*Full Length Research Paper*

# Analysis of Firewood Expenditure in Bauchi State, Nigeria

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**Firewood as a source of energy plays a vital role in household energy requirements. Due to accumulative economic hardship in the country, many people are finding it increasingly difficult to afford conventional fuels. This study measures empirical estimate and determinants of firewood expenditure in Bauchi State. To achieve these objectives, three hundred and sixty firewood buying units (households) were selected using a combination of random and purposive sampling techniques. The data were analyzed using descriptive statistics, independent t-test, and regression analysis. The findings of the study reveals that most firewood users had formal education and the mean family size per firewood buying unit was found to be 9.0 in Sudan Savanna and 7.0 in Guinea Savanna ecological zones of the State. The study has also equally revealed that firewood expenditure, family's income level and price of kerosene were found to be significantly (p<0.001) different between Sudan Savanna zone and Guinea Savanna ecological zones. Income elasticity of demand was reported to be less than 1. Result of the regression analysis has also revealed that family's income level, kerosene price and family size have significant (p<0.01; p<0.001 and p<0.01) influence on firewood expenditure. Accordingly, estimated firewood expenditure by the regression model in dry season per household was shown to be ₦ 5017.21 in Sudan Savanna zone and ₦ 7225.67 in Guinea Savanna zone. In wet season, estimated mean firewood expenditure per household was reported to be ₦ 6025.92 and ₦7570.98 per month in Sudan and Guinea Savanna zones respectively. Conclusively, the findings of the study have shown that firewood expenditure and price of kerosene were higher in wet season than in dry season. Some households were also shown to spend relatively higher proportion of their income on firewood expenditure. To cushion the effect of this, the study has recommended among other things the adoption of improved energy efficient stoves to curve wasteful spending. Also, the price of kerosene (firewood closest substitute) should be liberalize and be made easily accessible at a price which people can afford.**

**Keywords:** Firewood Expenditure; Sudan Savanna; Guinea Savanna; Dry Season; Wet Season

## 2.1 INTRODUCTION

Nigeria with a current population of over 180 million and with annual growth rate of 3.2% (NPC. 2016) is no doubt the most populous country in Africa. Its urban population as a percentage of total population has grown from 20% in 1970 to over 37% (Adegbulugbe and Akinbami, 1992). The country, an oil exporter with the largest economy in Africa is also blessed with other various form of primary energy

sources, both renewable and non-renewable. The renewable energy sources include solar, wind, hydro and biomass energy; while the non-renewable energy included fossil fuel and nuclear. The household sector is the largest energy-consuming sector in the economy. It accounts for about a quarter of total commercial energy and over 90% of traditional fuels, especially firewood (Obueh, 2000).

Biomass fuel remained the commonest source of household energy in Nigeria. In 1992 alone, firewood and charcoal production were estimated at 55 million tons (Obueh, 2000). More than half of the 9.6 million hectares of rain forest belt in the south of Nigeria has been used to meet the demand for firewood in rural and urban areas. Studies on firewood supply in developing countries have concluded that firewood scarcities are real and will continue to exist, unless appropriate approaches to resource management are undertaken (Anorld 1991, SADCC, 1992). Increased efficiency of utilization through efficient technologies can therefore be considered as one of the major prerequisites for attaining sustainable development in developing countries. Over the years, there is compelling evidence which suggests that firewood demand is increasing in Bauchi State. To cope with this growing demand, numerous firewood selling points had emerged, leading to systematic destruction of the State's forest reserves. Presently, all the State's forest reserves were heavily encroached. Illegal cutting of trees for firewood were the major disturbance noticed in all the forest reserves according to the information obtained from Bauchi State Ministry of Agriculture and Natural Resources. Undoubtedly, such an over whelming and persistent dependence on biomass fuels for household    energy has given rise to developmental concerns on several fronts and has become a serious issue to many developing countries. Consequently, the objectives of this paper primarily is to;

i. Determine the socio economic characteristics of firewood buyers
ii. Measure the determinants of firewood expenditure and
iii. Undertake empirical estimate of firewood household expenditure.

## 2.0    METHODOLOGY

### 2.1    Study Area

Bauchi State has a total land area of about 49,259.01 square kilometers, representing about 5.3% of Nigeria's total land mass. Out of this land mass, only 34,481 square kilometer was under cultivation (BSADP, 2011). The State lies between latitude $9.3^o$ and $12.30^o$ North and longitudes $8.5^0$ and $11^0$ East. According to the figures released by National Population Commission, the State has population of 4,676,465 people (NPC, 2016) and is divided into 20 Local Government Areas. It share common borders with 7 States, namely, Yobe and Gombe State to the North-East, Taraba and Plateau States to the South, Kaduna State to the West and Kano and Jigawa States to the North. The State enjoys both rainy and dry seasons with maximum rainfall of about 700mmm per annum in the North to about 1,300mm per annum in the South. The vegetation zones of the State consist of Northern Guinea Savanna and Sudan Savanna.

### 2.2    Sampling Procedure

A combination of random and purposive sampling techniques was employed in selecting the respondents. Three Hundred and Sixty firewood buyers were chosen for the study. Six Local Government Areas (LGAs) were randomly selected from each of the two ecological zones in the State, and in each LGA selected, three villages/towns were in-turn purposively selected and in each village or town selected, ten (100 firewood buying units were randomly picked for the data collection.

### 2.3    Tools of Data Collection

The variables used for the data analysis of determinants of firewood expenditure were; family's disposable income, price of kerosene, family size, location and seasons under which expenditure on the commodity was made. Family's disposable income and price of kerosene were all obtained using structured questionnaires and are measured in Naira (₦) per month. Absolute number of family size was also obtained using structured questionnaires, while location and season are two dummy variables used to capture the seasonal variations in firewood expenditure in the two ecological zones of the State.

### 2.4    Analytical Techniques

In order to achieve the stated objectives, descriptive statistics, independent t-test, and correlation and regression analysis were used for the data analysis.  These models were all available in the SPSS Software. Descriptive statistics was used to analyze objective number 1, while objectives 2 and 3 were analyzed with the aid of regression and independent t-test.

### 2.4.1 Hypothesis Testing

Testing the overall significance of the regression refers to testing the hypothesis that none of the independent variables help to explain the variation of the dependent variable about its mean. Therefore, the null hypothesis used in this study is succinctly given as;

$H_o$: $b_1 = b_2 = b_1$ . . . . . . . . . . . . . $nj = 0$ Against the alternative hypothesis

$H_1$: $b_1 \neq b_2$

### 2.4.2 Testing of Significance

The overall significance of his study can be tested with the ratio of the explained to the unexplained variance. These fallow an F distribution with $j - 1$ and $n - j$ degrees of freedom where;

n = number of observation and

j = is the number of parameter estimate

The coefficients of the estimated parameters were tested at 0.05, 0.01 and 0.001 level of significance. Thus, it follows that if the calculated F-ratio exceeds the tabular value of F at any of the conventional level of significance and degrees of freedom, he hypothesis is accepted that the regression parameters are not all equal to zero and the $R^2$ is significantly different from zero.

### 2.5 Model Specification for Firewood Expenditure

Consumption theory indicates that people increase their consumption expenditure C as their disposable income Yd increases. This can be stated in explicit linear equation form as;

$$c = b_0 + Yd \dots\dots\dots\dots\dots\dots\dots \text{ (1)}$$

Where the parameter is an unknown constant, the parameter $b_0$ is the slope coefficient representing the marginal propensity to consume, MPC. Since the even people with identical disposable income are likely to have somewhat different consumption expenditure, the theoretical and deterministic relationship in equation (1) must be modified o include a random disturbance term

$$C = b_0 + Yd + U \dots\dots\dots\dots\dots\dots \text{ (2)}$$

Equation (2) is further re modified to accommodate additional variables postulated in this model:

$$Fwex = b_0 + b_1 Yd + b_2 PK + b_3 FS + Loc + Sea + U$$

Where:  Fwex = Firewood expenditure (Naira)

Yd = Disposable income (Naira)

PK = Price of kerosene (Naira)

FS = Family size

Loc = location

Sea = season

In view of the aforementioned economic theory, the following apriori theoretical assumptions are therefore made in this study:

$$b^1 > 0, b^2 > 0, b^3 > 0$$

### 3.0 RESULTS AND DISCUSSION

### 3.1 Socio-economic characteristics' of Firewood buyers

**Table 1:** Socio-economic characteristics' of Firewood buyers

| Variables | Sudan Savanna | | | | Guinea Savanna | | | |
|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Mean | St.D | Min. | Max. | Mean | St.D |
| Age | 19.0 | 79.0 | 36.8 | 8.0 | 20.0 | 63.0 | 37.8 | 8.0 |
| Household Size | 3.0 | 17.0 | 9.0 | 3.6 | 2.0 | 25.0 | 7.0 | 4.7 |
| Years of Formal Educ. | 0.0 | 20.0 | 8.0 | 6.5 | 0.0 | 22.0 | 7.3 | 6.4 |
| Years of Family Exp. | 2.0 | 60.0 | 13.1 | 11.3 | 2.0 | 45.0 | 12.6 | 9.4 |

The mean age of firewood buyers in Sudan Savanna zone as indicated in Table 1 was shown to be 36.8 years. In Guinea Savanna zone, the mean age was almost similar to the one obtained under Sudan Savanna zone (37.8). The mean family size was 9.0 and 7.0 in Sudan Savanna and Guinea Savanna respectively. This is slightly lower than the findings of Silvi Consult (1991) where they reported an average family size of 10.7 in the Seven Northern Nigeria States as a whole (study area inclusive). Nevertheless, these two findings are still larger than the General house hold survey under taken by National bureau of statistics (2015), were an average household size of 5.9 and 4.9 persons was reported in rural and urban areas respectively. Education is an important variable considered in many field of human endeavor. The response pattern as indicated in Table 1 revealed that majority of firewood buyers in the two eco-zones had some formal education. The mean value of years of formal education was found to be 8.0 in Sudan Savanna and 7.3 in Guinea Savanna zone. This is in line with the findings of Maurice *et al* (2015). Similar findings was also reported by Umaru and Wammako (1999) where they reported that a large proportion of firewood buyers within Sokoto metropolis (87%) had formal education. Another underlying features of these findings suggested that users of the commodity cut across educational levels. On the other hand, the mean value of family experience in the two ecological zones was found to be nearly identical; 13.1 and 12.6 years in Sudan and Guinea Savanna zones. This could likely suggest that the firewood consumption patterns in the two ecological zones are likely to be similar.

**Table 2:** Result of the Independent t-test for parameter estimates for firewood Expenditure according to location in Bauchi State

| Location | Season | Parameter estimates | Mean | Means Difference | t -value |
|---|---|---|---|---|---|
| **Sudan Savanna:** | | | | | |
| Dry | | Firewood expenditure(₦/month) 1008.66 | | | |
| | Wet | | 1307.50  - 298.83 | -11.334*** | |
| Dry | | Family income(₦/month) 11855.00 | | | |
| | Wet | | 11855.00 | 0.00 | 0.000$^{NS}$ |
| Dry | | Kerosene price(₦/month) 1561.67 | | | |
| | Wet | | 2342.78 | -781.11 | -16.048*** |
| | Dry | Family size | 9.21 | | |
| | Wet | | 9.21 | 0.00 | 0.000$^{NS}$ |
| Guinea Savanna: | | | | | |
| | Dry | Firewood expenditure(₦/month) | 937.22 | | |
| | Wet | | 1268.44 | -331.22 | -7.844*** |
| | Dry | Family income(₦/month) | 19988.89 | | |
| | Wet | | 19988.89 | 0.00 | 0.00$^{NS}$ |
| Dry | | Kerosene price(₦/month) 1640.00 | | | |
| | Wet | | 2664.44 | -1024.44 | -12.989*** |
| | Dry | Family size | 7.31 | | |
| | Wet | | 7.31 | 0.00 | 0.00$^{NS}$ |

\*\*\* Significant at P<0.001
NS  Not Significant

**Table 3:** Result of the Independent t-test for parameter estimates for firewood Expenditure according to season in Bauchi State

| Season | Location | Parameter estimates | Mean | Means Difference | t -value |
|---|---|---|---|---|---|
| **Dry:** | | | | | |
| | **Sudan Savanna** | Firewood expenditure(₦/month) | 1008.67 | | |
| | Guinea Savanna | | 937.22 | 71.44 | 2.208* |
| | **Sudan Savanna** | Family income(₦/month) | 11855.00 | | |
| | Guinea Savanna | | 19988.89 | -8133.88 | -13.205*** |
| Sudan Savanna | | Kerosene price(₦/month) | 1640.00 | | |
| | Guinea Savanna | | 1561.66 | 78.33 | 1.399*** |
| | Sudan Savanna | Family size | 9.21 | | |
| | Guinea Savanna | | 7.31 | 1.89 | 4.268*** |
| **Wet:** | | | | | |
| | Sudan Savanna | Firewood expenditure(₦/month) | 1307.50 | | |
| | Guinea Savanna | | 1268.44 | 39.06 | 1.033$^{NS}$ |
| | Sudan Savanna | Family income(₦/month) | 11855.00 | | |
| | Guinea Savanna | | 19988.89 | -8133.88 | -13.203*** |
| Sudan Savanna | | Kerosene price(₦/month) | 2664.44 | | |
| | Guinea Savanna | | 2342.77 | 321.66 | 4.356*** |
| | Sudan Savanna | Family size | 9.21 | | |
| | Guinea Savanna | | 7.31 | 1.89 | 4.268*** |

*** Significant at P<0.001
* Significant a P<0.5
NS Not Significant

As shown in Table 2, mean firewood expenditure and kerosene price were found to be significantly (P<0.001) different between wet and dry season in Sudan Savanna as well as in Guinea Savanna ecological zones.

Result of the independent t-test of the parameter estimate according to season (Table 3) reveals on the other hand, that firewood expenditure, family income level and price of kerosene were all found to be significantly (P<0.001) different between Sudan Savanna and Guinea Savanna ecological zones. In the same vein, mean family income level and price of kerosene as well as family size were equally observed to be significantly (P<0.001) different between Sudan and Guinea Savanna zones. Both firewood expenditure and price of kerosene were found to be higher in wet season than in dry season. This indicates that firewood demand and prices of the two commodities were moving in the same direction. Seasonal price and demand fluctuations of firewood are well known, e.g. Anthony and Ojo (2012), Yisa*et al* (2012) and Silvi Consul (1991).Consumers were generally reported to spend more on firewood during wet season than in dry season. The period of lowest price was found to be on hot dry season between March-April-May. The reason for firewood price fluctuations is primarily due to labor supply factors.

## 3.2    Estimated Firewood Expenditure in Bauchi State (Naira/month)

**Table 4:** Regression Result for Firewood Expenditure in Bauchi State

| Parameter estimate | Coefficients | t-value |
|---|---|---|
| Constant | -5.931*** | -9.102 |
| Family income (₦/Month) | 0.250*** | 7.296 |
| Kerosene price (₦/Month) | 0.875*** | 43.538 |
| Family size0.031** | 2.710 | |
| Location0.380*** | 13.003 | |
| Season-0.130*** | -6.204 | |
| $R^2$ 82.8 F-value570.2*** | | |

  ***   Significant at P<0.001
  **      Significant a P<0.01

Four functional forms of regression model viz; linear, semi log, double log and inverse log were tested to determine the relationship between firewood expenditure, disposable income, price of kerosene and family size in Bauchi State. Based on the value of coefficient of determination and test of significance, the double log functional form was selected as the best functional form that explains the relationship existing between dependent and independent variables as presented in Table 4. This model indicated that 82.8% of the total variation in firewood expenditure is due to the influence of the independent variables. All the explanatory variables tested under the model were shown to be significantly related to firewood expenditure. These were; family income level (P<0.01); price of kerosene (P<0.001), and family size (P<0.01). The sign of the coefficients were all in consistent with our theoretical assumptions. This result is in line with the findings of Anthony and Ojo (2012), Leach (1992), Anderson and Fishwick (1984).

The study further revealed that income elasticity of demand was reportedly to be 0.25. i.e., less than 1. This implies that a percentage increase in the demand of firewood is likely to be less than percentage increase in income over time. The sign of the coefficient for income elasticity of demand was found to be positive. Heyman (1997) has reported that normal goods have a positive income elasticity of demand. The parameter estimate of the price of kerosene was also found to be positive. This suggests that the two commodities are compliments. Accordingly, estimated mean monthly firewood expenditure per household in dry season was found to be N5017.21 in Sudan Savanna zone and N7225.67 in Guinea Savanna zone. On wet season, estimated mean firewood expenditure per household was reported to be N6025.92 and N7570.98 per month in Sudan and Guinea Savanna ecological zones respectively. This findings is potent in view of the fact that the minimum wage agreed by Federal and State government currently stood at N30,000, which represent on the average 22.66% of monthly income of some respondents. It can be safely deduced that some households in the State nowadays are spending large proportion of their income on firewood. This is in line with the findings of Mas'ud (1991), where he reported that the poorest households in Zanzibar, Tanzania used to spend as much as 40% of their income on firewood. It is instructive to note presently that there is a wide spread agreement among consumers in the State that firewood prices has risen steadily in the past decades. A continuing upward trend in demand is widely predicted on the basis of both household and non-household consumer's expectations. This expectations are related to technical and supply considerations, as well as price relatives amongst possible alternatives. The equipment for cooking with gas, electricity or even kerosene is more costly than virtually costless three-stone firewood stoves. More ever, firewood supply is more reliable than that of any of its competitors. The price factor itself is expected to operate in favor of firewood in the next foreseeable future, as long as subsidies are removed from the prices of petroleum products. Momah and Soaga (1999) reported that in 1980 - 1993, the official price of 5 liters of kerosene rose by 6000% from N0.50 per 5 liters in 1980 to N30 per 5 liters in 1993. Similarly, from 1993 - 2019, the price of the same product has increased by 3333.33% from N30 in 1993 to N1000 in 2019.

## 4.0 CONCLUSION AND RECOMMENDATIONS

The study has shown that most firewood users had formal education and the mean family size per firewood buying unit (household) was found to be 9.0 in Sudan Savanna and 7.0 in Guinea Savanna zone. The study has also revealed that firewood expenditure, family's income level and price of kerosene were found to be significantly (P<0.001) different between Sudan Savanna and Guinea Savanna ecological zones. Income elasticity of demand was reported to be < 1. Result of the regression analysis has also revealed that family's income level, kerosene price and family size have significant (P<0.01;P<0.001;P<0.01) influence on firewood expenditure. Meanwhile, mean firewood expenditure in dry season per household was shown to be N5017.21 in Sudan Savanna zone and N7225.67 in Guinea Savanna zone. In wet season, estimated mean firewood expenditure per household was reported to be N6025.92 and N7570.98 per month in Sudan and Guinea Savanna zones respectively. Conclusively, the findings of the study has shown that firewood expenditure and price of kerosene were higher in wet season than in dry season. Some household were also shown to spent large proportion of their income on firewood. To cushion the effect of this, the study has recommended among others that;

✓ Adoption of improved energy-efficient firewood stoves should be promoted to reduce wasteful spending on the commodity.

✓ Price of kerosene (firewood closest substitute) should be liberalize and subsidized in order to make it easily accessible at a price that people can afford.

✓ The dynamics of household energy should be integrated in to the National energy policy in order to address the lingering problems of seasonal variations in the supply and prices of domestic household cooking energy.

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