of transport and gain easy access to the source of their inputs. It would also be advisable that the government should promote tree planting and agro-forestry to make forests ever closer to urban and rural dwellers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.191726	Prob. F(9,80)	0.3119
Obs*R-squared	10.63977	Prob. Chi-Square(9)	0.3012
Scaled explained SS	16.79789	Prob. Chi-Square(9)	0.0520

APPENDIX 2

Results of Collinearity Diagnostic

Coefficients[a] Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	668962.260	57862.528		11.561	.000		
	Age of Farmers in years	-375.433	646.669	-.034	-.581	.563	.800	1.249
	Household size (count)	-1071.632	1746.999	-.033	-.613	.541	.951	1.051
	Years spent on formal education	5198.519	2400.485	.141	2.166	.033	.633	1.580
	distance from the nearest forest in kilometers	-26487.992	3515.230	-.486	-7.535	.000	.644	1.552
	Years of fuelwood production and marketing experience	5904.531	1205.632	.336	4.897	.000	.571	1.752
	Price of kerosene in naira per litter	-235.300	235.178	-.055	-1.001	.320	.880	1.137
	Value of labour input expenses in Naira per farm	.030	.106	.016	.287	.775	.857	1.167
	Total Marketing expenses (including packaging, transport and storage)	.281	.358	.042	.784	.435	.949	1.054
	Price of fuelwood in naira per kilogramme	18.792	8.344	.157	2.252	.027	.555	1.801

a. Dependent Variable: output of fuelwood supplied in Naira per annum

Source: Output from SPSS 16.0 based on Field Survey, 2010.